National Commission on Innovation & Competitiveness Frontiers

2020 Compendium of Working Group Dialogues

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Letter From the President

Dear Colleagues,

In today's environment, leadership and expertise are needed now more than ever to accelerate and sustain U.S. economic and national security—as well as global competitive advantage. The National Commission's Working Groups comprise such leaders—each of whom has dedicated time and knowledge this Spring to prioritizing critical policy platforms and nascent recommendations for the National Commission.

Following the August 2019 launch of the National Commission—and a multi-month recruitment process to identify Working Group members—the Commission kicked off strongly in 2020, with a January "National Commission Community Launch Conference" at Arizona State University, hosted by its President—and the Council's University Vice Chair and Commission Co-Chair—Dr. Michael Crow. There, the Commission's Working Group members—as well as a few of our Commissioners, their Advisors and Outreach/Engagement leaders—met en masse for the first time. Nearly 200 leaders in total gathered to begin a series of deep conversations around three critical themes designated by the National Commissioners:

1. Developing and Deploying at Scale Disruptive Technologies—This group is charged with, among other things,mapping promising, strategic technology pathways to enhance productivity and economic growth for the United States.
2. Exploring the Future of Sustainable Production and Consumption, and Work—This group is examining the ever-evolving disruption underway in the production and consumption of goods, as well as the rapid evolutions unfolding in the American workforce.
3. Optimizing the Environment for the National Innovation Ecosystem—This group is exploring ways to optimize the entire system in which the nation's innovators and enterprises operate—from capital costs, intellectual property, standards and regulations, etc.—and examining the critical roles the private sector, and local, state and federal governments must play.

Unknown to everyone leaving the successful ASU launch conference was the exponentially escalating global health crisis that has, to this day, completely transformed how we all conduct our daily business. Empowered by an online collaboration portal and a mantra to conduct business in a more innovative fashion, the Commission Working Groups quickly transformed in scale and scope—moving away from a model of in-person mini-summits and workshops to regularly recurring, twice-a-week, moderated online dialogues. In the first eight to nine weeks of stay-at-home orders, the National Commission's Working Groups have engaged in nearly 50 virtual deliberations and dialogues, engaging hundreds of leaders.

During this period, Working Group members deliberated over numerous policy areas, raised many to urgent an priority status, began to articulate potential recommendation pathways, and highlighted critical issues that will require further, deeper analysis. In the near term, COVID-19 and the virus economy have demonstrated the need to strengthen U.S. resiliency, secure U.S. supply chains, and bolster the nation's capacity to innovate, create and make. For longer-term competitive advantage, Working Group members emphasized the needs to invest in critical technology platforms—from basic research to development and deployment; and, to create pipelines of opportunities for innovation, engaging many more Americans from diverse backgrounds—from the earliest levels of education to the highest—in the nation's innovation economy.

In the following pages, the Council is providing an in-depth look into this rich Commission Community conversation—sharing summaries from each of the Working Group sessions, with the intention to provide insight into the genesis of the key priorities of "Phase One" in 2020; and to shine the light on the path forward in "Phase Two," as the Working Groups hone ideas into actionable recommendations and help shape the Commission's year one call to acion.

We are grateful for the support, expertise, time, and leadership of the Working Group members during these challenging times. Together we will chart a path toward a more inclusive, creative, resilient and innovative economy.

Sincerely,

Deborah L. Wince-Smith

Deborah L. Wince-Smith
President & CEO
Council on Competitiveness

Working Group 1: Developing and Deploying at Scale Disruptive Technologies

Working Group 1 Summary

The virtual Working Group sessions began on March 31st and completed this first phase on May 22nd. This 'Phase I' of the Working Group sessions yielded insights and areas for further assessment ahead of the National Commissioner's meeting on June 16th. Below are highlights and themes from each of the Working Groups.

The Developing and Deploying at Scale Disruptive Technologies Working Group considered if the United States is maintaining a competitive advantage globally in developing and deploying disruptive technologies. In order to maintain competitive advantage, the Group determined it needed take an inventory of U.S. strengths and weaknesses pertaining to disruptive technology. Federal research and development (R&D) funding is at a 60 year low with R&D spending at 0.6 percent of U.S. GDP and 2.8 percent of total federal outlays in fiscal year 2019. With this decreasing focus from the U.S. government, he nation's public and private sector communities are facing challenges in determining how best to lever resources and drive long-term innovation capacity.

- Working Group members agreed that the United States is facing growing challenges to its technology supremacy in multiple, critical arenas—especially from China. This potential loss of long-term tech supremacy poses severe risks and challenges to U.S. innovation. The United States must take a hard look at key technology areas, and ask on a case-by-case basis which are crucial for domestic development and production. Key technology areas discussed include advanced microelectronics, artificial intelligence, advanced computing, quantum information sciences, communications, energy, biotechnology and material science based applications.
- Working Group members also discussed a shift in focusing from single technologies to streams or pillars of key capabilities that would combine to drive productivity growth and disruptive innovation across sectors. Platform-based capabilities could yield innovations in this regard as advances could enable, for example, expanded prototyping and experimentation efforts to accelerate technology maturation. This would also provide access and resources for innovators outside the traditional channels of scientific research—breaking down traditional stovepipes in scientific research and deployment to the marketplace.
- Regarding the challenge of scaling, Working Group members stressed the importance of geography and resources. Without addressing the concentrated nature of funding—including but not limited to venture capital—by industry and geographic region, most of the country will lack the capacity to scale up innovation in a meaningful way. An additional challenge with scaling technologies relates to intellectual property, especially negotiation of technology transfer agreements between academia and industry. The current COVID-19 pandemic has motivated some stakeholders to develop solutions because of the critical importance of timely response.

- Working Group members also identified a potential opportunity in lowering the barrier for innovation activities by calling for broadening and deepening of entrepreneurship initiatives at universities. While many universities have expanded entrepreneurial programs in recent years, scaling is still needed to include a more diverse base of potential innovators and entrepreneurs, additional incubators and accelerators, faculty externships at companies, and executives-in-residence.
- The development of novel, agile organizational designs are needed at universities to improve innovation outcomes—amplifying atypical combinations of talent and resources often at the heart of transformational/disruptive innovation.

To view video and read full transcripts of each Working Group session, log in to the National Commission Community Online Portal. Video and transcripts are available within Working Group Rooms.

Working Group 1 Calls March 31

Overview from ASU

Ms. Kathy Trimble summarized the discussions the Working Group had at the January launch conference at Arizona State University. Among important topics discussed were the overall state of the economy, America's industrial base, and the degree to which America's investment in new technologies should be guided by a national strategic plan. The conference goers agreed that America has many regional economies, and what works in one place may not scale or work well in another. They also felt it was important for the U.S. to prioritize which emerging technologies to focus on, as U.S. government and industry may not be able to invest in every disruptive innovation. There was strong consensus around the need for greater partnership, including transparency and collaboration via public-private partnerships. Particular fields the Working Group felt it important to focus on were manufacturing, biogenomics, and semiconductors for next-generation microelectronics. Participants stressed the need to identify how to engage in those spaces, whether through incentive programs, funding, regulatory policy, or other tools. Finally, the ASU participants discussed the tradeoffs between data sharing, openness, and transparency on the one hand, and national security on the other, particularly regarding academic research and international students and academics.

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Concept of Industrial Policy

Participants in the call had questions about the connotations of the term "industrial policy" to describe a national strategy for emerging technology. Mr. Bill Briggs of Deloitte asked whether the focus was primarily on enabling technologies or the end-use products and innovations that disruptive technology enables. Ms. Kathy Trimble noted there was debate among the Launch Conference attendees over this matter, and that the two were interconnected. Dr. Paul Hommert, formerly Director of Sandia National Laboratory, questioned whether "objective" would better describe a national strategic plan than something connoting specifics, like "policy." He also cautioned against replicating models from competitors with vastly different political and economic systems. He cited the defense industry's interaction with the federal government as an example to follow in framing strategic investments, characterizing it as a "meta-policy space." Dr. Tony Tether, formerly Director of the Defense Advanced Research Projects Agency (DARPA) asked for specific examples of what a national strategy might entail, citing the 1960s Moon Mission as an "objective" rather than a "policy." The Honorable Deborah L. Wince-Smith cited the Council's recent engagements on developing a strategy for manufacturing next-generation microelectronics to obviate Moore's Law as one such case. She also stressed that semantics were less important than the discussion of the issue.

COVID-19

Mr. Andre Doumitt of the Aerospace Corporation asked if the Commission should adjust its focus in light of the significant disruptions to the economy stemming from the COVID-19 pandemic. Mr. Chad Evans responded that it was likely the Commission would primarily focus on longer-term challenges, but that the upcoming meeting of the Council's Board, which includes the co-chairs of the National Commission, would be discussing the Council's response to COVID-19 among other topics shortly, and that the Council in general and National Commission in particular would likely weigh in if its work was especially relevant. He cited questions of resiliency and sustainability as examples. Dr. Hommert predicted that an event as significant as the pandemic would inevitable have long-term consequences that would naturally intersect with the Commission's work. He distinguished between immediate responses to the crisis, knowledge and experience gained from the crisis, and the process of extending and applying those lessons to other emerging scenarios in the future. Ms. Trimble noted that the pandemic provides a case study of the challenges and opportunities in deploying advanced technology to address a crisis. Mr. Evans cited a discussion between Council leadership and Chairman Dr. Mehmood Khan on the structural issues facing the nation going forward that can be addressed with innovation.

Education and Technological Focus

Mr. Guy Snodgrass of Defense Analytics brought up the issue of education and training, both for workers and executives, as an emerging issue in developing and scaling technologies. He described his time working as a special assistant to General James Mattis at the Department of Defense, and how the directors of the Artificial Intelligence program Project Maven cited a shortage of AI-literate workers as their major obstacle, ahead of technology and data. Dr. Robert Dixon, formerly of PepsiCo, urged the group to focus on specific technologies to identify as candidates for scaling, arguing that doing so would make it much easier to develop specific recommendations. He pointed out that some technologies may be held back currently because of issues of worker training, others by insufficient or inadequate partnerships, and so on. He recommended prioritizing no more than three areas. Ms. Trimble welcomed detailed suggestions by the group on technologies to invest in, and Mr. Evans mentioned the Council's collaboration with Deloitte in producing a report on advanced manufacturing technologies, and the challenges and opportunities facing U.S. firms in maintaining or establishing leadership in each of them.

Supply Chain Security/National Security

The final major participants discussed was the security of America's advanced technology supply chains, and of the role of national security considerations in shaping the Working Group's work. Mr. Snodgrass cited the need for executives to trade off between profitability and security in their offshoring decisions, but believed that thoughtful and deliberate decisions by business leaders could strike an appropriate balance. Dr. Bernard Arulanandam of the University of Texas, San Antonio noted that the COVID-19 pandemic has illustrated the urgency of addressing supply chain security issues by demonstrating America's reliance on multinational supply chains during periods of crisis. Dr. Tether stated that national security threats have historically driven American technological innovation, using the examples of semiconductors, designed to protect the guidance systems on missiles, and AI, designed to reduce human error in Sonar detection caused by fatigue. Dr. Hommert expressed concern that the predominance of private industry in research investments made collective national focus on strategic priorities more difficult, while Dr. Tether believed it still provides a powerful incentive. Dr. Gene Robinson of the University of Illinois at Urbana-Champaign emphasized the need for the country to incorporate predictive functions into advanced technology, as the current pandemic was predictable but still caught the nation off-guard.

Next Steps

Ms. Trimble and Mr. Evans encouraged the participants to continue their discussions online via the online collaboration platform, and went over the schedule and topics for the remaining calls for the group, including another introductory call for the Working Group on Thursday afternoon.

Working Group 1 Calls April 2

Recapping Arizona State University Community Launch and Setting the Stage

The Honorable Deborah L. Wince-Smith welcomed the group and praised the discussions at the Arizona State Launch Conference in January. She encouraged participants going forward to think about the ways the COVID-19 pandemic might be relevant to the group's discussions, including issues of supply chain resiliency, cyber security, and work and unemployment. Mr. Chad Evans set the stage for the group's upcoming milestones, including a virtual Commissioners' meeting in June, possible in-person Commissioners' meeting in August or September, and the National Competitiveness Forum in December when Year 1 findings will be released. Mr. Bill Bates discussed the ongoing Advanced Computing Roundtable and University Leadership Forum, and highlighted the similarities in the topics being discussed between these groups and the Working Group.

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Ms. Kathy Trimble summarized the discussions from the January Launch Conference. The first theme was the economy as a whole, including how to scale and deploy disruptive technologies across the ecosystem given the challenges and opportunities in the economic landscape. Not all solutions that work in one region or local economy will scale or be successfully replicated elsewhere because of the diversity of local conditions. The Working Group should survey what does and doesn't work around the country and determine what solutions are transferable. A related issue is that of access to capital, which includes not only money, but also the education pipeline, training, standards, regulations, and other structural issues. The second theme was strategic priorities. Should the United States develop a list of emerging technologies, or enabling structures, to prioritize for investment and scaling? It is possible that the country will not be able to invest fully in every new technology, so identifying which innovations, such as 5G or Artificial Intelligence, require an all-of-nation strategic approach to steer funding and research. The final theme was America's industrial base. Which elements of the national level infrastructure are most crucial to supporting key sectors of the economy, and how can they incorporate the entire research and development ecosystem? Ms. Trimble also suggested topics for "deep dive" discussions centered around developing or maintaining U.S. leadership in key areas, including manufacturing, biogenomics, and semiconductors. She also encouraged discussion of the balance between openness of research and national security, and of partnership and contract models to facilitate collaboration and technology transfer from labs and universities to the market.

Technologies vs. Applications

The group debated whether its focus should be on specific end-use technologies, or whether it should focus on market and application spaces and platforms that allow for the deployment of multiple technologies. Mr. Dave Copps of Worlds Enterprises characterized AI as an apex technology that will be part of nearly every future disruptive innovation, and cited both AI and 5G as areas for greater investment and collaboration between the private and public sector. Dr. Al Pisano of the University of California, San Diego highlighted sustainable smart mobility as an application space that ties in AI with other emerging technologies. Mr. Mark Minevich of Going Global Ventures advocated the development of specific solutions that impact government, society, policy, and industry, rather than specific technologies. He stressed the need for American companies and venture capitalists to be pioneers in adopting disruptive technologies across all sectors to create a vibrant digital economy. He estimated that the digital economy could add $17 to $19 trillion annually in value from greater productivity and innovation across the world, and characterized the Commission as essential to ensuring the United States captures a substantial share of that added value and remains a leader in disruptive technology.

Mr. Evans noted the Council's emphasis on innovation as the driver of productivity growth that is key to long-term prosperity for all Americans. He characterized the Working Group's mission as being focused on solutions for driving productivity growth through the development and scaling of new technology. He cited as an example the need for a replacement technology for semiconductors due to the looming end of Moore's Law. He encouraged the group to focus on the portfolio of technologies and application spaces that will set the next generation of Americans up for success in the global marketplace. Ms. Wince-Smith added that the group needed to focus on both technologies and business transformation. She cited the example of the Council's creation of the first "critical technology" list in the 1980s, which helped shaped public investments in R&D and public-private partnerships.

Interdependence

Dr. Arun Rai of Georgia State University characterized the key theme in the group's deliberations as that of interdependence. He initially identified three dimensions of interdependence: between foundational technologies, such as AI, and their application level deployment, such as smart cities; between the

public sector and private or university sector; and between technology and people, as disruptive innovations disrupt skills and needed skill sets in addition to industries. Later, he noted the interdependence between patenting and other forms of intellectual property protection on the one hand, and the dynamism and innovativeness of open-source data, as in software development, on the other.

Prototyping

Dr. Pisano suggested the group identify promising innovation platform technologies and advocate for them at a national level. He cited the example of the MOSIS program for semiconductor research, and said such a platform would provide 24/7 internet access, design tools, and baseline technology to allow innovators from around the country to collaborate and work from a shared infrastructure. He noted its particular utility in the current COVID-19 pandemic, when innovators don't have access to labs and could make use of virtual collaboration spaces. It would also provide access to resources for innovators outside the traditional channels of scientific research. Ms. Trimble agreed with the suggestion and characterized it as the "connective tissue" that would provide platforms and help identify promising sectors for investment going forward.

Short- and Long-Term COVID-19 Recovery

The group discussed the short- and long-term weaknesses in the country's economic system and infrastructure exposed by the ongoing pandemic, and how to use the lessons learned from the crisis to fuel a dynamic recovery that makes use of disruptive technology. Dr. Thomas Campbell of Future Grasp noted that because of the huge spike in unemployment, the government will be preoccupied with short-term solutions, and the leveraging of technology without having to go back into the lab for further research. However, when the pandemic is passed, the economy will look very different, and require a new set of long-term solutions to address this sudden reorganization. Ms. Sara Lawrence of RTI International summarized this perspective with the phrase "short-term rejuvenation, long-term transformation," and said it the group would be remiss in not addressing the immediate disruptions caused by COVID-19. Dr. Laurie Locascio of the University of Maryland pointed out how the crisis has exposed weaknesses in America's manufacturing supply chains, which began experiencing disruption even before the pandemic reached the United States because of their reliance on international suppliers. Mr. David Vasko of Rockwell Automation said that the pandemic has shown the dire need for universal broadband access in the United States, as well as the importance of telehealth in addressing basic medical problems. Dr. Pisano concurred and added 5G as another technology that needs to be made universal to adjust to new economic realities. Mr. Minevich warned that cash-strapped firms were discussing scaling back their R&D efforts, and urged the Council to help illustrate how to address the supply chain weaknesses exposed by the pandemic through human and digital resources. He spoke of the need to stop the momentum away from "moon shot", and of the need for companies to avoid becoming solely dependent on China for their supply chains. Ms. Wince-Smith noted the overlap between this discussion and the discussions held by the Future of Sustainable Production and Consumption, and Work group, as well as the Optimizing the Environment for the National Innovation System group. In addition to supply chain resiliency, she cited the vulnerability of digital infrastructure to cyberattacks, the Defense Production Act and industry's ability to rapidly shift production in response to emergencies, and the role of smart manufacturing in enabling rapid production shifts, as important issues for all three groups to consider. She predicted the three Working Groups would need to engage in significant cross-pollination to fully explore these issues.

Semiconductors, Moore's Law, and Productivity

Ms. Trimble asked what the cost-benefit balance was from innovation spurred by crisis, and noted that semiconductors were facing such a crisis with the end of Moore's Law. She asked what the priority technology areas should be within the semiconductor space. Dr. Neil Thompson of MIT echoed the need for a long-term replacement technology as Moore's Law stalls out, and noted that none of the potential candidates, including carbon nanotubes, light-based computing, or quantum computing, is close to deployment. He stressed the importance of leadership in semiconductor technology to America's economic competitiveness, and said that in the intervening time, bridging technologies will be crucial. He specifically mentioned specialized processors, such as Graphics Processing Units for machine learning, that offer a processing speed improvement equivalent to several extra years of Moore's Law. He also highlighted the importance of productivity in long-term economic growth, and the drop in productivity growth in the U.S. economy since the mid-2000s, which is connected to stagnating standards of living. He characterized this slowdown as being driven by the continued separation of a small group of highly productive firms from the majority of companies, which are seeing stagnations in their productivity. Dr. Thompson urged the group to study this issue and apply lessons from it. Mr. Minevich advocated taking an even broader perspective, asking how technology impacts not just productivity, but society as a whole. He urged the group to be both comprehensive and predictive in analyzing the impact of new technologies and how they could be used to drive productivity improvements. He stressed the necessity of making Americans more digital-savvy, especially as digital and remote work grow, and asked how to combine human capital with autonomous systems to improve both lifestyle and workforce productivity.

Competition with China

Competing with China for leadership in disruptive innovations, as well as securing American intellectual property, data, and information, was a major focus of the group. Dr. Gary Pratt of Kansas State University expressed concern at the lack of funding for enforcement of new intellectual property standards, and emphasized the importance of securing American IP in the race to innovate. Ms. Trimble concurred and noted that this issue had come up in all three Working Groups. Dr. Pisano noted that in China, innovation only occurs in pockets across their economic landscape, and suggested magnifying America's advantage in this area with a national Innovator Corps that could counter China's dominance of global supply chains. Ms. Wince-Smith expressed grave concern over China's nationalization of 3M's Chinese plants, and its predatory attempts to acquire startups in the United States that are impacted by the COVID-19 pandemic and facing funding problems. She urged greater funding for the Committee on Foreign Investment in the United States (CFIUS), and mentioned Dr. Michael McQuade of Carnegie Mellon University's warnings for academia and industry to rethink research and collaboration. Mr. Copps echoed this sentiment, revealing his company had turned down an offer from a Chinese investor and that Chinese investors are now trying to acquire licenses to technology before building a company around that license. He also noted China's control over Greece's economy through its investments in its shipyards and ports.

Next Steps

Ms. Trimble discussed the schedule and topics for the next three weeks of calls, and reminded the group that topical "deep dives" will begin next week. She also asked for group members to send along any suggestions for topics for focused discussions.

Working Group 1 Calls April 7

Setting the Stage

Ms. Kathy Trimble and The Honorable Deborah L. Wince-Smith welcomed the group to the discussion. Mr. Chad Evans announced the Council is closing in on a schedule for this summer and fall. Ms. Trimble then introduced the kickoff speaker for the session, Dr. Tom Campbell of Future Grasp, LLC.

Kickoff Remarks

Dr. Campbell's remarks focused on U.S. leadership in emerging technology. He noted that while the United States remains the global leader in disruptive technological innovation, it is beginning to falter in that role. He mentioned the National Academies' attention to this trend in their "Gathering Storm" report, and characterized this slippage as a combination of declining funding for science and technology relative to inflation in the United States, as well as increased investment by foreign competitors, especially China. Citing China's "grand plans" for nearly every emerging technology and U.S. slippage in biotechnology, 5G, and artificial intelligence, Dr. Campbell urged the United States to engage more deeply in science and technology. He called for more public-private partnerships and for bridging the "gulf" he observed in priorities, knowledge, and attitudes between Silicon Valley and Washington, DC. Noting that policy makers often lack crucial scientific knowledge to inform their decision making, Dr. Campbell called for greater scientific pedagogy within the government, and for both venture capital and policy makers to focus on long-term, strategic funding decisions over short-term, tactical ones.

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Mr. Gourang Wakade

Ms. Carol Ann Meares

Dr. Campbell also urged greater investment in 5G and broadband technology domestically, as the number of people working from home due to the COVID-19 pandemic will accelerate trends toward digitalization and the importance of telecommunications. Dr. Paul Hommert, formerly of Sandia National Laboratory, asked what the key differences are between basic research and investment in moving "up the value chain" toward productization. Dr. Campbell, while praising the research going on in venture capital centers like Silicon Valley, Boston, Austin, and even Washington, DC, focused on the need to secure funding for startups in the "Valley of Death" between prototyping and scaling. He described the countless startups with great ideas that failed due to lack of funding, and the Chinese government's co-option of their ideas and innovations, including manufacturing via 3D printing. Ms. Wince-Smith asked what could be done to get hedge funds and other entities sitting on idle capital to deploy them in strategic investments. Dr. Campbell said he did not see significant movement in this direction during the COVID-19 pandemic as likely, and suggested the Council would be well-suited to work on identifying solutions to this problem. He also cited the issue of corporations offshoring their earnings rather than paying taxes in the United States as a contributing factor. Ms. Wince-Smith said that the current venture capital model will not be sufficient to encourage these long-term investments, and that the Commission should focus on incentives, the regulatory environment, and other solutions. In particular, she mentioned pension funds as having a role as a source of long-term investment capital, and warned that the policy community cannot "go in circles" on this matter.

Opportunities for Leadership and Emerging Challenges

Dr. Hommert suggested that the Working Group address technologies where the United States as an opportunity to seize a leadership role spanning the entire value chain, as well as identifying future opportunities that leverage America's strengths in foundational research. Mr. Evans highlighted the connection between Dr. Hommert's remarks and the Council's previous work with Deloitte on emerging technologies and the nations with the strategic assets to emerge as leaders in these fields. He also listed areas where the United States still leads, including aerospace, materials, communications, and healthcare. Participants also discussed the importance of intellectual property policy. Ms. Sara Lawrence of RTI International discussed China's emergence in shaping the World Intellectual Property Organization, and lamented the lack of thinking on the implications of long-term changes in power structures. Dr. Roland Stephen of SRI International noted that increasing concerns about physical and intellectual property rights in China might encourage greater investment in productization in the United States by companies.

Participants also discussed the importance of "Competing for the Next Economy," a phrase that emerged from the Council's Executive Committee and Board meeting on Monday. Ms. Lawrence seconded this formulation, and Dr. Robie Samanta Roy of Lockheed Martin emphasized the United States' continued advantage in quality of innovation, which Dr. Stephen seconded. Dr. Samanta Roy argued China has too much capacity for the United States to out-quantify them, but could continue to innovate more effectively and disruptively.

Encouraging Collaboration Without "Picking Winners and Losers"

Many participants experienced in interacting with Congress and the Federal government discussed strong concerns by policy makers over the risks of "picking winners and losers" when the government becomes directly involved in supporting investment and research. Dr. Candy Culhane of Los Alamos National Laboratory noted that federal involvement with projects runs the risk of over-specification, with the end result of disappointing products, something she experienced first-hand while involved with the intelligence community. She urged either a more flexible approach to collaboration or a shift to incentivizing private companies to invest, which she

framed as "winning the race" versus "how to run the course." Dr. Hommert also discussed encountering these concerns during his time at Sandia National Laboratory, and emphasized the Commission must acknowledge the validity of these concerns, and the challenges inherent in public-private partnerships. He pointed to consortia with transparent decision-making processes as examples of collaboration that assuages these fears.

Participants noted numerous examples of successful collaboration that avoided the "winners and losers" concern. Dr. Culhane discussed DARPA's use of prizes to encourage research on autonomous vehicles, and how this initiative inspired universities to partner with corporations. After the initial round of investments was unsuccessful, participants learned from the experience and eventually the prize was claimed. Dr. Samanta Roy mentioned the X Prizes, which helped spur the creation of the sub-orbital launch and commercial space flight industries, and of Sematech as a successful industry-government consortium. He characterized prizes and consortia as successful when they establish a clear mission among participants and reach a consensus on maximizing benefits for all stakeholders. He hoped that the country would retain its sense of national purpose after the COVID-19 pandemic passes. Dr. Stephen strongly agreed with the use of prizes, noting that they do not pick winners and losers, but "shoot at" a disruptive technology. They also motivate people who were not previously part of the innovation space to become involved. He expressed support for consortia but encouraged the Council to develop a blueprint for avoiding the challenges of industry collaboration. Ms. Yasmin Hilpert described the Global Federation of Competitiveness Councils' work on prizes as drivers of extreme innovation, and Ms. Wince-Smith added that the report included a global scan of the structure, process, and impact of such activities around the world, as well as future opportunities.

Focusing on Specific Technologies

The group also discussed which technologies to encourage American investment in, including AI, 5G, healthcare, climate change, and manufacturing. Dr. Samanta Roy noted the Administration's aggressive actions on artificial intelligence, including an AI Task Force that recently released its first set of quarterly recommendations. He identified several areas for public-private partnerships in the AI space, including ethics, data availability, hardware development for large-scale data analytics and machine learning, and AI application spaces. He cited the example of Oak Ridge National Laboratory's use of its supercomputer to comb through drug research data to identify candidates for human trials. Dr. Samanta Roy also warned that China is investing heavily in these areas, and does not share America's ethical or privacy norms. However, he also argued that China's strategy comes with vulnerabilities, and urged the United States to move from investment in "second wave" AI, like machine learning and big data, to "third wave" AI, including artificial cognition and sense-making and human-machine interfaces. Dr. Stephen discussed the importance of AI and machine learning in genetic research, and Dr. Campbell concurred on funding AI sense-making research. He added that venture capital does not have the time horizon or risk tolerance to engage in crucial basic research in this area. Dr. Stephen said that because of venture capital's risk- and time-aversion, only Fortune 500 companies currently possessed the resources to conduct their own research in disruptive technologies. Ms. Trimble noted that China is not the only competitor with the United States in AI, and Dr. Campbell added that fifty other countries either already have a national AI strategy or are developing one, and that South Korea and Singapore are particularly invested in AI research. Dr. Campbell also argued that no single government should "own" AI advances, as this would exacerbate global inequality between the technological "haves" and "have-nots."

Ms. Trimble asked the group where the United States was falling behind in investment. Ms. Wince-Smith also asked the group to find three major issues to zero in on and form task forces around. Dr. Ravi Prasher of Lawrence Berkeley National Laboratory suggested climate change, as firms and venture capital have so far not shown interest in the scale and risk of investments in climate change-mitigating technology. Ms. Wince-Smith suggested climate change as an opportunity for collaboration between Working Groups 1 and 3, and discussed her past work on consortia, including Sematech. She noted that even during a Republican administration, the threat of semiconductor competition from Japan led to consensus about the need for an organized U.S. response because of the national security ramifications. Dr. Campbell stressed the increased global interest in telecommunications during the COVID-19 pandemic, and warned that China was already leading in 5G through Huawei. He suggested telecom AI as an opportunity for the Council to encourage government investment, especially since many people may be working from home for the next year or more. Ms. Wince-Smith agreed with this, and mentioned that during the Executive Committee and Board meeting, she learned that Verizon is managing 800 million mobile calls each day in the United States. She added that 5G is an enabling platform for numerous other technologies, along with advanced microelectronics. She also cited healthcare as an enabling factor, and stressed the importance of being able to respond with less loss of function when the next pandemic hits. Ms. Trimble also suggested manufacturing and supply chain issues as a topic for a task force, and Ms. Wince-Smith said that would be an opportunity for a Working Group 2-led collaboration effort.

Closing

Mr. Evans encouraged participants to reread the issue primers from the January Launch Conference, especially since they serve as the basis for guiding questions for the weekly calls. Ms. Trimble reminded the group that the next discussion will take place on Thursday afternoon.

Working Group 1 Calls April 9

Setting the Stage

Ms. Kathy Trimble and The Honorable Deborah L. Wince-Smith welcomed the group and introduced the kickoff speaker, Mr. Mark Minevich of Going Global Ventures, on the topic of the U.S. competitive position in emerging technologies relative to China.

Kick-off Remarks

Mr. Minevich kicked off the discussion by contrasting the American response to COVID-19 to that of countries such as South Korea and Singapore, which use contact tracing rather than social distancing, as an example of America being caught unawares and losing its leading edge. He then focused on four major elements of the U.S.-China competition: China's rise, its strategic plans, its current comparison to the United States, and its strategic advantages.

Mr. Minevich noted that China's economy has grown tenfold since 2000 and threefold since 2008, and that its firms have become increasingly large and sophisticated. Although the first large Chinese firms to emerge did so in finance and energy, China is increasingly shifting to technology with the rise of companies like Baidu, Tencent, and Alibaba. China now has firms competing in nearly every industry, from online shopping to mobile payment, with U.S. firms, and they are already approaching those firms in size. China's large financial sector is an important part of its rise as a scientific power through funding of research, and the four largest banks in the world by total assets are Chinese.

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Worryingly, China has a strategic plan to dominate the next wave of emerging technologies, and to leverage this dominance for geopolitical power. The Made in China 2025 initiative details China's attempt to be the leader in all of the top ten manufacturing industries by 2025, as well as to lead in artificial intelligence. On the latter front, China has made clear its plans to dominate the AI marketplace by 2030, starting with a $150 billion investment in its domestic industry before jumping internationally. China's "Belt and Road" initiative has allowed it to control the technological infrastructure- particularly wireless networks- in numerous countries, including Italy. Further, Chinese companies are investing heavily in surveillance technology and the use of AI for facial recognition.

Mr. Minevich described the U.S.-China battle for technological supremacy as a "Global Technology Cold War." He noted that China has more robots, supercomputers, and internet users than the United States, and that in China, companies must operate with national goals in mind. China has also either equaled or surpassed American expenditures on research and development, and is leading in the number of patent applications and scientific publications. While they are still behind the United States in semiconductor manufacturing, they are rapidly gaining, and have already caught the United States in supercomputing ability. China is also turning to Singaporean and South Korean manufacturers to develop the next round of semiconductor chips, and is engaged with the United States in a struggle to take the lead in quantum technology. Mr. Minevich warned that losing this battle would leave the United States at a severe disadvantage in a variety of domains, including encryption.

However, Mr. Minevich noted the United States retains some advantages. The United States has a free society that enforces the rule of law, protects intellectual property, and encourages independent thinking. It also possesses an independent judiciary and robust startup culture. The United States possesses major firms like IBM and Google, which recently achieved quantum supremacy, and has spent $92 billion on basic research since 2017. Agencies like the Defense Advanced Research Projects Agency (DARPA), which has a $3.6 billion budget, provide valuable research funding, and most of the current leading-edge AI firms are American. The current administration has backed the $1.2 billion National Quantum Innovation Act, and the Department of Energy has also invested $80 million in quantum research. Mr. Minevich warned that this was insufficient, and that China was already developing quantum technology for use in stealth military craft that could pose a serious threat to America's national defense.

American Strategies for Competing with China

Participants questioned whether the United States should adopt a holistic, strategic approach to investing in priority technologies to regain the lead from China. Dr. Laurie Locascio of the University of Maryland asked whether the United States needed to rethink its science and technology portfolio, and Ms. Trimble echoed this concern, while noting that the United States has historically placed great value on the separation of private and public sector research. Ms. Trimble also asked how the United States should address the talent pipeline and ensure a supply of skilled workers in these fields. Mr. Minevich emphasized that the United States should not copy China's authoritarian model, as evidence in its Draconian response to the COVID-19 crisis, but should seek to match it in expertise. He also urged the United States to pay attention to China's willingness to "capture" expertise it cannot produce at home via copying of research and recruitment of talent. He praised the White House for issuing a strategic plan on AI, but urged the incorporation of multilateral efforts, ethics, compliance, and regulatory concerns into strategic plans, as well as plans for resilience in the face of future disruptive events like pandemics.

Ms. Trimble noted that there is reluctance in the United States to direct private firms to conduct research in particular fields, and Dr. Locascio sug-

gested a "bifurcated" approach, with a test case of one or two industries to see if such efforts were effective in spurring innovation, while waiting for "winning" technologies to emerge in other sectors. Other participants were focused on questions of framing. Dr. Robert Dixon, formerly of PepsiCo, asked what the stakes were if China obtained a commanding lead in these key technologies.

Unique Aspects of the American Innovation Landscape

Dr. Neil Thompson of MIT broke China's rise down into two categories. The first, which involves increases in scale due to China's large population becoming wealthier, he categorized as not threatening the United States' competitiveness. However, he urged intense focus on areas relevant to American innovation vis-à-vis China, including the ability to attract foreign talent to universities and science and technology funding by the government. Dr. Arun Rai of Georgia State University agreed with this demarcation, and also pointed out that the United States' culture of open-source innovation in software, owing in part due to narrow patent laws, means the extent of U.S. innovation is not fully captured by patent applications, and pointed to benefits of such collaboration. Mr. Minevich agreed, but reiterated that his concern was with the emerging pattern of systematic approaches by China to lead across major technologies. Dr. Rai asked how the United States could leverage its strengths, including an open and collaborative environment, to compete with China, and urged developing strategies to do this for apex technologies like AI. He noted that companies such as Microsoft and Google are invested in helping startups scale up their research, and cited the American startup environment as a significant asset. Participants also noted differences in the research environments of the two countries. Dr. Gary Pratt of Kansas State University questioned how much China relies on original research versus appropriation of other countries' work. Dr. Ramprasad Balasubramanian of the University of Massachusetts-Dartmouth echoed Mr. Minevich in urging the United States not to copy China in a reactive fashion, but to independently develop a strategy for achieving technological supremacy.

The Role of Necessity in Determining Priorities

Dr. Tony Tether, formerly of DARPA, stated that invention is spurred by needs, and encouraged the group to focus on what problems the United States needs to solve, and where it is falling behind. He described how Chinese companies are focused on AI for surveillance and facial recognition because of the Chinese government's preoccupation with identifying individuals planning disruptive or rebellious acts against the state, as well as how DARPA helped kickstart the GPS and geolocation industries under his tenure. Concerned that American forces were not able to locate each other during operations, he offered funding to anyone who could develop a small, fast device for determining global positioning, and how this work led to the development of portable, accurate GPS devices that used gallium arsenide rather than silicon as semiconductors.

Mr. Chad Evans asked the participants which technologies they classified as "needs", and noted Ms. Wince-Smith's example of next-generation microelectronics. Mr. Minevich cited AI as a priority and need for the United States, noting its applications to computing, surveillance, and decision making, and urged the United States to align commercial research with this goal, even to the point of picking "champion" firms. Dr. Locascio added quantum computing, synthetic biology, and biotechnology.

Finding the Next Innovation

Dr. Gloria González-Rivera of the University of California, Riverside urged the group to think about finding the next disruptive technology, noting that the current generation of emerging technologies evolved from basic research, including that done by universities, in the past 5 to 10 years. She warned that universities had insufficient funding for basic research,

and characterized academia, as well as federal agencies like the National Science Foundation and National Institutes of Health, as the key to generating the research that will inspire the next wave of transformative technology, especially because of the risk aversion of the private sector. Dr. Tether agreed, but noted that the private sector was generally much better at identifying groundbreaking applications of that research than universities. He noted that the idea to use gallium arsenide in a GPS device was made possible by basic research on transistors, but that the U.S. military was the body to identify a problem that could make use of this research.

Re-framing the Discussion

In concluding the discussion, Ms. Wince-Smith urged fresh language and a fresh perspective on bolstering U.S. competitiveness. Rather than thinking about "winners and losers", she urged a re-characterization of key technologies as platforms for enabling continued prosperity. She warned about the dangers of losing leadership in quantum, AI, and microelectronics to an authoritarian regime with incompatible values, and that shoring up these platforms, as well as the infrastructure needed to support them, was a necessity. She identified the intersection of the physical and virtual worlds, AI and cognitive technology, and telecommunications infrastructure (especially during the COVID-19 pandemic), as crucial platforms. Dr. Tether encouraged using stories like the development of GPS as test cases to encourage greater appreciation of the importance of research for disruptive innovations.

Working Group 1 Calls April 14

Introduction and Setting the Stage

The Honorable Deborah L. Wince-Smith welcomed the group and introduced the kickoff speaker, Mr. Andre Doumitt of the Aerospace Corporation, who discussed his experiences in the startup environment and the internal and external factors that contribute to the success of scale-up efforts for innovations. She stressed the importance of increasing basic research funding at the federal level to its mid-20th century share of GDP, and urged the group to identify priorities for research, public-private partnerships, and commercialization.

Kickoff Remarks

Mr. Doumitt discussed his experiences working at an aerospace startup that spun off from intellectual property developed from university research on satellite imaging. After struggling to illustrate the uses of his company's innovation to clients, who didn't understand the applications of the technology, the firm began rebooting its product line based on feedback and input from end users. He said that a disconnect between the designers of products and their end users is a major contributor to the "Valley of Death." Mr. Doumitt praised the Council's work on problems of technology transition and touted the idea of a national prototyping initiative, discussed during the January Launch Conference at Arizona State University, as a potential solution. He noted that both universities and industry frequently face a lack of expertise in converting early-stage research into adoptable technology, and he expressed frustration at the lack of interest many engineers and designers had in "business problems."

Mr. Doumitt also discussed the importance of incorporating feedback from end users throughout the design process, rather than after the prototype had

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been developed. As an illustration, he described the successful development of a new model of Medevac helicopter whose success was due to continual input from hospitals about important design features and capabilities, and which later became the most popular model for medical evacuation craft. He encouraged more researchers to cultivate the understanding of "market traction" that startups have by necessity, and also advocated for increased funding of research. He noted that the federal government formerly funded 70 percent of the nation's basic research, but that the share had declined to 40 percent. In what he described as a "post-Marshall Plan world" and with rising competition from China, he urged greater activity from both government and industry to maintain U.S. competitiveness.

Cultural Dimensions of Scale-Up

Mr. Ryan Haines of Sundt Construction shared a similar "success story" to Mr. Doumitt in the culture of his company. He described how Sundt seeks to "mine its inefficiencies" to innovate internally by examining weaknesses. A key aspect of this process involved cultivating diverse talent. He described how his firm sought out people without specific construction experience to leverage their mathematical or technological expertise, and how this enabled the company to reconceive construction challenges as math or technology challenges. This reframing of problems led to new insights and helped the company successfully innovate to solve problems. Mr. Doumitt concurred with this assessment, and described how his current company, the Aerospace Corporation, discovered that employees were afraid to ask "stupid questions" and as a result frequently didn't understand the problems they were trying to solve. By creating a more open, "playful" space and actively encouraging these "stupid" questions, the company was able to actually generate new headspaces for its employees that enabled them to approach problems differently and generate more and better ideas. Many of these ideas turned into prototypes or even products because people felt free to ask questions without fear of embarrassment. Ms. Kathy Trimble discussed the argument that frequent job turnover among software engineers spurs innovation because workers become exposed to many different corporate environments and ways of thinking, and bring those mindsets with them to new companies.

Structural Dimensions of Scale-Up

Dr. Paul Hommert, formerly of Sandia National Laboratory, discussed the problem of "gaps" between government needs and approaches to problems and those in the private sector. As an example, he cited the failure of his lab to successfully develop solutions to homeland security problems after the September 11 attacks, because the government was focused on acquiring technologies that had already been developed rather than looking for ongoing or new research projects to support. He expressed concern that similar gaps could develop in extremely pressing areas, such as climate change and public health. Ms. Trimble then asked the group how the government could address these gaps. Dr. Kelvin Lee of the University of Delaware discussed the Manufacturing USA initiatives, which were designed to pool resources among academia, labs, industry, small businesses, and the government. He characterized the strength of these institutes as their ability to bring in creativity and innovation from the academic and research worlds while de-risking technologies for investors. He described how the government was able to support entire sectors without either "picking winners" for specific technologies or firms or investing so heavily in technologies that there was no meaningful co-investment from the private sector. He described this approach as a "leverage" approach that enables the government to convene and deploy resources while letting industry lead the way and providing a nurturing environment for small firms and startups.

Dr. Lee also discussed the current state of the Manufacturing USA program. Originally, there were plans for 40 institutes, but there are currently 14, with two more set to commence during 2020. While existing institutes have focused on advanced technologies and the manufacturing techniques needed

to produce them, new concerns about supply chain security and workforce upskilling have catalyzed a new wave of discussions on expanding the program. Currently, the Departments of Commerce, Energy, and Defense are the primary governmental sponsors, but Dr. Lee expressed the importance of continuing to expand the program to meet new challenges, and said that "all the pieces need to come together" in the innovation ecosystem to solve technology challenges in manufacturing. Dr. Hommert questioned whether the government should wait to see if investments in areas like commercial space flight, renewable energy, and vehicle electrification will achieve sufficient market penetration and cost efficiency that they become viable on their own, or whether the government should intervene with support to maximize the potential economic and employment benefits of the technologies.

The Effects of COVID-19 and Gaps in the Innovation Ecosystem

Mr. Doumitt described how the ongoing COVID-19 pandemic has revealed underlying weaknesses in both firms within the aerospace industry as well as the government's approach to facilitating innovation there. He described how two prominent firms have filed for bankruptcy recently, one of which was in talks with the government for a collaborative venture. Now, that entire initiative will be scrapped and any ideas or uses the government had for the new technology the firm was developing will not be realized. He predicted that the COVID-19 crisis will lead to a shift in the government's approach in which they provide underlying support for all aspects of advanced technology development, rather than merely "filling in the gaps" on the commercial side, because of the need to ensure a viable commercial sector for developing advanced technologies during periods of crisis. Dr. Neal Woodbury of Arizona State University described similar problems in academia to those Mr. Doumitt mentioned in his kickoff remarks. He said that finding people with the expertise needed to "pitch" innovations to clients was expensive and time consuming, and that innovators often missed their window of opportunity to attract investment because of it. He said it was incumbent on innovators to make their case for their inventions, but that he did not have a complete answer for how to address this issue.

Connections With Previous Council Efforts

Mr. Bill Bates described the Council's previous work on advanced manufacturing and scaling of technological innovations, including the Energy and Manufacturing Competitiveness Partnership (EMCP), which produced several sector-specific studies as well as the summary publication Accelerate (2018). He noted two major takeaways. First, across sectors as diverse as aerospace, agriculture, manufacturing, and biotechnology, key commonalities emerged, including talent and workforce development and getting ideas into the marketplace. He noted that many solutions were difficult to scale, and that processes and structures that worked in one sector or location didn't work in others. Second, he discussed the Manufacturing USA initiative, and the ongoing debate about whether its mandate should be made permanent, as the funding stream is subject to sunsetting and the program was intended to be temporary. He asked if it might be better to establish it as a permanent program given the new competition the U.S. economy is facing in advanced technology deployment.

Case Studies and Illustrations

There was general consensus on the value of case studies to illustrate the dynamics of successful scale-up and make the case for investment. Mr. Haines discussed how Sundt Construction was able to identify a challenge in concrete production. By leveraging 3D modeling, the firm was able to automate a significant part of its production process, and generated returns on this innovation that far exceeded the costs of acquiring 3D modeling capability. He described how Sundt uses a combination of legacy knowledge and experience and judicious investment in innovations to generate

higher productivity that allows the firm to self-fund many upgrades and technological innovations. He also stressed the need to partner with other industry actors and not "reinvent the wheel", citing Sundt's use of drone technologies developed by other firms. Ms. Wince-Smith suggested publishing a case study looking at a critical strategic technology with both governmental and commercial applications where the United States faced competition from China, like hypersonics. Dr. Tony Tether, formerly of the Defense Advanced Research Projects Agency (DARPA) agreed. He described how the United States has long been hampered by a lack of tunnels in which to test hypersonic engines, which has slowed the pace of innovation. Meanwhile, China has spent significant resources on building test tunnels, and the United States government continues to be unwilling to spend the money to do the same. He also described a positive story in hypersonics in the form of additive manufacturing. The adoption of additive manufacturing allowed DARPA to cheaply develop a fuel nozzle that would prevent fuel from leaving the center of the engine and lose energy. He concluded by noting that companies where people spend their entire career in one place develop stale cultures, and people with new ideas brought in from elsewhere struggle to win acceptance for them, slowing innovation. Dr. Hommert agreed that hypersonics provided a good case study, but he cautioned that there would be some challenges around classified information. Ms. Wince-Smith concluded the discussion by suggesting the Commission pursue this idea, and to involve Lockheed Martin personnel in the initiative as well.

Working Group 1 Calls April 16

Introduction and Setting the Stage

The Honorable Deborah L. Wince-Smith welcomed the group, and Mr. Chad Evans stressed the importance of the National Commission's work in light of the recent news that unemployment claims have increased by 22 million over the past four weeks. He stressed the importance of creating new industry and job creation engines for the country.

Opening Remarks: The Problem of Geography

Dr. Roland Stephen of SRI International kicked off the discussion by stressing the importance of geography to the scale up problem. He argued that without addressing the concentrated nature of venture capital investment by industry and geographic region, most of the country will not have the capacity to scale up innovation in a meaningful way. He described the decline in the United States capacity to produce across a variety of sectors, especially since the 2008 recession, and added that investors who do choose to invest in a startup are perfectly willing to offshore the scale-up process as a result. Dr. Stephen emphasized the topical relevance of such offshoring: the supply chains for vaccines and tests for COVID-19 stretch all around the world but almost entirely bypass the United States. He closed by identifying the reasons venture capital does not invest outside of a handful of areas of the country. First, there is a lack of knowledge of opportunities for venture capital in much of the country due to information deficits. Second, the infrastructure, or lack thereof, makes investment difficult, including the lack of broadband access and other critical IT

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infrastructure in rural areas. Finally, there is an issue of talent pipelines- many regions are not producing the kinds of human capital needed to scale up ideas, and some of the regions that are, like the Pittsburgh metropolitan area, are still seeing an exodus of talent to traditional venture capital hotbeds. He stressed the need to not only replicate the success of regions like Pittsburgh in producing talent, but also reach a "tipping point" where talent is abundant enough to bring venture capital to it rather than the other way around.

Opening Remarks: Case Study in Rapid Scale Up

Mr. Dave Copps of Worlds Enterprises used his recent success in securing venture funding for an innovation to provide a case study in how scale-up can occur rapidly and efficiently. His company was connected with an investor for a non-invasive test for COVID-19 that was repurposed from an earlier technology thanks to the facilitation of the venture capital arm of the U.S. Air Force. He then received matching funds from both the U.S. Air Force and the Small Business Innovation Research (SBIR) program. He noted that co-investment lowers the risk for any individual venture capital investor, encouraging them to make larger investments as a result. Dr. Robie Samanta Roy of Lockheed Martin noted that in this case, the Air Force choosing to match investment funds, and to help facilitate securing an initial funder, was due to necessity. Most personnel in the defense and intelligence communities cannot work from home, and need a way to safely return to work. As a result, the Undersecretary for Acquisition Technology and Logistics put COVID-19 mitigation at the top of the agenda, at the expense of other initiatives. This included doing market research and making connections within the startup community, like Mr. Copps. This occurred within a ten day span, and illustrated how the combination of deeply engaged senior leadership that prioritizes innovation and a platform to connect funders to ideas can make the scale up process very fast and efficient.

Current and Future Venture Behavior

Mr. Mark Minevich of Going Global Ventures reported that his discussions with the VC community indicated that venture firms were focused on shoring up their existing portfolio of investments, rather than looking for new opportunities. He also expressed uncertainty about how venture capital firms would invest once the crisis had passed, including whether there would be activist VC firms, and whether they would rethink their emphasis on quick profitability over long-term growth potential. He also said it was an open question what kinds of products and services they will invest in. Mr. Copps echoed this assessment, noting precipitous drops in value for many startups due to the recession. He also said that the recent WeWork scandal had caused investors to rethink the valuation of startups when those startups' perceived value draws so heavily on a single investor. He further predicted that after the crisis, venture firms will increasingly seek outside validation to guide their decisions, including greater participation in public-private partnerships. Mr. Copps also expected the concentration on software to continue, and for investment interest in services to decline, since service-based startups are valued at roughly their current revenue, while tech startups, especially in "enabling" fields like AI, can be value at 10 to 15 times their current cashflow. Conversely, Dr. Samanta Roy referenced a Bloomberg report that 62 venture capital firms had collectively raised $21 Billion in new financing last quarter despite the recession. Dr. Stephen asked what the medium-term picture was for investment when venture began looking to invest again and there was public money going to tech startups, and Mr. Copps said the picture looked bleak unless venture firms felt a startup had immediate relevance to the COVID-19 crisis or was somehow positively impacted by the current economic environment.

Potential Funders of Innovation

Participants discussed various potential sources of capital outside the traditional venture capital world. Ms. Sara Lawrence of RTI International agreed with Dr. Stephen's analysis of the geographic problems in venture capital, and highlighted state-supported efforts to boost startups in Ohio and Utah as potential models. She further added that these initiatives were increasingly starting to encourage greater diversity in recipients of venture capital funding and in venture capital networks generally. Mr. Copps reported that venture firms were sitting on large amounts of cash, and that many startups, including some on the verge of positive cashflow, were not going to survive the economic downturn due to lack of funding. He said companies needed to discover ways to pivot in response to the crisis and improve their pitch for more funding. Mr. Evans said that there was $1.5 trillion in idle capital that could be deployed in hedge funds and private equity firms, but Mr. Minevich warned that pension funds, family offices, sovereign wealth funds, and university endowments were all pulling back from venture capital investments. He asked where investment capital would come from after these retreats.

The Role of Crowdfunding Platforms

Dr. Arun Rai of Georgia State University spoke about the promise of crowdfunding platforms, both as a source of capital for innovators who could not attract venture capital funding, and as a mean of signaling to venture capital firms about potential profitable investments. He described a Ph.D. student he advised whose dissertation found that VC firms follow developments on platforms like Kickstarter, and that this reduces venture capital concentration by both location and industry. He urged the group to think about the use of platforms in the different phases of the venture capital process. Mr. Copps agreed with this assessment, and spoke of a desire to create National Innovation Network platform that would both allow investors and innovators to locate each other by searching industries or key words, and enable different innovators to collaborate and investors to co-invest in products, accelerating the development of ideas and expediting funding for scale up. He added that the technology for such a platform already existed. He predicted this rapid matching of ideas to resources could result in "Direct to Phase 2" experiences like his COVID-19 test startup, and said that "innovation accelerates" when more people come together to work on ideas. Dr. Stephen added that crowdfunding platforms could be an excellent signaling mechanism for venture capital.

Necessity as a Driver of Innovation

Ms. Trimble discussed her experiences working at the Joint Chiefs of Staff, and how senior acquisition personnel were frustrated by the time-consuming nature of the evaluation process. She said that understanding trade-offs, and then scaling up technology and persisting in that scale up over time, was the biggest challenge in technology transfer. Dr. Samanta Roy added that no significant innovation in military technology came about from a stated written requirement. Instead, innovations came from tech-savvy senior personnel who understood the operational utility of basic research discoveries and worked to advance them to scale-up. He discussed the Department of Defense's efforts to increase the frequency of this process through programs like Air Force Ventures and the Defense Innovation Unit, but noted that large programs eventually require innovations be entered into programs of record with their extensive standards and requirements. Dr. Samanta Roy added that wars, pandemics, and other "stress cases" that forced personnel to take shortcuts end up spurring innovation, as the time pressure helps them identify which processes can be expedited and which hurdles eliminated. If senior staff can institutionalize knowledge of these shortcuts once the crisis has passed, the organization becomes more innovative. Ms. Wince-Smith asked if there was a systemic way to facilitate this process, and Dr. Samanta Roy said that changing the focus of military

acquisition standards from perfection to near-perfection in a shorter timeframe was needed. He said that startups are innovative precisely because they work on a short timeline that necessitates creativity.

Non-Deployment of Capital

Dr. Tom Campbell of Future Grasp, LLC noted that many potential investors were not deploying their capital, and asked if there was any comprehensive reporting on the past, present, and future status of investment, or a systematic analysis of why capital was not being deployed. He suggested that such a project from the Council would be very influential. Mr. Minevich said that while there was not yet any granular data, initial attempts to gather such information by Goldman Sachs, as well as his own conversations with people in the venture world, suggest a bleak picture for investment by venture capital, family offices, private equity, sovereign wealth funds, and pensions funds. He further identified human capital and product market fit as key ingredients to successful scale up, and said startups will also need assistance in finding these things, not just funding. Dr. Neil Thompson of MIT referenced a Duke University study showing a retreat by businesses from investing in basic research, leaving the federal government as the only basic research funder. He worried about the impact this would have on the future commercialization of innovation, because most innovations build on basic research and applying knowledge gained in novel ways. Mr. Evans agreed that the drying up of funding would have a significant impact in 15 to 20 years.

Supply Side Considerations

Dr. Thompson questioned whether the problem of capital availability was truly one of demand. He said that while entrepreneurs complain about the unwillingness of venture capital to invest in their ideas, venture capitalists he talked to explain that they are seeing fewer promising ideas with sufficient potential returns to justify their investment. He pointed out that prior to the recession, capital was already far cheaper than its historical average, and asked how to help entrepreneurs generate more good ideas. Ms. Lawrence added that she had heard the same things from venture capitalists, and reiterated that there was increasing concern in the venture world about broadening and diversifying venture capital networks and recipients of investment.

Tax and Regulatory Incentives and Conclusion

Ms. Wince-Smith asked what sorts of tax and regulatory incentives might increase venture capital's willingness to invest, especially in longer-term projects with more risk involved. Mr. Copps said that many firms use warrants to limit their tax liability, but that the benefit of existing tax preferences is skewed toward investors with the most money, and that the incentive system overall was messy and complicated. Ms. Wince-Smith emphasized the importance of catalyzing investment in key technologies that are relevant to U.S. competitiveness, including AI, microelectronics, and bio-resiliency. She said that if a company like Intel were trying to launch today, they would fail to receive funding because of the risk aversion of venture capitalists, and wondered if government intervention was necessary to encourage investment in these areas. Ms. Trimble noted that next week's discussions would be kicked off by former Sandia National Laboratory Director Paul Hommert, and would focus on developing strategic priorities and roadmaps for critical technologies.

Working Group 1 Calls April 21

Introduction

The Honorable Deborah L. Wince-Smith welcomed the group, and Mr. Chad Evans shared that the Council would make its previous works on the subject of scaling technology available via the online portal. Ms. Kathy Trimble introduced the day's topic, developing priorities for technology scaling, and the opening speaker, Dr. Paul Hommert, formerly of Sandia National Laboratory.

Opening Remarks

Dr. Hommert drew on the concept of the "value chain" developed by Dr. Michael Porter, a former affiliate of the Council. He spoke of how Dr. Porter distinguished between "primary" components, including logistics, manufacturing, sales, marketing, and customer service, and "supporting" components, including human resources, firm infrastructure, technology development, and procurement. Dr. Hommert identified pressing issues in the U.S. value chain space as ensuring maximum societal benefit from investments in the value chain and the appropriate distribution of foundational research efforts.

Dr. Hommert noted that different industries had dramatically different supply chains. Apple, despite employing over 90,000 Americans, has significant components of its value chain in China and South Korea, while the defense and oil and gas industries have primarily domestic supply chains for national security or resource endowment and infrastructural reasons. He discussed how new companies, like Tesla, have some of their value chain in China- like battery manufacture- but the majority is located in the United States. He stressed the need for the United States to not lose out on the fruits of its

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efforts, giving the example of Extreme Ultraviolet Lithography (EUVL), which Sandia helped develop in conjunction with American microelectronics firms in the 1990s. Although there was no commercial use at the time, leading firms, like Taiwan's TSMC, are making use of it to develop better processors. He discussed the loss to the U.S. economy from not being the "first to market" with an American innovation, and asked how the United States could strengthen its control of the value chain.

Dr. Hommert also discussed the different levels of research in innovative technology. He noted that government, nonprofits, and academia account for the majority of basic research and business for the majority of experimental development research. However, there is a roughly even split when it comes to applied research, which he characterized as the middle of the research value chain. He said this space offers the greatest opportunities for public-private partnerships, giving examples of previous successful collaboration. Fracking, and its expansion of the domestic natural gas industry, is possible because of a combination of three innovations. Diamond drill bits were developed by General Electric and perfected by Sandia, seismic mapping developed from Department of Energy experiments, and directional drilling was developed by the private sector. Dr. Hommert said that by focusing on the middle of the research process, government and industry can identify the key components of the value chain for a given technology.

Finally, Dr. Hommert discussed other issues that will require the collaborative development and scaling of innovation. These include establishing climate-resilient infrastructure, long-term storage options for renewable energy, carbon capture, nuclear power expansion, and healthcare. In particular, he discussed the potential value of pan-viral drugs that could be prepared and stockpiled in advance of future pandemics. He suggested reallocating existing funds to help pay for such research, and said that federal support for key technologies could de-risk their introduction and scaling.

Capturing the Value Chain in Advanced Technologies

Ms. Wince-Smith asked about the importance of maintaining leadership in next-generation microelectronics with the looming end of Moore's Law and diminishing productivity from CMOS processor technology. Dr. Hommert said that microelectronics must be carefully evaluated against the value chain, and that it will be difficult to get "ahead of the curve" because the industry is so large and has so much capital investment. He reiterated his disappointment in seeing Taiwan develop the first instantiation of American-designed EUVL technology, and warned that without pressure, the microelectronics value chain would continue to move offshore. He then pivoted to the development of pan-viral therapy as an example of how to avoid this pitfall. Because pharmaceutical manufacturers are profit-driven, they will not invest in developing a therapy that may not need to be used, making advance development of drugs for future pandemics an opportunity for public investment. He also suggested the involvement of nonprofits, like the Bill and Melinda Gates Foundation, in such an endeavor, since they play a role in connecting academia and government with industry and tend to be forward-looking in their research agendas.

Prioritization Strategies and Opportunities for Collaboration

Dr. Laurie Locascio of the University of Maryland asked whether the United States should prioritize continued leadership in technologies where it already leads, or if it should invest more in catching up in areas where it lags behind. Dr. Hommert argued that the country needed to balance both objectives, and mentioned that the United States lagged China and the EU in multiple critical arenas. He further warned that the United States formerly led in many technologies before "losing sight" of the value chain and ceding leadership to foreign countries. He urged for the United States to take a hard look at those areas, and ask on a case-by-case basis if it is crucial for

those technologies to be manufactured domestically. Mr. Ted Agne of Communications Strategy Group discussed biotechnology as an opportunity for collaboration between the United States and its allies that makes use of each side's respective leadership. He described how Swiss companies and British research universities were doing innovative work on incorporating AI into biotechnology, but they lacked the expertise in scaling and implementing their discoveries. Mr. Agne said there was great potential for American partnership with Switzerland and the UK, where both sides could benefit from faster development and scaling of innovation. Dr. Hommert concurred, and he praised the strength of the UK university system in developing innovation, but emphasized its profound difficulties in the engineering and application of innovations. He stated that recognizing the strengths and weaknesses of different parties was the basis for successful collaboration. Dr. Tony Tether, formerly of the Defense Advanced Research Projects Agency (DARPA) described how Britain has struggled to set up an equivalent agency to DARPA because of the unwillingness of their government to reorient from basic research to problem-driven research.

Healthcare and Technology "Streams"

Mr. Evans spoke of shifting focus from single technologies to "streams" of key technologies that would combine to drive productivity growth and disruptive innovation across sectors. He mentioned the Council's collaboration with Gallup to produce No Recovery (2016), which discussed the slowing of the U.S. economy due to lagging productivity in education, healthcare, and the built environment. He suggested determining priorities and "pillars" via this integrated framework that focuses on unlocking productivity and solving problems. Ms. Carol Ann Meares of TechVision 21 identified technology streams as key to scaling, and scaling as the key to job growth and productivity growth. However, she noted policy makers focused more on funding of basic R&D and the Valley of Death than on expediting deployment. Dr. Robert Dixon, formerly of PepsiCo, echoed the importance of healthcare as productivity-slowing industry. He predicted that unless innovations stemmed the increase in healthcare costs as a share of GDP, the healthcare system would collapse under its own weight in the coming decades because of affordability issues. He said streamlining the healthcare value chain will require disruptive innovation and novel thinking, and encouraged the group to think about critical opportunities in the healthcare value chain.

Challenge-Driven Research

Dr. Tether argued that problems and challenges spur successful innovation, and urged a reorientation of national science and technology priorities around solving major problems. Mr. Evans agreed, but noted there were areas where the problem was clearly defined, such as healthcare, but unlocking greater productivity remained an obstacle. Ms. Meares asked if academia's and government's research portfolios should be more problem-driven. Dr. Neal Woodbury of Arizona State University replied that universities and government institutions like NSF and NIH will always have some focus on basic research, especially because of unforeseen discoveries that emerge from this research, like CRISPR technology for gene editing. However, he also said that these groups are increasingly focusing on making connections between their academic research and concrete problems in government or industry. He said finding a way to facilitate these connections is crucial, as is developing greater resiliency. Dr. Woodbury said that it will take 18 months to develop a COVID-19 vaccine, but this is because of the lengthy safety demonstration process. To be more responsive to crises in the future, researchers will have to develop a way to gather relevant data faster, possibly using advanced technology.

The Importance of Resiliency

Dr. Tom Campbell of FutureGrasp, LLC also advocated focus on resiliency. He argued that technology does not exist in vacuum, and must be relevant to emerging geopolitics and current events. He stressed the importance of near-term resiliency solutions because of the massive disruption to supply chains caused by the COVID-19 pandemic, and warned that the expert consensus was that they would not return to their pre-pandemic states. Mr. Evans noted reports that firms experienced fewer losses in the Chinese market than they had predicted, and wondered if they would alter their supply chains as dramatically as believed. He also discussed the Council's ongoing work on a report addressing resiliency in the American economy, which will be released shortly, along with recommendations for investment priorities.

Intellectual Property

Dr. Robie Samanta Roy of Lockheed Martin identified intellectual property, especially negotiation of tech transfer agreements between academia and industry, as a major obstacle to quicker scaling of innovation. He said the current pandemic has motivated the parties involved to develop a solution because of the critical importance of timely response to mitigating its effects. He discussed Harvard, Stanford, and MIT's joint decision to change their IP policies to enable the private sector to make use of their research in developing COVID-19 responses. Dr. Locascio added that the University of Maryland had joined this agreement, and Dr. Dixon discussed his experiences negotiating IP agreements through his work with Georgia Tech. He added that any work the Commission could do in streamlining and expediting tech transfer agreements would have significant benefits for the pace of innovation.

Concluding Thoughts

Ms. Wince-Smith thanked the group for their discussion, and emphasized that the Council must balance short-, medium-, and long-term issues to maintain its impact and credibility. She particularly stressed the need to identify solutions for problems generated or exacerbated by the COVID-19 crisis, like mass testing and deployment of treatments and vaccines. She also discussed the applications of AI and High Performance Computing in accelerating research on treatments and vaccines. Dr. Hommert discussed other areas where broad infrastructural resiliency will be key in the coming years, including climate change and intellectual property. He spoke of the importance of balancing the "whats" and "hows" of innovation, and said it was unlikely the country would run out of problems to solve. Dr. Samanta Roy suggested exploring the DOD framework for intervention in research projects, which delineates roles including "lead", "follow/partner", and "watch." He said this framework would help policy makers balance long-term strategic goals with short-term dynamic reallocations to deal with emergent crises.

Working Group 1 Calls April 23

Introduction

Ms. Kathy Trimble and The Honorable Deborah L. Wince-Smith welcomed the group. Ms. Trimble introduced the opening speaker, Dr. Paul Hommert, formerly of Sandia National Laboratory.

Opening Remarks

Dr. Hommert opened his remarks with a discussion of former Council affiliate Dr. Michael Porter, of Harvard Business School, and his conception of the "value chain." The value chain consists of primary components, such as supply chains, manufacturing, delivery, marketing, and sales, and of supporting components, including human resources, procurement, and technology development. He said that technology development and inbound logistics (like supply chains) were particularly relevant to the group's discussion. Dr. Hommert surveyed the varied nature of American companies' supply chains. Apple has a significant supply chain presence in China, but still employs over 90,000 Americans and has domestic suppliers. The oil and gas industry has an almost entirely domestic supply chain for historical and resource reasons. Tesla has factories abroad but has its value chain located mostly in the United States. Dr. Hommert said identifying why Tesla chose a domestic value chain, whether from founder pref-

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erence, government incentives, or other reasons, was important to understanding how to capture more of the value chain from American innovations.

Dr. Hommert identified societal benefit as a valuable construct for organizing thinking about how to prioritize policies, segments of the value chain, and technologies. He defined societal benefit as comprising national security; economic security, including manufacturing capacity and technological connectivity with production; and health and well-being, including healthcare and the environment. He cited the Council's 2018 report Accelerate, particularly its list of "Exponential Technologies" on page 44, as examples of valuable cross-cutting, enabling technology. These include AI, 3D printing, cybersecurity, high-performance computing, biotechnology, and advanced materials. He described these fields as areas where the United States was a leader in innovation, but was not controlling or capturing the full value of these innovations. Mr. Chad Evans added that the Council had partnered with Deloitte in 2018 for a deep dive on exponential technologies and their applications called Exponential Technologies in Manufacturing.

Dr. Hommert characterized applied research as an ideal focus for public-private partnership in disruptive technology. He noted that the public sector conducted most basic research and the private sector most experimental development, but that there was near parity in public and private expenditure on applied research that bridged the two. He advocated collaboration in this area to de-risk investment in exponential technologies, citing the example of Sandia's collaboration with microelectronics manufacturers to develop Extreme Ultraviolet Lithography. However, this technology, which enabled the development of 13.5 nanometer laser lithography, was first brought to market by a Taiwanese semiconductor manufacturer, and illustrates the costs of failing to capture the value chain in technology development. For future areas of partnership, Dr. Hommert suggested low carbon energy, post-lithium ion energy storage, high-density energy generators like modular nuclear reactors, and nuclear fusion, which has been made more feasible by advances in magnet and containment technology. He also identified resilient infrastructure in light of climate change and rising sea levels, and healthcare, especially pandemic deterrence via pan-viral drug therapies, as valuable endeavors.

Facilitating Serendipitous Discoveries

Dr. Al Pisano of the University of California, San Diego asked how to increase the frequency of serendipitous discoveries of applications for technologies, such as improvements in magnet technology that have expedited research on nuclear fusion. He said generating more of these connections could move latent innovation through the ecosystem faster, and Dr. Hommert agreed on the benefits of such connectivity. He suggested creating policies, forums, platforms, and partnerships between entities that would force more intersection between exponential base technologies and unmet needs, including healthcare and low-carbon energy. Dr. Hommert said the United States does well in basic research, but not in realizing its applications and turning them into products. He also warned that too much focus on a particular end-use for an innovation, which is what motivates private sector investment, can lead to stakeholders overlooking potential alternative applications. Dr. Pisano asked if the country needed more "ecosystem" thinking with respect to innovation, and Mr. Evans discussed the Council's 2018 Clarion Call, which includes a graphic illustrating the role ancillary technologies play in disruptive innovation.

Improving the Value Chain

Mr. Mark Minevich of Going Global Ventures asked what concrete, specific steps the country could implement to improve the national value chain, in both the short and long-term. He said that experts believed the economy would never return to its pre-COVID-19 state, and that the United States needed disruptive innovations to improve its manufacturing and logistical systems in light of this new reality. The pandemic has altered supply chains, human capital, and the future of work, and Mr. Minevich spoke of the need to move manufacturing out of China and help Americans adjust to the new economic reality,

which will include the transformation or elimination of many businesses and new deployments of information and communications technology and artificial intelligence. Dr. Hommert said he wasn't sure exactly what the solutions to these problems were yet, but noted there would be pressure both to forge ahead in the new economic landscape and to resurrect parts of the old one. He spoke of the opportunity to clarify what constitutes value in the "new normal," and of the continued need for traditional sectors like energy and transportation, even if in modified form. Dr. Roland Stephen of SRI International said the general inclination for policy makers was to look through the "wrong end of the telescope", and that the focus was always on market applications of technologies and industry needs. He predicted the crisis would accelerate existing trends, like the development of shorter, more agile supply chains and the deployment of new technologies in the service sector. Dr. Pisano asked if the "new normal" would provide as many job opportunities as the old landscape, and how innovation could be leveraged to create them if not.

Mr. Dave Vasko of Rockwell Automation said the crisis offered an opportunity for companies to radically rethink and improve their processes and business model. He noted that the "old normal" often included many techniques and models that were "good enough" but not optimally designed. He noted that familiarity and a lack of flexibility previously prevented firms from making changes that would yield efficiency improvements, and that this crisis could provide them with a springboard toward a robust, flexible supply chain. Dr. Gary Pratt of Kansas State University added that the crisis was accelerating changes in the higher education arena, including the closing of institutions, the changing relevance of traditional pedagogy, and new challenges in supporting research and compliance.

Changes in Trends

Ms. Margaret Hallbach of Verizon predicted that the COVID-19 pandemic would reverse the trend toward rapid urbanization in the United States, as people became desirous of more open spaces and feared the public health implications of population density. She also forecasted an increased emphasis on supply chain diversity, which she characterized as a microcosm of the government's competitiveness challenges. She added that the country needed to think about competitiveness in challenging times and crises as well as normal times, and of reframing competitiveness as protection and security, including access to food, medication, and crucial raw materials. Ms. Wince-Smith agreed, and added that movement away from urbanization made the development of robust 5G communications infrastructure in rural areas even more urgent, and noted that a healthy, economically secure populace was crucial to competitiveness as well. She added that reliability was an important component of competitiveness along with security.

The Need for Security

Dr. Gloria González-Rivera of the University of California, Riverside identified food production as an area where the United States needs to invest in supply chain security. Mr. Evans agreed and noted that disruption to the food supply would stifle efforts at enhancing security, productivity, or prosperity. Mr. Minevich added healthcare and biotechnology as key sectors for ensuring supply chain security, and Ms. Sara Lawrence of RTI International echoed the emphasis food security, adding agricultural technology as a key component. Dr. Stephen noted that new needs prompt transformation in applied technology, and that problem-driven approaches would expedite the development of technology to address these issues.

Priorities, Problems, and Platforms

Ms. Trimble asked the group if the United States should adopt a list of strategic technology priorities. Dr. Stephen suggested the development of priority challenges that will require advanced technology to solve, as it gave the country the opportunity to "pull on threads" and uncover new applications for innovations. He discussed the need for the casino industry in Nevada to placate customers regarding the spread of disease by developing ways to remotely identify the sick, and Ms. Lawrence said that Disney World was researching the same issue. Mr. Evans predicted this would become important for all industries that deal with crowded spaces, including cruise ships, airlines, and even office buildings. Dr. Stephen discussed Apple and Google's joint venture to create a platform for COVID-19 testing and contact tracing, and of the need to adequately handle privacy concerns from the gathering of people's personal data. Dr. Pratt urged the continue recognition of the importance of privacy. Ms. Lawrence asked if the focus should be on individual technologies or on cross-cutting platforms to prioritize, and Mr. Evans suggested thinking about problems and the platforms to collaborate on solving them on the one hand, and the technologies and investments needed to do so on the other. Ms. Carol Ann Meares of TechVision 21 asked if a problem-focused approach would change the way the government makes R&D funding decisions, and Ms. Lawrence said that at the regional level innovation blueprints have already shifted from single technologies to cross-cutting clusters that have more applications and opportunities and greater impacts.

Dr. Arun Rai of Georgia State University discussed the potential value of platform technologies for collaboration at scale and through uncertainties. He discussed Bill Gates' recent article on the future of vaccine development, and how creating a common platform for innovation enables the stakeholders who are most important during different stages of the innovative process to easily enter into the process, resulting in a fundamental transformation of the nature of experimentation. This new paradigm would be built for navigating uncertainty, constant innovation, and collaboration at scale. Ms. Meares asked if such a platform would generate problem-specific technologies that could be fed back into improving or informing basic research, and Dr. Stephen said that upstream signaling was critical, with platform technology providing a bridge solution. Ms. Lawrence suggested the group develop criteria for choosing platforms, technologies, and industries to help the prioritization process and focus national and regional conversations in investment in disruptive technology.

Dr. Neil Thompson of MIT suggested delineating three categories of output, especially in light of a "grand challenge" framework. First, there are market-driven research projects, intended to solve pressing issues in key industries like healthcare or energy. Second, there are research projects fundamental to basic research, such as deeper understanding of the brain, or of the nature of matter. Finally, there is research into the technologies needed for the other two kinds of research, such as advanced computing. Ms. Trimble noted that any focus of government research would face political, social, and resource constraints, and that there would always ultimately be trade-offs between different approaches.

Public Desires and Human Capital Questions

Mr. Minevich stressed the importance of considering the societal implications of economic change. He discussed how organizations like the G20 and the International Chamber of Commerce were shifting their focus away from questions of productivity growth and disruptive technology and toward a sustainable, comprehensive, robust, and inclusive economy of the future. Dr. Stephen added that technology was not sufficient to solve societal challenges. Dr. Rai said the emphasis on inclusion was very power-

ful, and too many people were not participating in the innovation ecosystem through expressing their needs and participating in developing solutions. He said in a diverse, democratic country like the United States, an emphasis on expanding participation in the innovation ecosystem was both powerful and imperative.

Ms. Hallbach discussed the importance of the current pandemic on the future of work. She noted that while even some low-wage workers such as call center employees were able to work remotely, "non-critical" service employees who do not have the luxury of working from home were unable to participate in the economy. She said this has the potential to create new groups of "haves" and "have-nots," and will shift the manner in which economic models are contemplated. Dr. Stephen agreed and said it was worrying that a large share of the workforce could be "sidelined" for such a long time. He also expressed hope that "essential" workers, including sanitation workers, food service workers, and first responders, would see an increase in their perceived value, bargaining power, and subsequently pay and conditions. Ms. Trimble noted a similarity in this conversation to issues being discussed in the second Working Group.

Dr. Hommert said he was also concerned about the needed transitions when the COVID-19 pandemic ends after the development of a vaccine and treatments, including how to reassure people about returning to crowded events. He stressed the need to develop the technology to enable people to feel safe from the spread of contagious disease in public. He also suggested developing a priority list for technologies with widespread societal benefit, including healthcare, infrastructure, and climate resiliency. He further emphasized the importance of prioritizing cross-cutting platforms that will enable these innovations.

Concluding Thoughts

Ms. Wince-Smith thanked the group for participating, and noted the common themes that were emerging across all three working groups, particularly those focusing on quality of life and human capital concerns. She compared the current landscape to that of the late 1980s and early 1990s, when U.S. manufacturing capabilities were off-shored and the production infrastructure deteriorated, and the U.S. economy faced significant competition from Japan. She said movement toward advanced production and manufacturing gave the United States an opportunity to develop a more balanced economy, and spoke of the national security and health implications of America relying on foreign manufacture of pharmaceuticals and medical devices. Ms. Wince-Smith added that the Commissioners had charged the working groups with developing short-, medium-, and long-term policy recommendations, and that it was crucial to develop responses to the COVID-19 pandemic to offer short-term solutions.

Working Group 1 Calls April 28

Introduction

The Honorable Deborah L. Wince-Smith welcomed the group and introduced the opening speaker, Mr. Greg Morin of Argonne National Laboratory. Ms. Kathy Trimble said the day's discussion would be focused on the issue of national leadership and strategies for competitiveness. She cited the Commissioners' charge to increase innovation "tenfold", and encouraged the group to think about the structures the country needs to implement to bolster innovation, along with ways to strengthen industry investment in universities and national laboratories.

Opening Remarks

Mr. Morin opened with a discussion of the innovation ecosystem in Chicago, where Argonne is based. He noted that innovation ecosystems vary throughout the country, but felt that Chicago's successes and challenges offered lessons. He described the ecosystem in Chicago as "stovepiped", with insufficient local, state, and federal leadership, a lack of coordination and collaboration, and insufficient incentives for innovators and entrepreneurs to remain in Illinois. He cited the lack of necessary infrastructure and equipment, including lab facilities, as a major obstacle to keeping innovators in the Chicago area.

Mr. Morin also emphasized the importance of tax incentives for investment and construction of manufacturing facilities, and called for a clear plan with defined leadership roles and the involvement of private equity firms in a joint venture to increase innovation tenfold. He warned that venture capital and startups did not possess sufficient resources to shoulder the burden of exponential innovation growth alone. Mr. Morin also called for the creation of incu-

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Ms. Carol Ann Meares

bation spaces for entrepreneurs that would provide access to labs and other scarce facilities and equipment, to be co-located with research universities and national laboratories. In the wake of the COVID-19 pandemic, Mr. Morin urged the country to seize the opportunity to reexamine its supply chains, and to make use of tax and trade incentives that would encourage on-shoring of key production facilities, especially since the United States' competitors use these policy tools.

Another theme of Mr. Morin's remarks was talent development. He praised the decision by President Michael Crow of Arizona State, a Commission Co-Chair, to overhaul the school's engineering program, and encouraged other schools to follow suit with disruptive innovations. He said that because engineers design and make things, without developing the capacity to put knowledge into practice domestically, U.S. engineering schools would become training grounds for the world's workforce but not our own. He also encouraged incentives for students to attend technical schools, and predicted the promise of a job at the end of training would be more enticing going forward as the pandemic and ensuing economic crisis disrupt the traditional four-year college system.

Mr. Morin also addressed the issue of national leadership on innovation. He noted that while the executive branch's ad hoc approach to innovation policy had worked well in the past, the national research enterprise currently suffers from a lack of coordination and collaboration, and is failing to seize opportunities to maintain U.S. leadership in critical technologies. He suggested that the Office of Science and Technology Policy (OSTP) could provide organization and leadership, but worried its support would fluctuate heavily with election cycles. He described AI and quantum technology as opportunities to catalyze a new era of collaboration, and while praising the coordination of efforts by stakeholders in response to the COVID-19 crisis, argued that those systems should have been in place already. Mr. Morin suggested the development of analogs to the Department of Energy's Office of Technology Transition in other agencies, and underscored the importance of coordination from the executive branch given the efforts of America's competitors. While supportive of a national body to integrate research efforts, he expressed concerns that such an initiative could become heavily bureaucratized, like the Department of National Intelligence created in the wake of the September 11th attacks, and identified the need for an organization like the Office of Technology Assistance, which provided in-house education to members of Congress from 1972-1995. At the state level, Mr. Morin discussed Illinois' creation of the Discovery Partners Institute, designed to coordinate research, bring together government, industry, labs, and academia, and encourage entrepreneurs to remain in the state.

Finally, Mr. Morin discussed the role of industry in investing in academic research. He said that companies were willing to invest in universities if they could find a value proposition, but added it was crucial for universities and labs to have appropriate funding to help companies with their needs. He said that most

companies that approach Argonne have specific technological challenges in product development, creating an obvious value proposition with clearly defined roles for the participants. He said that issues around intellectual property and tech transfer were being solved, but warned that continuing declines in R&D funding were decimating America's research capabilities. He also warned that the United States was falling behind not only China, but countries like Japan and Germany, in making the coordination of stakeholders in research a standard operating procedure.

Examples to Replicate

Mr. Chad Evans asked if there were examples states or the federal government could learn from, including endeavors like the BRAIN Initiative, clean energy projects, the National Strategic Computing Initiative, or the Manufacturing USA institutes created by the National Manufacturing Innovation Initiative (NMII). Dr. Robie Samanta Roy of Lockheed Martin said that while the jury was still out on the long-term benefits of Manufacturing USA, there were still key takeaways. First, the NMII showed that government and industry had identified key technologies such as composite manufacturing and advanced computing that were important for the nation to prioritize. He added that the Department of Defense was the key sponsor for many early Manufacturing USA institutes, with corporate sponsors including Lockheed Martin also joining. He described the importance of creating win-win propositions where all stakeholders believe they are getting value, and cited scalability as the biggest issue. He warned that companies were beginning to get "institute fatigue" and were afraid of diluting their efforts by sponsoring more and more institutes. Dr. Samanta Roy further stressed the need to identify a "burning platform" that would focus the energies of participants. In the recent past, national security questions filled this role, but in recent years, innovations themselves were creating challenges. In particular, the deployment of 5G wireless networks has required both government and companies like Lockheed to redesign many communications systems to be compatible.

Dr. Samanta Roy said that the biggest problem facing U.S. technology leadership was advanced microelectronics. He warned that America relied on processors manufactured in South Korea and Taiwan, both of which are in striking distance of strategic adversaries like China and North Korea. To develop protections against supply chain disruption, the United States needs to prioritize the development of microelectronics manufacturing capacity, as well as find a way to fund the tens of billions of dollars in investments this will require.

Mr. Evans asked what the value proposition was from the Discovery Partners Institute (DPI) in Illinois, and asked how the German Fraunhofer Institutes managed to escape the challenge of "institution fatigue." Mr. Morin said that the value proposition for the DPI involved clear leadership of its various components, and noted that prior to the crisis, the state had allocated $1.2 billion in funding, but bud-

getary uncertainties might alter this. He added that one purpose of the DPI was to keep entrepreneurs in Illinois by providing them with access to resources. He discussed how a colleague had relocated multiple startups from Chicago to Boston due to insufficient access to wet labs in Illinois. Mr. Morin said the Fraunhofer Institutes are funded indirectly by the government through funding to industry that is then invested in the institutes, which provides an incentive for engagement with laboratories and causes the institutes to function as a shared service. He also cautioned that it was better to concentrate on finding incentives for all firms to benefit from investment in facilities rather than create long-term projects like the NMII with uncertain value propositions.

State Level Efforts

Dr. Laurie Locascio of the University of Maryland asked if states should engage more with federal science and technology strategy, noting their leadership in response to the COVID-19 pandemic. Mr. Morin said that state engagement was inevitable because funding for national laboratories and for basic research was disbursed at the federal level. He added that states have significant control over innovation ecosystems through tax policy and the environment they create for entrepreneurs, and in their ability to respond to the unique challenges and conditions of regional innovation ecosystems. He said that Argonne struggles to attract and retain startups because of a challenging environment for entrepreneurs at the state level. Mr. Morin also called for improved coordination frameworks across agencies, noting that none of the national laboratories conduct medical research because there is no way for them to collaborate with NIH. Finally, he praised the current administration's funding of AI and quantum research, saying that picking targets for labs, universities, and industry to focus on is the right policy, provided those targets are relevant to America's national interests.

The BUILD Initiative

Mr. Evans discussed the Council's Building University-Industry-Laboratory Dialogue (BUILD) Initiative, the final report for which will be posted on April 30. Funded by a grant from the National Science Foundation, the final report contains ideas for public-private partnerships to create the next generation of microelectronics, as well as "bridge" technologies to allow for continued progress before a new technology with its own "S-Curve" innovation path is found. He discussed America's need for semiconductor leadership, and the rapid consolidation of the processor market, as cutting-edge 7nm fabs are only being manufactured by Intel, Samsung (South Korea), and TSMC (Taiwan), in contrast to 8 leading-edge firms just 10 years ago. He said the United States needs to think about resiliency and innovation in this space, and noted that the recommendations are geared toward the Joint Program Office of the National Strategic Computing Initiative.

Continuity Across Administrations

There was significant discussion by participants about ensuring continued support for scientific research in national priority areas across presidential administrations. Dr. Paul Hommert, formerly of Sandia National Laboratory, said any coordinating office needed the capacity to span administrations, and had to develop a "burning platform" to encourage ongoing focus, such as national security. He said that securing Presidential support was the most important element of robust investment in research. Ms. Candace Culhane of Los Alamos National Laboratory noted that current initiatives in quantum computing and artificial intelligence are the result of policy groundwork laid by the National Strategic Computing Initiative of the previous administration. Ms. Trimble highlighted a graphic produced by NSF showing how its investments in basic research in past decades contributed to the development of current commercial technologies, which is available on the online portal. Dr. Tom Campbell of Future Grasp Ventures noted that because administrations change frequently and bring their own priorities with them, some sort of legislative or legal structure was necessary to ensure long-term research enterprises were not disrupted. He said it was frustrating to watch great projects "die on the vine" due to a change in administration or a new session of Congress.

Next Generation Microelectronics and the Importance of Administrative Support

Ms. Wince-Smith identified microelectronics as the "holy grail" of U.S. competitiveness, and spoke of the need to encourage collaboration and shared investment across departments and agencies. She noted that the Department of Defense, with its large budget and clear mandate, was in a strong position to help guide such efforts, especially with renewed focus on national security in the wake of the COVID-19 pandemic. She also identified several challenges in the governmental and legal structures surround the research ecosystem that required addressing.

First, agencies face arbitrary rules restricting their funding activities- the National Science Foundation cannot invest in the national laboratories or universities, but the Department of Energy's Office of Science faces no such restrictions. Second, funding for research is appropriated by Congressional Committees whose purview does not match with the mandate of the agencies they oversee. A case in point is the National Institute of Standards and Technology (NIST), which, along with the rest of the Department of Commerce, is funded largely by committees with other focuses, including housing. Third, administrations and Congresses led by both major parties have defunded important efforts due to changing political goals. In the 1990s, the administration gutted funding for nuclear energy through the Department of

Energy, which continues to hamper deployment of nuclear technology in the United States today. She also noted that many times new administrations shut down their predecessors' programs before belatedly realizing their value and trying to restart them. She urged cultivation of bipartisan support for scientific research to mitigate these problems.

Ms. Culhane noted that American innovations in High Performance Computing stemmed from the HPCC Act of 1992, which was a response to Japanese challenges to American leadership through the Fifth Generation Project. She said that the United States often seems to respond better when it is reacting to leadership challenges from competitors rather than thinking proactively. Ms. Wince-Smith also praised the current Under Secretary of Energy for Science, Dr. Paul Dabbar, who has expressed a desire to continue initiatives in advanced microelectronics and quantum computing from the previous administration.

A Tipping Point?

Dr. Hommert suggested engaging with Congressional committees responsible for science and technology, encouraging them to take a bigger role in fostering understanding among government officials of the importance of scientific research, and in enhancing connectivity between the parts of government responsible for funding scientific endeavors. He said that while full-scale change of governmental structures would be difficult, the committees could highlight and push for implementation of valuable adjustments to the existing structure. Mr. Evans noted renewed interest in microelectronics from policy makers, and asked if the government was reaching a "tipping point" of interest in research in next generation semiconductors.

Industry Investment in Universities

Ms. Trimble asked the group for thoughts on bolstering industry investment in academia. Dr. Samanta Roy identified intellectual property as one area for improvement, although he said the issues were not insurmountable, and praised Dr. Locascio's work on collaborative research with the University of Maryland. He said that universities and industry collaboration could enhance the talent pipeline of students and workers, and could generate more ideas and help turn them into products and processes. He added that the relationship works best when universities produce students who can fill unmet needs for industry, industry invests in university infrastructure, and they co-create ideas and work to bring them to market.

Dr. Samanta Roy also identified a tension between the openness of the U.S. university research system, which is a strength, and the risk of having intellectual property stolen or used for asymmetric benefit by strategic competitors like China. He praised OSTP for recognizing the importance of the issue and soliciting university and industry input in addressing the problem, but warned that the nation needed to strike a balance. He said an overreaction in one direction could damage the university enterprise, and

that his own company often faced challenges when working on projects with a national security dimension. Mr. Dave Copps of Worlds Enterprises characterized the problem as one of urgency. He noted that universities accept funding from China because the Chinese government is willing to provide prompt funding and assistance. He also characterized the university technology transfer system as archaic and highly uneven in quality. He advocated for a national system that tracks research projects, funding levels, and resource and equipment needs at universities around the country, warning that money was wasted when it was not spent with a strategy in mind. Mr. Evans noted a recent presentation by an academic at a leading research institution arguing that American and Chinese research efforts were complementary, and said this view prompted questions about how to ensure that America's investments in research redound to our own benefit.

Concluding Thoughts

Mr. Morin reiterated his call for greater entrepreneurial access to research facilities owned by the government, warning that Argonne and other national laboratories turned away hundreds of great startup opportunities every year over resource and authorization concerns. He added that the Department of Defense and other federal agencies possessed labs facilities that could benefit entrepreneurs as well. Mr. Evans praised the idea of entrepreneurs-in-residence at research facilities and institutes, and added that the Council's AEMC initiative with the Department of Energy included a report with a public-private partnership proposal to encourage these arrangements. Ms. Wince-Smith thanked the group for their discussion, and praised the work Argonne National Laboratory has done to make Chicago an innovation hub. She discussed the region's importance to economic progress throughout American history, as well as present initiatives like financial institutions that provide liquidity to small businesses and startups and the Climate Exchange to encourage low-carbon innovation. She also praised the work of Argonne and the University of Chicago on the Advanced Battery Consortium. Finally, she warned that it was crucial for universities to reopen for the new academic year, as it would be catastrophic to America's higher education ecosystem if universities suffered another fiscal blow following the COVID-19 pandemic.

Working Group 1 Calls April 30

Introduction

Ms. Kathy Trimble welcomed the group and discussed the focus of the day's conversation: leadership in national strategies for innovation and competitiveness. She then introduced the two featured speakers, Mr. Greg Morin of Argonne National Laboratory, and Dr. Arun Rai of Georgia State University.

Opening Remarks: Creating a Hospitable Ecosystem for U.S. Technology Leadership

Mr. Morin framed his remarks around the guiding questions for the day's discussion: increasing innovation capacity, improving the national leadership structure for innovation, and fostering greater industry investment in research and development at universities and national laboratories. He opened by listing federal support for basic research, the education system, and infrastructure as the backbone for America's innovation ecosystem. He praised the development of a national innovation strategy by the Obama White House, and hoped it would become a best practice for future administrations. In Chicago, where Argonne is located, Mr. Morin praised the investments the city and state have made in the innovation ecosystem, but said it was hampered by a lack of leadership at the federal, state, and local levels. He urged the creation of policy incentives for building innovation capacity, and stressed the importance of having engaged and committed policy makers in addition to adequate funding. Mr. Morin

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warned that Chicago was still losing innovators to the coasts in spite of its investments because of a lack of infrastructure and facilities.

For his first category of recommendations, Mr. Morin called for a coordinating body that would establish clear targets and hold policy makers accountable for implementing them. He said increasing innovation "tenfold" per the Commissioner's charge, was a real goal, but that it needed an explicit framework to be achievable. He called for tax incentives to spur investment in innovation, trade policies that put American manufacturers on even footing with competitors, and the leveraging of private equity and large firms in fostering innovation. He reiterated his call for more local infrastructure for innovators to use, including co-location programs that would allow entrepreneurs to access federally-owned research labs. He warned that America's competitors were using trade and tax levers against U.S. firms and urged a response, and strongly urged an overhaul of the talent development pipeline. Mr. Morin praised Arizona State University's revamping of its engineering school to significantly increase its output of graduates, calling for other universities to follow its lead. He said that engineers want to make things, and without manufacturing capacity, America's engineering schools would become international training grounds for overseas jobs. However, improving the talent pipeline is essential to increasing American manufacturing capacity. To that end, he called for greater leveraging of technical schools, with manufacturing jobs available to students upon graduation. He predicted the appeal of such programs would increase as the COVID-19 pandemic disrupted the conventional four-year college model.

Mr. Morin also made several recommendations regarding governmental leadership in innovation. He observed that the executive branch lacked a central coordinating entity for overseeing innovation policy. He said that while the White House Office of Science and Technology Policy (OSTP) could fill such a role, its funding and emphasis vary significantly across administrations. Mr. Morin also criticized the "stovepiping" of research by different federal agencies, with minimal opportunities for coordination or collaboration among the Departments of Defense and Energy, the National Institutes of Health, the National Science Foundation, and other science-focused agencies. However, with the last two administrations providing ample funding for quantum computing and artificial intelligence research, he expressed hope that this, along with the efforts of America's competitors, would spur action on better coordination, especially with the rise in collaboration during the COVID-19 pandemic. Mr. Morin suggested that other agencies create analogues to the Department of Energy's Office of Technology Transition, and creating an integrating body for the national research enterprise. However, he urged the government to learn from the example of the Office of the Director of National Intelligence, which he said was too bureaucratic and inefficient. His final recommendation for the executive branch was a well-funded program allowing entrepreneurs to access federal research facilities. He noted that Argonne was forced to turn away hundreds of entrepreneurs every year due to lack of funding for partnership opportunities, and praised the Department of Energy's advanced manufacturing program as a model for scaling.

Mr. Morin offered further suggestions for Congress and for sub-national governments. He advocated the creation of an office analogous to the Office of Technology Assistance (OTA), which provided in-house, bipartisan information to Congress on emerging technologies from 1972-1995. Between the demise of the OTA and the dearth of scientists in Congress, Mr. Morin expressed concern at policy makers' lack of scientific understanding and appreciation of the value of scientific research. At the state and local level, Mr. Morin called for all states to develop offices similar to the Illinois Science & Technology Coalition. He said that businesses found this office so valuable that they financially supported it after it was privatized by the state.

Finally, Mr. Morin offered his thoughts on increasing industry investment in universities and national laboratories. He said that industry is willing to invest in these organizations when it can see a value prop-

osition, citing the examples of companies turning to national labs to research solutions to technical challenges during their design process. He said that intellectual property challenges were navigable provided companies have effective legal counsel, and warned that America's competitors, especially China, were far ahead in making industry-academia partnerships standard. Mr. Morin cited the German Fraunhofer Institutes as a model for collaboration, and called for greater internal R&D efforts by corporations, which would provide more opportunities for partnership. He encouraged the use of tax incentives to increase corporate research, and urged companies and labs to pay attention to China's infiltration of American academia and its security implications.

Opening Remarks: Ramping Up "Solutions" Innovation

Dr. Rai distinguished between innovations that occur serendipitously as the result of basic scientific research and experimentation, and "solutions" innovation in response to a market need or societal problem. He said the latter were most directly connected to competitiveness, and identified four aspects to increasing America's capacity for solutions innovation.

First, he called for broadening and deepening entrepreneurship initiatives at universities. While many universities have expanded these programs in recent years, particularly at his institution, Dr. Rai urged scaling of the many grassroots efforts in this space, which include incubators and accelerators, faculty externships at companies, and executives-in-residence. Second, Dr. Rai argued that innovation requires atypical combinations of talent and resources. He noted the development of novel, agile organizational designs at universities to improve innovation. One example is Hong Kong University of Science & Technology's sister campus in Guangzhou, focused on cross-cutting themes and technologies like AI and entrepreneurship. Another example is MIT's College of AI, which is focused on translating academic knowledge into practice, developing a pipeline of students and workers, and bringing together expertise in disciplines ranging from computer science to ethics to cognitive psychology. He added that these initiatives incentivize industry investment by providing a value proposition up front, and called for continued improvement on IP and tech transfer frameworks, noting the lagging U.S. position relative to countries like China and Germany

Dr. Rai called for investment in improving digital platforms and infrastructure, which he said would "democratize" innovation. He criticized the heavy geographic, demographic, and industry concentration of venture capital and human capital, and argued for greater engagement from professional schools outside the STEM field and demographically diverse universities in the innovation space. He said this democratization would require much greater interconnectivity and sharing of data and digital assets. He noted that China just announced a national initiative for a new wave of digital innovation, and said widespread data sharing will require 5G, cloud technology, and blockchain to preserve privacy. However, with over 100 universities classified by the Carnegie foundation as "highest research activity," Dr. Rai said the United States possessed the capacity to prototype new structures between academia, industry, and government.

Finally, Dr. Rai called for the architecting of regional innovation ecosystems to shorten the flow from innovation to commercialization. He described NSF's efforts to build regional innovation ecosystems around the country, including one in the southeast focused on healthcare technology with participation from Georgia State University, Georgia Tech, and the University of North Carolina-Chapel Hill, among others. He praised the initiative's partnering with Amazon to provide access to cloud capacity and platform infrastructure, and its focus on developing prototypes for experimentation. Another key component of regional innovation is community outreach, especially to high schools. By encouraging students to think about becoming innovators at an earlier age, the United States can develop a larger cohort of future entrepreneurs with an innovation mindset.

Measuring Innovation Capacity

Participants debated and discussed the definition of "innovation capacity" and how best to develop metrics that were relevant, comprehensive, and understandable. Dr. Al Pisano of the University of California, San Diego noted that a tenfold increase in innovation capacity was a very lofty target, and that he doubted the United States was currently equipped to even double its innovation output. Lt. Col. Stewart Parker of the Center for a New American Security stressed the importance of clarity in metrics, lest we end up chasing meaningless statistics and ascribing value to things because they are measured, rather than vice-versa. Ms. Sara Lawrence of RTI International embraced the "tenfold" goal, asking who would drive exponential innovation if not for the United States. She also voiced support for a national coordinating body, which she said could ignite a renewed regional development push and foster innovation mindsets around the country.

Dr. Tony Tether, formerly director of the Defense Advanced Research Projects Agency (DARPA) asked what a tenfold increase in innovation capacity would look like. He warned that without a clear picture of what to aim for, stakeholders would not know where or how to spend money. Dr. Neil Thompson of MIT responded that there were many proxies, including patents issued and citations in academic journals. He also expressed alarm at two other proxies for innovation that he said were trending in the wrong direction- the number of new FDA-approved drugs and the cost of bringing them to market, and the decreasing contribution of scientists and engineers to U.S. GDP. Of particular note is that the latter value is decreasing even as the share of scientists and engineers relative to the total population increases, meaning the productivity of America's scientific research is declining. He suggested greater use of automation and other innovations to make scientific research more productive. Dr. Tether expressed a desire to define innovation capacity for the entire country, rather than a single sector like universities.

Dr. Pisano suggested the creation of platforms allowing collaborative innovation. He cited the MOSIS Project, which allowed large numbers of innovators access to experimental resources and used crowdsourcing of experimentation to develop advances in microelectronics. He suggested tracking the number of innovators participating in these initiatives as a metric, arguing that more "shots on goal" would lead to more breakthroughs. Dr. Tether asked how to develop a metric for overall capacity, and Dr. Pisano suggested that platforms could be one component of a composite measurement that spans different sectors. Mr. Bill Bates clarified that the tenfold increase in innovation was aspirational, and that the Commissioners wanted the Working Groups to think more boldly than just increasing funding for different agencies. He also described the attempt of the Council to define innovative capacity in the National Innovation Initiative in 2005, summarized in Innovate America. Mr. Bates described innovative capacity as a combination of talent, investment, infrastructure,

and technology, and provided a succinct definition of innovation as "value from ideas." Dr. Tether said that using gross national product per capita was a possible metric for innovation, even if a tenfold increase was a high bar to clear.

Another idea for a metric came from Dr. Tether, who suggested setting a goal of increasing the number of newly licensed technology companies by a factor of ten. He said this metric would reveal America's capacity of innovation, and added that to achieve it the country would have to vastly improve its ability to connect people with ideas to funding. Dr. Rai said that while metrics are important, they must also specify whether they are measuring novelty or value. He discussed attempts to leverage the USPTO's database of patents to identify which inventions are breakthroughs using citations, and noted that many papers and patents are never cited after publication. He added that an output-focused metric should also distinguish between improvements from greater inputs and improvements from better connectivity between existing inputs, and overall favored a "scorecard" approach that measured innovation along multiple dimensions.

Dr. Tether suggested that striving for a tenfold increase in innovation, however defined, would necessarily generate better government leadership in innovation and increase industry investment in universities and labs. Dr. Rai said that digital infrastructure improvements would provide us with far more data and enables researchers to measure things they previously couldn't, which would enhance the ability to develop effective metrics. He described data as the biggest constraint facing researchers, and warned that U.S. scholars were doing and publishing empirical work in China, including on COVID-19, because that was where they could get real data. He emphasized that use of blockchain could protect privacy while giving researchers far greater resources.

Mr. Andre Doumitt of the Aerospace Corporation suggested creating a national innovation metrics dashboard. It would track the number of new technology companies, new laboratory licenses of technology to industry, the number of SBIR awards to startups, STTR awards to universities, technology internships filled by high school and college students, and other metrics. Ms. Lawrence echoed this idea, saying it would also provide away to develop a common innovation agenda for stakeholders. Mr. Doumitt emphasized its simplicity and marketability, while Ms. Lawrence discussed and shared examples of similar dashboards that RTI International had developed in Southeast Asia and in North Carolina. Mr. Morin shared a link to Illinois' Innovation Index as another potential model.

Institutional Design

A common theme in discussions was the need to better support innovators with systems that facilitate, rather than obstruct, innovation. Dr. Roland Stephen of SRI International stressed the need for end-user inspired research and greater collaboration, arguing these would facilitate transition of innovations out of

the lab. Ms. Lawrence called for cultivation of entrepreneurship outside the university system. Mr. Phil Weilerstein of VentureWell said that while the economic impact of an innovation is hard to predict, there were too many cases of ideas failing to leave the laboratory, or of startups failing to take off, due to a lack of basic support. He said the market is sometimes too clogged with competitors relative to the opportunities in a given space, and he encouraged the group to think about what the pipeline should look like. Mr. Weilerstein said that with thoughtful support, policy makers could also begin to identify the yield ratio of ideas needed to advance a given number to the next stage of development. He also stressed that gathering this information would not require significant time or capital, and could rely on existing mechanisms, but that there would be a need for new forms of capital once promising ideas had been identified. Without this support structure in place, there will be no value proposition at the stage of development where de-risking investment is most needed.

Existing Mechanisms for Fostering Innovation

Participants discussed the challenges and opportunities present in existing mechanisms for fostering innovation, including the Small Business Innovation Research (SBIR) program and the Small Business Technology Transfer (STTR) program. Mr. Doumitt noted that STTR now allows a faculty member to start a small business and obtain Phase 1 and Phase 2 funding while working full time, and that this de-risks innovative spinoff companies at universities. He suggested that this model be followed for national labs and federally-funded research and development centers (FFRDCs) as well. Mr. Weilerstein said that the pathway from idea to impact needed to be made more efficient to keep good ideas from dying. He advocated better early funding, easier access to talent, and more flexible early stage capital. He also criticized many of the program rules in SBIR, arguing that they disincentivized doing the right thing. He noted there were mechanisms in other agencies that would provide value to SBIR participants in terms of talent and infrastructure, but that there was no coordination across agencies to weave these resources together in a more coherent way. Dr. Tether pointed out that getting venture capital funding could be even more challenging than obtaining SBIR funding, and Mr. Doumitt praised SBIR's recent revamp that cut down on bureaucratic. He described how the Phase 1 funding process had condensed from 9 months to 3 months, and that the funding amounts for Phase 2 had increased to between $750 thousand and $3 million. Mr. Doumitt also praised the Air Force Venture track, which enables recipients to receive up to $60 million over four years.

Problems and Platforms

Dr. Stephen Roland encouraged a focus on platform technologies to facilitate innovation, and on a problem-centric national mindset to sharpen innovators' focus on major societal challenges. He characterized

stove-piping and lack of communication as a major obstacle, and suggested redesigning institutional environments to focus on problems as a starting point. Dr. Stephen also suggested academia work with business and other external partners on identified problems. Ms. Lawrence said developing a platform for collaboration was a key first step, and would then allow stakeholders to develop criteria for problems to select. Dr. Stephen added that a platform approach would help with the developing and monitoring of innovation metrics, but urged the group to focus those metrics on being more efficient in generating innovation outputs from existing resources, not just increasing inputs. He also reiterated the need to instill a problem-focused mindset in universities. Ms. Lawrence said that in a time of crisis, it made sense to connect problems to ongoing societal needs, including healthcare and economic challenges.

Efficiency and Total Factor Productivity

Dr. Thompson discussed the link between innovation capacity and Total Factor Productivity (TFP), the residual economists use to measure productivity improvements that translate into a higher standard of living. TFP is calculated by measuring the observed increases in capital and labor (both size and skill of the labor force) and their impact on economic growth, with remaining growth explained as productivity increases. TFP growth has been declining in the United States in recent years. Dr. Tether asked if TFP was a proxy for innovation capacity, and Dr. Thompson said that while they were not identical, TFP represented innovation manifested as prosperity, and was thus an extremely important metric. Dr. Stephen asked what the causes of the TFP slowdown were, noting some commentators had identified the lack of technological adoption in fields like healthcare and education as a cause. He asked if it was possible to look at what the U.S. economy was doing differently when TFP was higher. Ms. Lawrence noted that the dashboard her company made for southeast Asian clients included a TFP tracker, and echoed the importance of measuring and trying to increase it.

Other participants were cautious about too much emphasis on resource efficiency as a proxy for innovation. Lt. Col. Parker said that while it is important to be good stewards of resources, the innovation ecosystem is full of unforeseen dead ends, and that too much emphasis on efficiency will result in restrictive control mechanisms by innovators and leave them without alternatives if a line of inquiry hits a dead end. Mr. Weilerstein agreed that efficiency in research and experimentation was not everything, but reiterated that the country could not afford to lose ideas or companies because of insufficient advice and support or excessive bureaucracy.

Concluding Thoughts

Ms. Trimble asked the opening speakers how the conversation had shaped their thoughts. Mr. Morin said he was glad to see robust discussion on definitions and metrics for innovation capacity, and

Dr. Rai said the group should continue to explore different aspects of its discussion. Dr. Rai said that if the group develops a solid metric for innovation, it could become a valuable reference for stakeholders. He also called for greater understanding of how different components of the innovation system connect with each other, and said that while the patent system is important, the United States must do a better job connecting different fragments of the innovation pipeline. He concluded by urging a coordinated initiative to increase data and data access, which he said would enable more robust measurement of innovation capacity.

Ms. Trimble connected the innovation capacity dashboard discussed by the group with the idea in Working Group 3 of a dashboard containing information on ongoing innovation projects and their funding levels and needs. She noted they shared the ideas of transparency and creating a "one-stop shop" for important information, making it easier to leverage resources and connect the dots between different components of the system. Dr. Tether noted that the patent system was the United States' first attempt to encourage innovation through intellectual property, and Ms. Trimble mentioned Working Group 3's exploration of the challenges of the patent system in an increasingly digital economy.

Working Group 1 Calls May 5

Introduction

The Honorable Deborah L. Wince-Smith welcomed the group and introduced the featured speaker, Ms. Sara Lawrence of Research Triangle Institute International (RTI). She noted that the Council studied the innovation ecosystem in the North Carolina Research Triangle, anchored by the cities of Raleigh, Durham, and Chapel Hill and their associated institutions of North Carolina State University, Duke University, and the University of North Carolina-Chapel Hill, in the late 1990s. This initiative was the first Council publication focused on regional innovation ecosystems.

Mr. Chad Evans announced that following the June 16 virtual meeting of the National Commissioners, the Working Groups will undergo two substantive changes for phase II of the Commission. First, a fourth working group will be spun out of the second working group, with Working Group 2 focusing on the future of sustainable production and consumption, and the new Working Group 4 focusing on unleashing capabilities for work and entrepreneurship. Additionally, starting the week of June 22, calls for each group occur once per week, and will be led by co-chairs nominated by the Council, with Council support. Each call will be preceded by a primer with background information and policy recommendations to debate and consider, and the focus of the next phase of calls will be the development of actionable policy recommendations stemming from the conversations the working groups have had.

Opening Speaker

Ms. Lawrence began her discussion with a background overview on RTI. Started by the three Research Triangle universities in 1959, it is a nonprofit venture with offices across the United States

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Ms. Carol Ann Meares

and around the world, featuring staff trained in over 230 disciplines. She characterized the institute as a "university without students" due to its research and thought leadership activity. She discussed her background in helping states, regions, and other countries diversify their industrial base, foster innovation, and create jobs as head of the institute's economic development practice. Ms. Lawrence said the takeaways from her work internationally had significant relevance to the challenges of developing regional innovation ecosystems in the United States.

Ms. Lawrence identified seven major lessons in developing successful innovation hubs. First, it is necessary to establish a coordinating organization to prevent different agencies and stakeholders from fighting for control of the initiative and to align all the different parties' activities. Second, policy makers must make innovation plans and stick to them over time. Ms. Lawrence said that over 50 countries have launched a national innovation initiative of some kind in the past decade, but the United States has not. Third, it is crucial to invest in education, both to prevent "brain drain" as talent leaves for other opportunities and to help create the talent needed to take advantage of facilities and other assets. Ms. Lawrence warned that building research parks and laboratories will not result in innovation without a skilled workforce and a means of connecting workers to opportunities to innovate. Fourth, countries and regions need to invest in R&D. While many countries have set targets for R&D as a percentage of GDP, often around 2 percent, most countries are not spending at that level. Ms. Lawrence added that ideally R&D funding should come from both public and private sources. Fifth, policy makers must strengthen university-industry partnerships through intern and externship programs, curriculum co-development, joint R&D grants and projects, faculty sabbaticals in companies, and shared facilities and working spaces. Sixth, innovation plans must have a sector focus. Ms. Lawrence noted the success of nations like Taiwan, Singapore, and South Korea in fostering dynamic economies through focusing on key industries and building infrastructure to benefit entire sectors. Finally, there must be places to innovate. These include science and technology parks, innovation hubs and districts, incubators and accelerators, and shared working spaces. The keys to place-based innovation are dense, multi-purpose, mixed-use infrastructure and facilities to ensure people from different sectors with different ideas and skill sets interact.

Ms. Lawrence also stressed the importance of assessing the innovation policy climate. While she emphasized that assessing political institutions and political economy were more of a focus for emerging economies, she encouraged evaluating the existing policy landscape. Policy makers should identify policies that reinforce innovation, policies that create bottlenecks, useful policies that are missing, and policies that should be modified or eliminated. To the extent that political economy becomes important, policy makers should identify potential leaders who will champion innovation initiatives, and identify potential bottlenecks and mitigation strategies in advance. Ms. Lawrence also stressed institutional capacity, which she said develops when stakeholders feel a sense of urgency. She expressed her belief that the United States was finally shaking off complacency about the importance of innovation for competitiveness, and characterized the current moment as an opportunity for the Council and the Commission to help chart a bolder course for the future.

Framing Questions

Ms. Wince-Smith praised the presentation and said that the focus on urgency was especially important. She emphasized that the Commissioners gave the working groups a mandate to "knit together" different regions and establish innovation centers throughout the country, not just on the coasts. Mr. Mike Cassidy of Emory Biomedical Catalyst praised RTI's work in the tech sector around the country, and Ms. Kathy Trimble drew attention to the framework Ms. Lawrence presented for assessing the policy climate. This includes identifying actors and organizations (capital, government and public agencies, the private sector, support services and contractors, and uni-

versities and research institutes) and foundational components (human capital, digital infrastructure, and culture, values, and norms).

Successes and Challenges in Setting Up Collaboration

Dr. Paul Hommert, formerly of Sandia National Laboratory, asked Ms. Lawrence if RTI had seen success in fostering innovation ecosystems at the state level. Ms. Lawrence said that RTI had seen progress in developing industry clusters of innovation, but that the institute had struggled to cultivate regional innovation centers. She described the successes of the IT and biotechnology hubs in the Research Triangle region, which stem from investments made up to 40 years ago by the state government in microelectronics and biotechnology. In particular, grants and collaborative projects for microelectronics research helped draw IT companies to the region, and the North Carolina Biotechnology Center seeded and cultivated initiatives to attract researchers, funding, and industry investment. However, expanding this innovation beyond metropolitan centers, both in North Carolina and across the United States, has proved challenging, due to funding constraints, the difficulty of identifying potential growth clusters outside of urban areas, and the need for a more comprehensive focus.

Mr. Cassidy described Georgia's efforts to build an innovation cluster centered around Atlanta after the state saw the creation of the Research Triangle initiative as a wake-up call. He said that while Atlanta had succeeded in developing robust financial and security technology industries, more comprehensive innovation would require a more comprehensive approach. He warned that simply creating industry clusters or trying to attract venture capital is not sufficient to develop innovation centers, and praised the Commission's attempts to develop a comprehensive framework for addressing the issue. Ms. Lawrence described RTI's "blueprint" for extending innovation in a 125-mile radius around the Research Triangle, and encouraged the group to think of the geography of policies and opportunities.

The Importance of Leadership

Mr. Evans, drawing on the Council's previous work in this space, said that "clusters" follow economic activity, not political boundaries. He stressed the importance of leaders who think beyond their electoral jurisdictions and work to connect experts and innovators throughout the broader region. He added that because of changing personnel, it was important to continually push this focus as new leaders emerge, and characterized the present as a good time to re-emphasize the Council's existing thought leadership on the issue. Dr. Tony Tether, former director of the Defense Advanced Research Projects Agency (DARPA), encouraged the development of a problem-focused mentality. He said that when stakeholders realize what they need, they make significant progress on innovation. Mr. Evans added that even though many Council reports on regional innovation and leadership are dated, they are foundational and contain many takeaways worth restating or updating. He added that there are more Council efforts underway on the regional dimensions of specific advanced technologies, like high performance computing, and said that the group's conversation had illustrated clear advances in how to think about regional innovation. Nevertheless, he cautioned that many problems will never go away and require constant vigilance from thought leaders and stakeholders.

Flows of Funding, Ideas, and People

Dr. Robie Samanta Roy of Lockheed Martin characterized the key components of successful innovation systems in terms of flow. First, he discussed the flow of people and talent. While acknowledging their good intentions, he characterized policies that restrict the movement of people between government and industry as an impediment to innovation. He said that the United States has become too risk averse in this regard, and that our competitors do not have these restrictions. He suggested that it was possible to develop inter-personnel agreements between government and industry to facilitate the flow of expertise and human capital while maintaining robust conflict of interest protections.

Second, Dr. Samanta Roy discussed the flow of ideas. He stressed the importance of expediting the creation, regulation, and preservation of intellectual property in order to streamline the flow of ideas. He praised ongoing efforts by universities including Harvard, MIT, Stanford, and the University of Maryland to cut through IP red tape and make public their research and ideas to address the COVID-19 pandemic.

Third, Dr. Samanta Roy emphasized the flow of money. He criticized provisions surrounding federal research grants to industry, which must be used within two years or else returned, and suggested allowing recipients to "bank" unused research funds for future opportunities, since there are not always chances to deploy funding immediately. He also suggested addressing tax incentives and other policies that influence the flow of money among government, industry, and academia.

Mr. Evans framed Working Group 2's discussions of test beds and demonstration platforms as an example of flow, from sharing ideas across groups and individuals to ensuring a flow of funding to startups and inventors. He added that national labs and universities are natural hubs for regional innovation clusters, and that many projects can be done in a regional context. He also discussed the flow of topics across working groups, and suggested an opportunity for cross-pollination between this group and Working Group 2 on the issue of test beds. He emphasized that technology must ultimately be deployed and scaled in a way that drives manufacturing and value creation.

Another example of flows and connections arose in the discussion of university-industry collaboration. Ms. Carol Ann Meares of TechVision 21 asked how universities in the Research Triangle incentivize industry collaboration. Ms. Lawrence said the major draws were a pool of students who were already partially trained for jobs in industry and provided firms with a fertile recruiting ground, and shared access to research facilities and working spaces. She cited the Georgia Research Alliance in the Atlanta area as another example of such collaboration.

Cultural Dimensions of Regional Collaboration

Ms. Lawrence agreed with Dr. Samanta Roy's comments on risk aversion. She noted that one challenge in building regional innovation ecosystems in North Carolina was a sharp divergence on how stakeholders viewed risk. While academic and industry leaders in urban centers were enthusiastic about dynamic transformation and risk-taking, and smaller urban centers also expressed a desire to transform their economies, in more rural areas a scarcity mindset predominates. Some stakeholders are focused on trying to regain assets and industries they have lost, and view collaboration as inviting further unwanted transformation in the form of deindustrialization. Ms. Lawrence noted that even high school sports rivalries have served as barriers to different jurisdictions cooperating on projects. She said this lack of underlying vision is the cause of many breakdowns at the state level. To combat this, Ms. Lawrence stressed the importance of highlighting examples of successful collaboration, even at levels as granular as specific university departments or subsets of industries. By describing these ventures and showing how they work, policy makers can encourage broader adoption of best practices. She observed that universities, companies, can capital can only generate innovation if they have frequent, high quality interactions.

Political Splintering

Ms. Wince-Smith observed that there was little collaboration between North Carolina and South Carolina, even though both states had invested heavily in innovation. She characterized this as an example of lack of coordination across jurisdictions hindering regional innovation efforts. She added that while some organizations, like the Western Governors Association, are designed to foster this collaboration, the Council needs to engage more with the National Governors Association and encourage the formation

of more alliances. As an example of the pitfalls of the status quo, Ms. Wince-Smith described the failure of an alliance centered around Rochester and incorporating former executives from major companies like Xerox and Kodak that failed because county governments could not come to an agreement on funding shared infrastructure. She also discussed the problems regional splintering is presenting for state responses to the COVID-19 crisis. She said it was imperative for the Commission to look at the innovation capacity of the whole country, and not just certain parts.

Mr. Cassidy agreed with Dr. Tether's assessment that innovation stems from perceived needs, but added that national innovation strategies require the engagement of national leadership, He lamented the lack of national action on innovation in the years since the America COMPETES Act, stemming from Council research, was passed, and asked what lessons could be drawn about securing national engagement. He added that organizations like the National Governors Association have emphasized this issue, but have been unable to make any policy headway. Ms. Wince-Smith said the Council's National Innovation Initiative succeeded by carefully cultivating industry leaders who were deeply engaged with the areas where they worked, and through engaging leaders in Congress and among state governors from both parties alongside university leaders. She noted the Council is active in engaging with current governors regarding the National Commission, but that the COVID-19 pandemic presents challenges in this regard. However, she praised the actions of governors in northeastern states, and of universities around the country, as they come together to coordinate a response to the pandemic.

Concluding Thoughts: Keys to National Engagement

Ms. Wince-Smith encouraged the group to think about cutting across regions in developing innovation, and to take the best elements of the federal system and marry it to state and regional innovation initiatives. She stressed the importance of leaders in industry, government, academia, and the national laboratories, who she said care deeply about the good of the country but need to be identified and engaged with. While the Council can serve as a powerful systems integrator, it is ultimately these leaders who develop ideas and solutions and put them into practice. She also stressed the need to carve out a regional focus for the Commission's work going forward.

Working Group 1 Calls May 7

Introduction

The Honorable Deborah L. Wince-Smith welcomed the group and introduced the featured speaker, Ms. Candace Culhane of Los Alamos National Laboratory. Mr. Chad Evans discussed two important changes to the structure of the Working Groups following the June 16 virtual meeting of the National Commissioners. First, a fourth working group will be spun off from the second working group. This new group will focus on unleashing capabilities for work and entrepreneurship, while the second group will concentrate on the future of sustainable production, manufacturing, and consumption. Second, beginning the week of June 22, Working Group calls will move to once per week, and will be led by co-chairs nominated by the Council. Calls will be preceded by a primer containing background information as well as concrete policy recommendations for the group to discuss. The second phase of the Working Groups will be focused on generating actionable policy recommendations ahead of the National Competitiveness Forum in December.

Featured Remarks

Ms. Culhane discussed her background in the federal government as both a scientist and a member of the intelligence community, and Los Alamos National

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Laboratory's focus on the safety and security of the country's nuclear weapons. She focused her remarks on various challenges to U.S. leadership in advanced computing, and the numerous national initiatives and their impacts on the development of advanced computing technology.

The first major challenge to American computing dominance came in 1982, when Japan introduced its "Fifth Generation" project, which aimed to make Japan the leader in parallel circuits and logic programming within ten years, leapfrogging third generation (integrated circuits) and fourth generation (microprocessors) technology. This alarmed the United States sufficiently to establish the Microelectronics and Computing Consortium (MCC), which was actually illegal until the 1984 passage of the National Cooperative Research Act. This initiative was driven by industry and did not receive government funding for many years, but contributed to the AI boom of the 1980s and 1990s before being dissolved in 2000.

Similarly, Japanese dominance in semiconductors led to the establishment of the nonprofit Sematech consortium in 1987 as a joint venture between the federal government and fourteen American semiconductor manufacturers. Although initially funded with matching contributions, the consortium eventually eliminated public funding, and gradually pivoted toward the much larger international semiconductor market. Sematech was crucial to the United States regaining competitiveness in semiconductor manufacturing, and Ms. Culhane attributed this to its having a required outcome to reach, which sharpened participants' focus and fostered engagement with stakeholders across the R&D space.

In 1991, the High Performance Computing Act (HPCA) established a requirement of continued U.S. leadership in high performance computing. The federal research conducted in response to this act built on earlier network infrastructures like ARPANet and NSFNet, funded the development of the Mosaic web browser, and helped create the information superhighway and high-speed fiber optic computer network that were crucial to the development of the internet. Also as part of this initiative, NASA created the Beowulf cluster of supercomputers, which took over the supercomputer market due to their cost, accessibility, and scalability.

The next milestone came in 1995, with the Department of Energy's Advanced Strategic Computing Initiative (ASCI). The ASCI came with the requirement that DOE develop modeling and simulation capabilities to enable them to ensure the functioning of the country's nuclear weapons in the absence of the ability conduct nuclear tests, as well as to maintain the security of the nuclear stockpile. While it failed to achieve all of its goals, ASCI helped accelerate the development of high performance computing (HPC), and inspired the Department of Defense to authorize five major studies in HPC through the Defense Advanced Research Projects Agency (DARPA). This project was one of the first initiatives with a ten-year horizon that stretched beyond single administrations.

In 2002, Japan released the Whole Earth Simulator, sparking a new wave of concerns about U.S. dominance in computing, especially because U.S. scientists were increasingly traveling to Japan to run their experiments. This led to increased funding for DARPA and the Department of Energy, and in 2004, ASCI had developed the Blue Gene supercomputer in conjunction with IBM, reestablishing U.S. computing dominance. Japan's advances also spurred the 2002 Integrated High-End Computing Study and the 2003 High-End Computing Revitalization Task Force, as well as the Department of Energy's Roadrunner supercomputer in 2008, the first computer in the world to break the petaflop barrier. Roadrunner also represented a breakthrough in using non-native languages to program computers.

By 2010, the federal government increasingly began to view supercomputing as a "meaningless arms race", and the President's Technical Advisory Committee suggested that further investments were not important given the rise of cloud technology and the diversity of computer architectures. However, in 2012 China announced plans to become a leader in high performance computing, and openly boasted of being capable of beating any American benchmark.

In 2013, they developed the faster supercomputer in the world, displacing the United States from the TOP 500 list of fastest computing systems, while using American technology to build it.

In 2018, the United States regained the title of fastest computing system with the launch of the IBM Summit System in June of that year. While the United States has retained this title since, there are concerns that China is currently sitting on even more advanced computers. Other notable developments in recent years include China's winning the Gordon Bell Prize for supercomputing in 2016-2017. This was the first indication of China producing innovative research and algorithms, as well as a clear vision of computing problems to solve.

Ms. Culhane also described other developments in U.S. computing over the past decade. In 2013, based on concerns about the end of Moore's Law, the Department of Energy launched the Exascale Computing Project, as it felt that the current rate of progress required unacceptable energy expenditures. The National Strategic Computing Initiative (NSCI), launched in 2015, established five key priorities for U.S. computing: accelerated delivery of advanced computers, increased coherence between modeling and simulation and data analytics, a viable path to quantum computing, a stronger HPC ecosystem, and more public-private partnerships. The NSCI faced criticism for not providing new funding or including requirements, as well as moving the Cancer Breakthrough 2020 program under its umbrella. However, this whole-of-government focus enabled the Department of Energy to collaborate with the National Cancer Institute, using its supercomputers to run major pilot efforts without legal red tape.

In 2016, the Department of Energy also launched the Exascale Computing Program, with a goal of fielding exascale machines by 2022. During 2016, the White House also released a National Strategic AI Plan, although it did not include any hard targets or requirements. However, it incorporated eight sub-strategies and represented a comprehensive framework for AI research, and was renewed in 2018. In 2017, DARPA launched the Electronics Resurgence Initiative, aimed at ensuring far reaching improvements in electronics beyond conventional scaling and increasing the complexity of component integration. This initiative included $216 million in dedicated funding, including $75 million in new funding. Finally, in 2018, Congress passed the National Quantum Initiative with near unanimous support, focused on advancing quantum technology in general and quantum computing in particular. This initiative did not provide new funding or requirements, but has spurred action by the National Science Foundation and Department of Energy to establish quantum computing centers.

Ms. Culhane concluded her remarks with an illustration of the importance of hard targets and requirements in securing funding and spurring action. She discussed the Space Race and the U.S. project to put a man on the moon following the USSR's 1957 launch of Sputnik, which provided a clear threat to the United States. She stressed the necessity of illustrating the importance of advanced technologies like AI and quantum computing through the threats they protect us against. She noted that the COVID-19 pandemic will provide an example of such a threat to policymakers in the form of mass mortality, spurring research on viruses and vaccine development. However, she warned that it is much harder to create urgency for investment in computing because of the prevailing belief that government research cannot keep up with industry giants and should just wait to buy their technology. She made the case the public and private sector must collaborate for major technological advancements using their respective strengths. The government can establish targets and requirements and provide a vision, while industry excels in productization and scaling of innovation.

Catalyzing Action on Advanced Computing

Ms. Wince-Smith thanked Ms. Culhane for her remarks, and discussed the Council's history of developing the business case for advanced computing dating back to 2003, including partnerships with DARPA, the Department of Energy, and the National

Science Foundation. She asked how the Council could take the next steps in carrying forward leadership in advanced computing. Ms. Culhane said the Council has been very helpful in "telling the story" in the past, and said that perceptions of threats to U.S. leadership have historically been the most effective means of securing U.S. investment in advanced technologies, citing the examples of Sputnik and of China surpassing the United States in supercomputing capacity in 2013. She expressed regret that the United States is not more proactive in making these investments, and noted that it is challenging to elicit investment in mature industries because technologies advance much more slowly. She said this was a particular problem for the semiconductor industry, and expressed the need to find an event to "react to" to encourage investment.

Dr. Paul Hommert, former director of Sandia National Laboratory, discussed his time working on ASCI, and said that ASCI's clear focus and imperative made it easy to explain to public officials and funders. He said that depending on political developments over the next year, the United States could soon have clear national imperatives in the fields of pan-viral deterrence, low-carbon energy, and national security, all of which have enormous embedded computing challenges. He said capturing the challenges in each that are independent of underlying technological enablers and connecting them to the competitiveness aspects of high performance computing will be key. Ms. Culhane agreed and framed this as emphasizing the "what" of the problem at hand and the "how" of technology. Dr. Neil Thompson of MIT said he wanted to stress the importance of this problem to the group, because computing is essential to productivity improvements everywhere. He discussed economic research attributing 1/3 of all U.S. productivity gains since the 1970s to information technology improvements, even at the level of individual firms. He said making future leaps in science and technology, especially critical fields like AI and machine learning, will require major improvements in computing power.

Dr. Laurie Locascio of the University of Maryland echoed the importance of perceived threats in catalyzing action, describing her experiences at the National Institute of Standards and Technology (NIST), in which discussing potential threats increased the budgetary authority available to the agency. She asked the group if there were examples of major research initiatives not prompted by threats. Ms. Culhane said that even things like public health and climate change were responses to immediate or long-term threats, even if not prompted by a specific national security concern. She also mentioned the HPCA as an example of an initiative that was not particularly reactive, but which helped rapidly scale up network access. She said that the impetus for networks was the National Science Foundation searching for more cost-effective ways to have widespread access to supercomputing than building supercomputers at every university.

COVID-19 as a Call to Action

Dr. Albert Pisano of the University of California, San Diego suggested the current COVID-19 crisis might serve as a wake-up call along key dimensions of scientific research. He said the current approach to virology is ripe for innovation in the midst of the emergence of coronaviruses, which attack humans in a unique way. He also recalled fellow Working Group member and former DARPA Director Dr. Tony Tether's exhortation to measure problems to organize an effective response. He discussed President Kennedy's goal of putting a man on the moon within nine years and suggested a similar time-bound initiative for developing a pandemic preparedness plan that will enable the United States to handle future outbreaks without completely shutting down. Ms. Wince-Smith agreed, noting that Commission Co-Chair Mr. Brian Moynihan of Bank of America expressed similar sentiments. She said we are seeing the consequences of under-preparation in real time, and advocated developing major end goals to work backwards from in formulating a plan to achieve them. Dr. Thomas Campbell of Future Grasp LLC agreed that COVID-19 represented the mostly likely threat to resonate with policy makers, noting that addressing

pandemics requires new capabilities in AI and high performance computing, among other technologies due to the need to model vaccines and disease progression through populations. Dr. Roland Stephen of SRI International suggested presenting the threat as a series of inter-linked existential challenges across sectors, including clean energy, public health, advanced manufacturing, and national security. He classified the solutions as inter-linked technology platforms, including 5G, advanced computing, and zero-carbon energy.

Creating a New Normal

Mr. Mark Minevich of Going Global Ventures said that the COVID-19 pandemic has permanently changed society, and that the focus of the Commission should be on creating a "new normal" in which advanced technologies provide a sense of security and stability for Americans, respond to a rapidly changing and increasingly volatile world, and enable the United States to remain prosperous and ultra-competitive. He said the United States came into the current pandemic empty-handed, and that in the future we must develop the AI and modeling capabilities to predict short- and long-term consequences of future disruptions to markets, supply chains, and other structures as they occur. He further stressed the need to adjust large systems, including production and consumption, consumer preferences, and business models for industries and universities, to this new normal, and the need to adopt advanced manufacturing technologies immediately.

The Positive Externalities of "Space Races"

Dr. Pisano said that the Commission should emphasize the positive externalities that come from all-of-society efforts to address challenges. He pointed out that both the Space Race of the 1960s and the Computer Races of the 1980s and 1990s led to numerous serendipitous inventions and led to the establishment of many companies and industries. He said the Council should emphasize the new jobs and boost to competitiveness that will follow from concerted efforts to address challenges in advanced computing and other disruptive technologies, and that these efforts will lift many boats, not just those directly connected to the research. Mr. Andre Doumitt of the Aerospace Corporation discussed a recent television series on the Space Force, and said that the Commission should seize on opportunities presented by popular culture to capture the public's imagination and awaken the workforce and educational system to the potential of disruptive technologies across the economy.

Using Chinese Competition to Frame Threats

Dr. Thompson discussed his work with the Council on the Building University-Industry-Laboratory Dialogue (BUILD) initiative, in particular his survey of advanced computing researchers in the United States. He said that there was a consensus that China was about even with the United States in terms of advanced

computing, and was improving at a much faster rate. He wondered why this was not seen as sufficient threat to induce greater funding. Ms. Culhane added that in 2012, the Office of the Director of National Intelligence assessed foreign computing capacity and identified China as a "fast follower." By 2016, they were starting to innovate rather than merely copying American research. She said the ultimate test of whether they will become leaders is if they advance science in a way that forces the United States to play catch-up to them, and that this is not easy to measure by simply looking at publication metrics. However, she warned that China has far more manpower than the United States.

The Importance of Biotechnology

Dr. Nathan Hillson of Lawrence Berkeley National Laboratory said it was surprising given the discussion of COVID-19 that the bioeconomy, biomanufacturing, and biotechnology had not been discussed. Dr. Locascio agreed, and noted the dire consequences if China developed a vaccine but withheld it from the United States or other nations. Dr. Campbell said the United States must be much more proactive in using modeling to accelerate vaccine development, and that high performance computing was crucial to such efforts. Mr. Evans agreed that this was a major concern and illustrated the linkages between competitiveness, prosperity, and national security. He also noted that Working Group 2 was having a discussion on the bioeconomy next week, and suggested there might be opportunities for cross-participation from this group's members. Mr. David Vasko of Rockwell Automation said his company is involved in biotechnology research initiatives, especially those aimed at scaling new innovations and brining them from the lab to the factory floor.

Concluding Remarks

Ms. Wince-Smith shared with the group the discussions she had with the Global Federation of Competitiveness Councils on the impact the COVID-19 crisis is having on competitiveness in general, and in participants' own economies. She stressed the need to identify the structural innovations that will take humanity into a new era that is prosperous, sustainable, and inclusive. She further emphasized the importance of modeling, simulation, and other advanced technologies in producing that future, and the role the Commission can play in understanding these advancements and articulating grand visions for the future of the country, including how to marshal the investments and capabilities to bring those visions to fruition. Mr. Evans added that in light of the group's discussion he would share the presentation of Dr. Steven Koonin of New York University on the path forward from COVID-19 that he shared as part of the Council's Technology Leadership and Strategy Initiative Competitiveness Watch Seminar in April.

Working Group 1 Calls May 12

Introduction

The Honorable Deborah L. Wince-Smith and Ms. Kathy Trimble welcomed the group, and Ms. Wince-Smith introduced the featured speaker, Dr. Kelvin Lee of the University of Delaware. She discussed Dr. Lee's role as the head of the National Institute for Innovation in Manufacturing Biopharmaceuticals (NIIMBL), one of the Manufacturing USA institutes. Mr. Chad Evans said he looked forward to hearing about the key lessons learned from Dr. Lee's experiences as head of NIIMBL.

Featured Remarks

Dr. Lee opened his remarks by contextualizing the importance of advanced manufacturing to American prosperity. He said it provides an economic multiplier of between four and twelve and is a major source of innovation. He also discussed the concerning trend since 2000, when U.S. manufacturing employment began to drop precipitously and the United States went from having a surplus in trade of advanced manufactured materials, including semiconductors and biopharmaceuticals, to a deficit. He

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Mr. Tim Planert

said the Manufacturing USA institutes, which began under the previous administration but have continued to expand in recent years, are designed to bridge the gap between basic research and commercialization, and are focused on high-value added sectors that have been transformed by digitization and automation.

A major problem in American manufacturing is the gap in funding for the middle section what the government defines as "readiness levels" in the manufacturing process. Readiness levels 4 through 7 comprise the space between the development of a proof of concept and the point where a technology has been de-risked enough to secure private sector investment. Dr. Lee said that the United States, while exemplary in attracting government and academic support for research in levels 1 to 3, and industry investment in levels 8 to 10, lags behind other countries over the middle of the curve. He added that the Manufacturing USA institutes, which combine public and private resources, are unique among such efforts because they are primarily "pulled" by industry rather than "pushed" by the public sector or academia.

Dr. Lee then discussed the defining features of the fourteen Manufacturing USA institutes. They are public-private partnerships and member consortia with clear missions. Each institute is focused on a technology with critical industry applications, and there is no overlap in the institutes respective mandates. Some institutes, like NIIMBL, focus on vertically integrating an entire industry, while others have a more cross-cutting focus. The institutes provide space to collaborate on pre-competitive R&D that solves major challenges facing all participants in an industry, and create value by providing an avenue for public-private co-investment. Federal funding must catalyze at least a 1-to-1 match in non-federal funding, and each institute includes workforce training and development programs to address the skills gap. Dr. Lee emphasized the importance of this last feature, noting that our technical capabilities will not produce any jobs if we do not have the workforce needed to fill them.

The Manufacturing USA institutes have already had an impact on the U.S. innovation ecosystem. Nearly 2000 organizations across academia, industry, and the nonprofit sector are members of at least one institute, with some participating in several, and many state governments have also co-invested in initiatives in their state. The ratio of "federally compliant" non-federal funds sits at approximately 1.7-to-1 vis-à-vis federal funding, but Dr. Lee estimated the true ratio to be in the neighborhood of 4- or 5-to-1. Overall, nearly $500 million has been invested, and the institutes have already provided workforce development and education to over 205,000 workers and students. There are currently fourteen institutes, with two more poised to launch by the end of 2020. Currently, eight are funded by the Department of Defense and five by the Department of Energy, with NIIMBL being funded by the National Institute of Standards and Technology (NIST) within the Department of Commerce. While the heads of the different institutes are in regular communication, this has been somewhat obstructed by the COVID-19 crisis, and their conversations in recent weeks have turned toward brainstorming policy responses to prepare our economy and supply chains for the next crisis.

Dr. Lee concluded his opening remarks by discussing NIIMBL in more detail. He described pharmaceutical products as falling into two major categories. The first, medicines made by chemistry, are relatively easy for manufacturers to develop because the process of creating stable molecules is well understood. As a result, as long as the manufacturer can accurately produce the molecule, the FDA will grant approval, and it is easy for competitors to enter the market with generic molecules once the exclusivity period ends. By contrast, NIIMBL focuses on biologic medicines, which are created through biology and are much more difficult to make, because it is harder to control the process of molecule development when there are living components involved. Examples of biologics include insulin, recombinant proteins and antibodies like Humira, vaccines, and cell and gene therapies, the last two of which can have life or death impact for critically ill patients. The FDA regulates both the product and the process for

making biologics, and because of the cost and risk involved in pioneering a new drug in this space, no firm wants to be the first mover toward a new manufacturing process, but instead a close second. The goal of NIIMBL is to encourage all the participants to be "first movers" together.

Bridging the Mindset Gap Between Academia and Industry

Dr. Tony Tether, former director of the Defense Advanced Research Projects Agency (DARPA), discussed the success he had in encouraging the development of commercialization-ready innovations. He instituted a policy in which researchers had to find at least one end user for their innovation by the end of the project's third year in order to continue receiving funding. He said this acted as a powerful motivator for researchers to adopt a problem-oriented approach to innovation and think about ways to make their ideas easy to bring to the market. Dr. Lee said that one of the biggest surprises he experienced heading NIIMBL was the clash of mindsets and approaches to research between academia and industry, especially in a field like biopharmaceuticals where there has historically been substantial collaboration. He described the academic mindset in which researchers attempt to keep a project going indefinitely and secure new funding for further exploration, and the industry mindset in which a project either succeeds or fails to generate a product in a clearly defined timeframe. He characterized much of his work as director as helping bring both sectors to a middle ground where each understands the other's needs and incentives. Dr. Tether agreed with this approach, and noted that as director at DARPA he had the power to compel different stakeholders to talk to each other through his control of funding for projects.

Mr. Phil Weilerstein of VentureWell connected this theme to his organization's work with the I-Corps program, which he said was designed to address cultural gaps between academia and industry. He described how the program provides postdoctoral students and graduate students to lead efforts and identify valuable applications of basic research and potential customers. He asked if there was a way to incorporate this process into the Manufacturing USA institutes, especially because the crucial element in actually bridging these divides in the I-Corps program is securing the resources to do so. Dr. Lee said that while he had not heard of any specific programs with a similar mission within the Manufacturing USA umbrella, that did not mean they didn't exist, but he stressed the need to identify a reliable funding source. As an example, he discussed the commitment by the Biomedical Advanced Research Development Agency to provide grants and agree to purchase from vaccine developers like Moderna and Johnson & Johnson in the wake of the COVID-19 crisis, noting that the hundreds of millions of dollars involved was still only a small portion of their total costs. He said that other nations have historically been more willing to pick priority sectors for investment, and suggested there might be value in the United States taking the same approach.

Addressing the Gap in Technology Development

Mr. Robert Dixon, formerly of PepsiCo, asked about the requirement for a minimum of 1-to-1 matching funds from non-federal sources, and also suggested a "policy reversal" in which the government shifted its resources from funding basic research to funding the missing middle of the manufacturing readiness curve. He also suggested officially clarifying that innovation would be measured by the successful commercialization of technology, and encouraged stakeholders to think about the entire value chain, including which areas were most lacking in needed investment, as well as critical priority areas to invest in.

Dr. Lee said that the government requires matching funds to avoid criticisms that it is engaging in "industrial welfare" and giving firms handouts, so co-investing allows them to de-risk ventures for firms while still requiring them to contribute. He said that each of the fourteen institutes has its own culture and priorities, and that the government views the institutes as fourteen different experiments, which will be allowed

to grow in ways that make sense for their business sector. He added that the early returns have been promising, but that it is impossible to change an economy after five to six years with a modest investment. Dr. Lee also noted that high-level thinkers in the federal government had identified priority areas that have influenced investment decisions, but that there was no formal national strategy for prioritizing investments.

Dr. Anne Marie Knott of Washington University in St. Louis attributed the emergence of the funding gap to a general decline in government support of R&D. She noted that from 1980 to 2000, this figure went from 0.8 percent to 0.3 percent of GDP, a 63 percent reduction. She pointed out that this corresponds to the drop in manufacturing employment and the advanced manufacturing trade deficit that emerged after 2000.

Challenges in Biopharmaceutical Manufacturing

Ms. Wince-Smith asked how to accelerate the development of vaccines, and whether the FDA was primarily a facilitator or a barrier to new drug development. Dr. Lee said the FDA was largely a facilitator, and that many of the obstacles to drug development come from the risk aversion of manufacturers. Because of the high costs of testing a drug and further high costs in building a facility to manufacture it, drug makers tend to go for safe, lowest-common-denominator products. With vaccines in particular, the margins are low, and the numerous approval processes required mean there is a long time lag before vaccines are ready to hit the market. Dr. Lee said NIIMBL operates test beds where manufacturers can run new safety tests and other processes alongside existing ones for established third party products to demonstrate the efficacy of the new techniques, in an effort to encourage their adoption. However, overall the costs of obtaining the data companies need to prove that a faster development and safety testing process works as well as the status quo are usually prohibitive. Because of this, most companies have not invested in new vaccine development processes that can telescope steps that take weeks or months into a few days.

Dr. Robie Samanta Roy of Lockheed Martin said that the success DARPA has had in bringing new products to market illustrates the importance of having open lines of communication between developers and the end user, as well as between developers and regulatory bodies. With better communication, developers can ensure they are testing the right functions and developing products with value for end users, and can catch mistakes earlier. Dr. Tether clarified that DARPA only sought FDA approval for products that would be marketed to the general public as well the military. He emphasized that the rules requiring customers for continued funding were the biggest driver of DARPA's success in scaling technology.

The Value of Platform Technologies and Facilities Access

There was significant discussion in the group about the value of platforms that give innovators access to facilities and technology. Dr. Albert Pisano of the University of California, San Diego cited the example of the MOSIS program to accelerate innovation in Complementary Metal-Oxide-Semiconductor (CMOS) technology for computer chips. MOSIS allowed remotely located innovators and educators to access manufacturing technology and learn its constraints and capabilities, and allowing lots of different people to work on innovating led to an accelerated development of innovations. He gave the example of modems, crucial to cell phone technology, and how the whole industry was pushed forward by the number of competing designs. He predicted similar value could be derived from competition in circuit technology, and he asked if there were similar programs providing access to facilities and technology within the Manufacturing USA umbrella. Dr. Lee said that several institutes did lease space and provide training to innovators testing out products, and noted that technologies like additive manufacturing had spread across the different institutes.

Dr. Pisano asked if there would be value in incorporating specific platform programs to encourage widespread sharing of facilities across the Manufacturing USA institutes, and Mr. Weilerstein added that providing these resources in high-tech sectors could drastically reduce the cost and complexity of moving from proof of concept to proof of demonstration. He gave an example of a problem in the chemical industry, where access to small-batch manufacturing is so expensive that innovators are in a chicken-and-egg situation in which they don't want to risk a large investment at an early stage but can't afford a smaller one either. Mr. Evans said that the Digital Design/Manufacturing Innovation Institute in Chicago likely had these capabilities, but that he wanted to hear from members of the group with experience in this space.

Ms. Wince-Smith said the group needed strong recommendations for U.S. leadership in advanced manufacturing and public-private partnership models that incorporate co-investment and dual-use platform technology. Dr. Pisano agreed and wondered if it would be valuable to invest in a program that provided the entire innovator community with broad access platform technology. Mr. Evans said that this is an example of what the Council refers to as "shared national innovation infrastructure." Mr. Weilerstein discussed an early stage advanced composites company that VentureWell is working with, and their difficulties in getting investment interest from manufacturers until they can provide data. He suggested developing a voucher approach that allows innovators to demonstrate their technologies in the relevant environment.

Questions for Consideration

Several participants posed questions to the group for future discussion and contemplation. Dr. Paul Hommert, former director of Sandia National Laboratory, discussed his experience working on the development of Extreme Ultraviolet Lithography, which did not see a market application until nearly two decades later because it was ahead of the technology curve. He asked if the Manufacturing USA institutes were considering the timeframe and technology curve dimensions of product commercialization when working on innovations to try to scale. Dr. Thomas Campbell of FutureGrasp LLC discussed the significant draw-down and disruption in supply chains caused by the COVID-19 crisis, and asked whether this would cause the scope of the gap between the lab and the market to increase, decrease, or remain unchanged.

Mr. Mark Minevich of Going Global Ventures emphasized the importance of advanced transportation to the economy of the future, including advanced manufacturing. He said that the U.S. transportation industry supports 10 million jobs and accounts for 3.5 percent of Gross Domestic Product, and urged the group to focus on the innovation needed in the transportation sector for it to remain capable of supporting and incorporating disruptive technologies. He added that younger generations want more sustainable products and substitutes for petroleum-derived plastic, and called for the promotion of advanced biofuels and bio-materials through touting their scientifically-backed sustainability and efficiency.

Concluding Thoughts

Ms. Wince-Smith thanked the group for its contributions to the discussion, and encouraged the participants to make bold recommendations. She said that thinking big was essential for delivering the transformative solutions the country needed. Dr. Lee agreed, and said that it was important to develop lots of ideas to experiment with because not all of them will end up coming to fruition.

Working Group 1 Calls May 14

Introduction

The Honorable Deborah Wince-Smith and Mr. Bill Bates welcomed the group, and Ms. Wince-Smith introduced the featured speaker, Mr. David Vasko of Rockwell Automation. She described the Council's previous collaborations with Rockwell, and said the firm was at the forefront of smart manufacturing, the subject of the day's discussion. Mr. Bates detailed Rockwell's involvement in the Council's Energy Manufacturing and Competitiveness Partnership (EMCP), and said it would be exicting to catch up with recent developments in the smart manufacturing space.

Featured Remarks

Mr. Vasko focused his discussion on the way re-purposing existing technologies is as important to scaling disruptive innovation as the new products and processes themselves are. He detailed the efforts at the BioFab USA institute in New Hampshire, part of the Manufacturing USA institutes, in developing human tissue to be used in medical procedures and transplants. He said that while the focus on novel ideas was appropriate for breakthrough technologies like quantum computing, many of the techniques the BioFab institute have long existed, but are being used for novel purposes. He also stated that the idea of "pre-competitive" collaboration is a myth, and

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that consortia like the Manufacturing USA institutes work best when the participants have complementary intellectual property interests and bring unique capabilities to the effort.

A major problem with tissue fabrication is the intensity of labor needed to produce a single tissue, which involves a Ph.D. scientist manually building it. The costs of hiring the number of Ph.D.s needed to mass produce these tissues would be prohibitive, and Ph.D. researchers do not have the inclination or expertise for assembly-line work. To address this, BioFab looked at the kinds of actions performed by researchers making different kinds of tissues and modularized them, allowing the repetition of basic operations. The institute also worked on modularizing the transportation and logistics to ensure the tissues could get to people who needed them. Mr. Vasko emphasized that modularizing is a standard manufacturing technique, and allows the 160+ participants in the initiative to specialize in different aspects of the process without conflict. He noted that manufacturers do not need the IP for tissue design, and the researchers do not need the IP for the manufacturing process. He also underscored the potential benefits from one day being able to manufacture organs within hospitals for rapid transplantation.

Mr. Vasko described the process for generating fabricated tissues using a new "closed-loop" modular technology that only required human interaction for the first step. Cells are put into the machine, from which point the machine develops a culture, harvests and washes the cells, and then assembles the tissue and lets it mature. All of the components of this process are used in other manufacturing operations, although the institute is working on improving the sensors used. As one example, the load balancing mechanism in the machine is the same mechanism used by soft drink manufacturers to maximize beverage production capacity in their factories. He likened the automation of the tissue process to mass producing cookies from a recipe made by one person- rather than trying to reproduce people with the exact same skills as the original creator, it leverages much more common capabilities in a new way to scale up production.

Mr. Vasko described a similar process for expediting documentation for FDA review, in the form of a software program that automatically collates relevant data generated during production and packages it in a format that makes it easy for reviewers to digest. These efficiencies combine to allow these closed loop systems to produce simple tissues like ACLs in 45 days, and in a converted textile mill rather than a high-tech clean room in a laboratory. Mr. Vasko predicted that facilities would be able to hold hundreds of these machines under one roof, and the process could be replicated for other kinds of tissues. He said that bringing more vendors into the production process with usable skills will accelerate this scaling and further innovations. Finally, Mr. Vasko attributed much of the success of the project to having a clear objective that allowed BioFab members to identify existing resources that could be deployed in service of that goal.

Scaling from Tissues to Organs

Dr. Anthony Tether, former director of the Defense Advanced Research Projects Agency (DARPA), pointed out that recipes often need to be tweaked to fit particular circumstances, which makes them challenging to scale. Mr. Vasko said that sensing technology addressed these issues. Ms. Trimble asked what the next steps were for scaling, and Mr. Vasko said the institute had five pilot programs for different types of tissue, with clear roadmaps for scaling them up. He said developing noninvasive sensing technology was the next major step, and that tissues like ACLs and knee cartilage will be the easiest to scale. He added that as more people adopt and implement fabrication technology, they will discover improvements and efficiencies faster, accelerating the development of ways to fabricate entire organs at scale.

Ms. Trimble asked how the institute was planning to handle the transition up to more complex fabrication projects, like organs. Mr. Vasko said scaling was the main problem, but that the basic work of creating tissues has opened up many different pathways. While initially researchers believed 3D printing would

be essential for building organs, during their research they realized that de-cellularization was also a viable means of constructing organs. While most research was focused on developing hearts, the same process could be extended to other organs, including kindeys, pancreases, and livers. He said the ability to develop replacement organs with the recipient's own DNA would eliminate the concern of rejection and massive reduce medical costs while providing lasting cures.

Addressing the Skills Gap

Ms. Trimble asked what role the skills gap had played in the institute's work. Mr. Vasko said much of the institute's work consisted in training medical researchers in automation, and translating technical processes into familiar terms and concepts. He said that the more automation is de-mystified and the more people see connections between existing technologies and the problems they are trying to solve, the more buy-in there is for adopting these technologies. He noted that many people expressed surprise at how the group was able to produce so many tissues with so few people while relying on existing processes.

The Need for Diverse Talents and Clear Roles

Dr. Roland Stephen of SRI International discussed the perception that some Manufacturing USA institutes were more successful than others, and asked what role complementary versus competing IP interests played in this. Mr. Vasko said having clear swim lanes not only reduced IP challenges, it meant that every stakeholder brought a unique capability, and that bringing in experts from different fields can help people in one field think about their problems in new ways and see solutions that they previously couldn't. He discussed a conference where he suggested using parameterized software for data analytics to solve a problem medical researchers were having. Because they lacked expertise in data analytics, they were unaware that they didn't need a separate software program for each function they were performing. Mr. Vasko also attributed the rapid six-week turnaround of the closed loop system to this synergy.

Balancing Scaling Against Regulatory Pressures

Ms. Trimble discussed the problems biopharmaceutical manufacturers have in production and scaling due to regulatory pressures and the long time horizon for various aspects of testing and safety review. She asked how to balance the need for scaling with regulatory pressures. Mr. Vasko said it was crucial to team researchers with experts in the regulatory process who could shepherd them through the different obstacles, and that coming up with a consistent process that was easily measurable was also essential. He said it was difficult to gain approval for an intuition-based process, and that getting tools into manufacturers' hands quickly enabled them to scale technologies much faster. He said that it was important to design products with long-run scalability in mind.

Preventing Rejection

Dr. Tether asked how fabricated organs would avoid the problem of rejection, and the associated issues of immunosuppression in organ transplant recipients. Mr. Vasko said that the sample tissue for generating the fabricated organs would come from the patients themselves, and with their own genetic material being the basis for the organ there would be no worry of rejection. Dr. Tether also asked how the institute planned to get from tissues to organs, because whole-organ regeneration was the real breakthrough technology. Mr. Vasko noted that even tissue manufacturing allows for the discovery of optimal cell-building techniques that will expedite the development of organs, and said the closed-loop system helps address the biggest challenge in developing manufactured hearts. Because the growth of

cardiac cells needs to be measured, conventional construction techniques involve invasive measurements that often contaminate the samples, something that is not a concern in a closed-loop system. He added that the other issue for organs was the structure, and that the current approach was to use the collagen structure, without cells, from a human or pig heart as a scaffold onto which the fabricated cells were grafted to construct a functioning organ.

Supply Chain Issues and Top-Down vs. Bottom-Up Approaches

Ms. Trimble asked if there were raw material or supply chain challenges facing attempts to scale up production of fabricated tissues. Mr. Vasko said that the major challenge was the timeframe. He said that even an ACL takes 45 days to grow in the closed-loop system, and that organs would take even longer. However, growing organs too fast also presents challenges. Dr. William Pike of Pacific Northwest National Laboratory asked if there was a difference in the success rate of Manufacturing USA institutes that developed from a top-down mandate from a government department as opposed to those that developed from a bottom-up decision by the various stakeholders to collaborate prior to securing government support. Mr. Vasko said that while many of the institutes predated his involvement, the success of the BioFab institute was the clear problem to be solved and the ability of stakeholders to determine the size of the gap they needed to scale, which made it easier to figure out how to deploy existing resources to address it. He said that while institutes come together in different fashions, those that try and bridge specific gaps tend to be the most successful, and added that the military has a great need for biofabrication for treating combat injuries. Especially important was the fact that this need was not likely to disappear any time soon. Ms. Wince-Smith suggested that it might be possible to one day print organs on the battlefield.

Making Manufacturing USA Programs Permanent

Mr. Bates described the Council's work on the U.S. Manufacturing Competitiveness Initiative from 2010 to 2011, and how the Council had called for manufacturing hubs that resemble the Manufacturing USA institutes. He said that the current institutes are far more extensive than the Council had imagined, and wondered if they should be converted from limited-support public-private partnerships to permanent public investments, since they concern technologies and industries where U.S. leadership is essential for our competitiveness and national security. Mr. Vasko said the institutes should be thought of as accelerators that expedite the development of robust private industry, and that it was important to provide incentives for manufacturers to invest in innovation, even as they struggle to stay afloat during the current crisis. Dr. Stephen suggested doubling down on funding the successful institutes that were meeting needs and integrating diverse groups of stakeholders with a variety of capabilities.

Anticipating Future Applications of Innovations

Dr. Tether stressed the importance of identifying the national security and competitiveness dimensions of innovations like tissue fabrication, as this was the key to securing investment. He described how the semiconductor industry developed as the Air Force sought to develop integrated circuits that could withstand shock and vibration in missile systems during the Cold War, and how additive manufacturing was spurred by the need to design engines with built-in coils that spun fuel and kept it from spreading to the walls of the engine and dissipating energy. While both of these technologies would have likely been developed at some point, Dr. Tether credited their immediate application to pressing problems with accelerating the development of both industries significantly. He said that while the humanitarian benefits of biofabrication were obvious, the institute needed to find a security or competitiveness angle as well.

Mr. Vasko said that one of the advantages of the Manufacturing USA institutes was the potential for serendipitous discoveries, as occurred in semiconductors, and Dr. Tether clarified that it was essential to think of secondary applications during the design phase rather than after. He said the best way to do this was to team researchers with "connectors" who were skilled in seeing implications of technology, because researchers are primarily interested in and skilled at design rather than application or marketing. He said universities often lack these experts, and that companies only deploy them when faced with competitive pressure. Dr. Stephen suggested embedding go-to-market teams at all of the Manufacturing USA institutes, modeled after those at the Advanced Research Projects Agency-Energy (ARPA-E). Mr. Vasko suggested that it wouldn't be necessary to do so provided different stakeholders could adequately communicate their needs, but Dr. Tether said in-person interactions between people from different fields was essential to generating ideas. Mr. Vasko said that he had seen the benefits of these connections while working at the BioFab institute.

The Competitive Position of the United States in Biofabrication and Gaps

Ms. Trimble asked where there were technological gaps that the country should invest in addressing, and Mr. Vasko identified explainable AI as the most important one. He said that AI will not be implemented on a broad scale unless people can understand it and its value, citing the example of suspicion around autonomous vehicles. He said that making AI that could be understood and operated by non-scientists was essential because it would be impossible to increase the number of data scientists by the orders of magnitude needed to operate much existing AI. Ms. Wince-Smith asked where the United States stood in tissue fabrication relative to competitors, and Mr. Vasko said the United States was currently the leader, with no other country possessing closed-loop technology. However, he said that the United States needs to follow through on its strong foundation, and that the biofabrication industry needs to become as large as the semiconductor industry to ensure continued U.S. leadership and reach its full potential. Ms. Wince-Smith said she would love to share this presentation with Australia's Commonwealth Scientific and Industrial Research Organization (CSIRO), because of the shared strengths between the United States and Australia and their close relationship.

Concluding Thoughts

Ms. Wince-Smith thanked the group for their participation, and said that she was excited to hear Mr. Vasko share his presentation with the second Working Group. Ms. Trimble said that themes and narratives were starting to emerge across the different working groups, and asked Mr. Vasko how BioFab measured success and value generated by its efforts. Mr. Vasko said that quickly transitioning these ideas out of the laboratory and getting more people involved in production and scaling was the most important metric, and that if something works, it is crucial to scale it because it is only the starting point.

Working Group 1 Calls May 19

Introduction

The Honorable Deborah L. Wince-Smith and Ms. Kathy Trimble welcomed the group, and introduced the featured speaker, Dr. Robie Samanta Roy of Lockheed Martin. Mr. Chad Evans discussed the upcoming hiatus in Working Group calls as the Council prepares to commence the second phase of the Working Groups' work. He added that he was looking forward to hearing from Dr. Samanta Roy about the challenges of scaling technology in a national security context given his experiences working with both the private and public sectors at Lockheed Martin.

Featured Remarks: Overview and Framing

Dr. Samanta Roy began his remarks with a discussion of the role science and technology played in the Allied war effort during World War II, including developments like radar and nuclear weapons. He discussed how the war established the position that science and technology would provide the United States with a critical edge on the battlefield, and how after the war Vannevar Bush, the president of MIT and a science advisor to President Roosevelt, formally stated this position in his publication Science: The Endless Frontier, which advocated basic research as a building block for the nation's continued scientific and technological advancement. He

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also emphasized the need for partnerships among industry, academia, and government laboratories to transition inventions stemming from basic research and turn them into commercial technologies on both the civil and military side. During the post-War period and for much of the Cold War, the United States and Soviet Union continually countered each other with newer, more sophisticated technology, but on a decadal scale. Dr. Samanta Roy argued that this paradigm no longer holds, as the United States is no longer the sole center of gravity for technology development, and because the commercial sector is now leading, rather than following, the defense and national security sectors in the scaling and deployment of disruptive innovations.

Invention vs. Innovation

Dr. Samanta Roy said that while the Department of Defense, the National Laboratories, and the National Science Foundation were often the first inventors of various technologies, they, along with the defense industrial base, were among the last to adopt them, due to timing and other considerations. He used this discrepancy to highlight the difference between invention and innovation, which is the adaptation of an invention into something useful. Examples of technology that the Department of Defense and other government bodies pioneered that were then first adopted by the private sector include microelectronics and artificial intelligence. The Department of Defense, through its creation of the Defense Advanced Research Projects Agency (DARPA) and its role in supporting the Sematech consortium, helped create and sustain the microelectronics industry in the United States through its investments in space technology and missile systems that drove the development of transistors and integrated circuits. However, the leading edge in microelectronics is now the private sector, with chipmaker Nvidia recently releasing a state-of-the-art Graphics Processing Unit chip and the Taiwanese firm TSMC announcing plans to invest $12 billion in chip manufacturing facilities in Arizona. Similarly, DARPA and the Department of Defense invented many of the seminal AI algorithms, but big technology companies like Google, Amazon, Microsoft, and Facebook have combined these with big data and sophisticated computational infrastructure to become leaders in machine learning. The Department of Defense is now in a position of scrambling to keep up, always one iteration behind the private sector.

Linear vs. Non-Linear Pipelines

Traditionally, technologies developed in a linear fashion, from the drawing board to testing to entry into the market. Now, the process is iterative and non-linear, with repeated rounds of prototyping and development and many non-traditional actors. Dr. Samanta Roy described a recent Air Force solicitation of technology solutions via the web platform Zoom, which over 5,000 people, 90 percent of them from outside of the defense contracting industry, attended. Now, startups, large technology companies, universities, and many other stakeholders are proffering ideas for national security technology, but they often lack the expertise needed to scale these technologies and develop them to withstand harsh environmental conditions. Many defense contractors are now partnering with these actors to co-develop useful innovations.

Platforms vs. Architectures

Dr. Samanta Roy said that previous generations of national security and defense innovations were developed on large, monolithic platforms, but that newer platforms are emerging that are more adaptable to new technology, enabling a much faster rate of technological refreshment. He described how many aircraft are still in use from generations ago, but rely on newer, more adaptable platforms to continually upgrade their technology. He also discussed the challenges of large bureaucracies, on both the industry and government sides, in trying to centrally plan the adoption of technologies while relying on decentralized execution by various actors or branches of the armed services.

The "Innovation Sandbox"

In attempts to harness the rising numbers of non-traditional actors in the national security space, the Department of Defense and its various constituent agencies have developed a large, complex web of organizations to identify promising technologies for investment or adaptation and more rapidly deploy and scale innovations. Many of these ventures, including the National Security Innovation Network and the Defense Innovation Board, have provided incentives for investment in AI and software and thought leadership on venture capital investment. However, there is also little coordination, as each branch of the military has stood up its own separate organizations, and there are many programs with overlapping goals and mandates.

Political Considerations and Supply Chains

Dr. Samanta Roy discussed the challenges of supply chain management for national security products, given that political imperatives require defense programs to be scattered across the country in different states. These dispersed programs have more complex and more international supply chains than they otherwise would, with the F-35 aircraft having thousands of different suppliers alone. These sprawling supply chains create significant vulnerabilities that require extra planning to account for, as well as opportunities for improving security.

Materiel vs. Non-Materiel Innovations

An important distinction Dr. Samanta Roy made in discussing innovation was that between product (materiel) and process (non-materiel) innovations. He stressed that new ways of doing business and platforms were as important to new technology, and the immense value that process innovations can bring through developing faster and more efficient ways to operate.

The Role of Necessity in National Security Innovation

Dr. Samanta Roy gave several examples of urgent needs being the primary driver of a major innovation in the national security space. During the wars in Iraq and Afghanistan, improvised explosive devices (IEDs) were a disruptive innovation from the perspective of enemy combatants, as they exploited vulnerabilities in United States forces and equipment. The Department of Defense not only had to develop IED-resistant armored vehicles, but also ensure the supply chain for these new vehicles was secure and robust. The government and industry collectively spent billions of dollars to develop IED-resistant vehicles through the Joint Improvised Explosive Device Organization (JIEDO), which successfully developed and scaled these new vehicles. Another example of such collaboration was the Intelligence Services Reconnaissance Task Force (ISR-TF), which helped develop reconnaissance and intelligence gathering technology that could operate in rugged conditions and brought it to scale. Finally, collaboration between the medical and pharmaceutical industries and the Department of Defense resulted in major improvements in treating combat trauma. Dr. Samanta Roy summed up these developments with the takeaway that urgent needs are more important than stated written requirements for spurring innovation.

Time Pressures and Cutting Corners

Dr. Paul Hommert, former director of Sandia National Laboratory, cautioned that during his time working on JIEDO, many ideas were rushed into testing or deployment due to time pressures and ended up not working or backfiring. He said that careful applied development is challenging during times of urgency, and also mentioned the early struggles and challenges involved in rapidly establishing the Department of Homeland Security after the September 11 attacks. Dr. Samanta Roy said that these examples illustrated the role of the Department of Defense and the Department of Energy as "honest brokers" for testing and evaluation, and that cutting corners can lead to negative consequences.

National Security Supply Chains and COVID-19

Dr. Thomas Campbell of FutureGrasp, LLC asked how innovation the defense and national security sectors was changing in the wake of the COVID-19 pandemic, and suggested that there might be a move toward decentralization in the industry. Dr. Samanta Roy said that one change flowing from the pandemic was an increased willingness by the Department of Defense to approve investments in synthetic biology and other pandemic-relevant areas, where previously those initiatives had struggled to secure funding. He said that government agencies and traditional actors in the defense industry were increasingly turning to crowd-sourcing and providing apertures for non-traditional players to become involved in innovation. However, he noted that it remains to be seen how these new actors will interface with the federal bureaucracy. Ms. Trimble said that there was an ongoing contraction in the domestic defense market that preceded COVID-19, and that the Department of Defense and the defense industry base had boosted exports of military technology, like military engines for aircraft, to keep those sectors going. She said it is too early to tell what the long-term implications of the pandemic will be for these initiatives, and for the defense industry generally. Dr. Samanta Roy noted that contractors often use proceeds from their sales to fund investment in innovation, and that these funds are being devastated by the economic downturn.

Mission and Necessity Driven Invention

Dr. Anthony Tether, former director of DARPA, discussed the importance of necessity in motivating innovation. He said that the Soviet launch of Sputnik took the United States by surprise and obviated a massive investment into a national air defense system. As a result, President Eisenhower investigated the state of U.S. national security research and found that the military's various branches were not heavily prioritizing space. He ordered the creation of DARPA and gave it the goal of researching every idea that could impact national security to ensure the Soviets never took the United States by surprise again. Dr. Tether said that the relative freedom afforded DARPA, combined with a clear mission, were the keys to its success. He noted that attempts to replicate DARPA invariably become bogged down with extremely long, detailed charters- in contrast to DARPA's one-and-a-half page charter- and that these operational documents can combine with a mindset of short-term returns on investment to stifle innovation. As an example of the long-range impact of DARPA's investments, Dr. Tether noted that Apple's Siri comes from DARPA's cognitive processing program. Dr. Hommert added that TSMC's new venture in Arizona will make use of Extreme Ultraviolet Lithography (EUVL), a technique pioneered by Sandia in the 1990s through a public-private partnership. He added that China is not the location of the new factory because the original Department of Energy partnership included the requirement for partial U.S. manufacture of the EUVL technology, which the Dutch tool company ASML is honoring.

Unlocking and Transitioning Technology from Labs and Universities

Mr. Dave Copps of Worlds, Inc. asked what Lockheed Martin was doing to make use of many of the technological inventions "locked" in national laboratories and university research facilities without avenues for deployment and scaling in the market. Dr. Samanta Roy said that national laboratories have technology transition offices with a mission to go through their portfolio of research projects looking for ideas with commercial potential, and that outside of the lab ,there are lots of organizations and companies looking to partner with venture capital, including Lockheed Martin. He said that Lockheed, like many other companies, has a venture capital arm that goes to universities, national laboratories, and federally funded research and development centers to scout ideas that are suitable for licensing and investment, and then offer to work with their developers. He that Lockheed also has a large program dedicated

to connecting with SBIR grant recipients and other small businesses for joint ventures, and that the company also works directly with the government, especially the Department of Defense, on joint projects to commercialize technology. He said that IP concerns can be a challenge, but that working together produces more than enough benefits to compensate.

Dr. Tether said that Lockheed Martin's skunkworks program, which used to not have a mandate to be profitable, was able to find lots of great ideas for joint venture because it was not constrained by a need for fast returns on investment. However, in the past decade it has become more profit-driven, which Dr. Tether characterized as a loss for innovation. Mr. Marcus Owenby of A&T said Bell Labs had a similarly effective skunkworks program, and Dr. Tether lamented that the company sold off much of the Bell Labs enterprise. Mr. Owenby said that AT&T is interested in expanding its investment in this space again, and has already established FirstNet, which is a foundry designed to fund investments in innovations benefiting first responders, FEMA, the Department of Defense, and other crisis and national security organizations. Dr. Samanta Roy said that in addition to its long-term research, which included innovations like the invention of the transistor, Bell Labs also worked on practical, applied problems, like secure harnesses for telephone pole repairmen, and that the proceeds from these applied efforts helped to fund their long-term, basic research.

Risk Aversion, Consolidation, and the Pace of Innovation

Dr. Samanta Roy said that the defense industrial base is not viewed as a high-tech sector, but as value stock, by investors. He said the sector has become very risk averse, and suffers from a lack of mutual understanding among industry, finance, and government. He noted that engineers no longer run the defense contractors that they founded, and that there were two opposing trends affecting the industry. On the one hand, there is considerable ongoing consolidation among traditional defense contractors, but on the other, many new players, including big technology companies, are entering the field. He noted that a handful of these companies and contractors are responsible for a disproportionate share of startup spinoffs in AI, and warned that big companies and big government needed to adapt to the new imperative for speed. Dr. Samanta Roy highlighted the speed gap between the defense industry and other sectors through the example of the F-22 aircraft, which took as long to get from initial mandate to market entry as it took the electronics industry to go from early personal computers to the iPhone. He also noted the rapid political and economic changes that occurred during this span, and noted that long gaps between ideas and productization can render the idea irrelevant.

Platform Technologies Vital to National Security

Ms. Wince-Smith asked which enabling platform technologies were key to U.S. national security and competitiveness, and warned that China was focused on controlling "civil-military fusion" technologies. Dr. Samanta Roy noted that this use of "platform" differed from the conventional defense industry term that refers specific technologies, but that there were three operational spaces that it is crucial for the United States to lead in. The first is microelectronics, which is the basis for all other advanced technology. Dr. Samanta Roy said the United States should be encouraging more developments like TSMC's investments in Arizona and Nvidia's new cutting edge graphics processing unit. He emphasized the importance of taking the lead on the "next big thing" as Moore's Law nears its end, and said that having the capabilities to on-shore the supply chain for these products provided additional security.

The second platform Dr. Samanta Roy mentioned was AI, where he stressed the importance of ensuring the proliferation of U.S. ethics and values governing the use of this technology. He discussed the DARPA classification of three "waves" of AI. The first wave consisted of "expert" programs like TurboTax, and the second (current) wave includes machine learning, neural networks, and text, image, and

speech recognition. The third wave involves brining sense-making and cognition to artificial intelligence systems. Dr. Samanta Roy urged the United States to continue to lead in bringing second-wave AI into operational use, citing the work of companies like Google, Amazon, and Microsoft. He also advocated leveraging the work of big tech companies and the government on third wave AI, and encouraged the Council to use its connections with the National Security Commission on AI to become thought leaders in this space.

Finally, Dr. Samanta Roy listed biotechnology and biopharmaceuticals as a critical platform, especially in dealing with pandemic preparedness and response. He encouraged the development of an open source platform for rigorous testing and evaluation to expedite the development of innovations in these fields.

Concluding Thoughts

Ms. Wince-Smith thanked the group for its discussion, and said the Council would have lots of ideas to synthesize as part of its transition to Phase II of the Working Groups. She characterized the imperative for U.S. leadership in microelectronics as the most important technological problem for innovation and national security, as microelectronics is the enabler of other key platforms and technologies. She added that in the next phase of discussions, new participants would be joining the Working Group. Mr. Evans reminded the group that Thursday's call will be combined with the Technology Leadership and Strategy Initiative Competitiveness Watch monthly call, and invited the participants to join the discussion. He highlighted the keynote presentation to be delivered by Dr. Victor Dzau, President of the National Academy of Medicine and a Commissioner, on the global effort to develop therapeutics and other responses to COVID-19.

Working Group 1 Calls June 23

Introduction

Mr. Chad Evans and The Honorable Deborah Wince-Smith welcomed the group. Mr. Evans discussed the agenda for the call, including a recap of the recent National Commissioners' meeting and of the Commission's Phase I output, the plans for the next phase of Working Group calls, and remarks from the group Co-Chairs to set the stage for future discussions. He reminded the group that meetings will be held every Tuesday from 11:30 AM-12:30 PM Eastern through September.

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Recapping the National Commissioners' Meeting

Ms. Wince-Smith provided an overview of the proceedings of the virtual National Commissioners meeting on June 16, which was attended by over 90 people. She discussed the featured remarks made in person by Senator Todd Young (R-IN) via video by Senator Charles Schumer (D-NY), as well as their co-sponsorship of the Endless Frontier Act to increase U.S. investment in scientific and technological research and innovation. She also discussed the Commissioners' endorsement of the "Nine Pillars" the Council identified as emerging from the first phase of Working Group discussions, and said that the second phase of discussions would be focused around developing concrete policy recommendations that address those nine pillars. She also discussed how the group's Co-Chairs were drawn from academia, industry, the National Laboratory system, and the Council's Senior Fellows, and highlighted their role in shaping and leading discussions during this second phase.

Mr. Evans said the Commissioners were pleased with the work of the Working Groups and that the Nine Pillars were well-received. He passed along their gratitude for the work the Working Groups had done, and relayed three major messages from the Commissioners. First, the Commissioners stressed that the United States is at a historic crossroads for our economy and global competitiveness, and the Commission has a distinctive and significant role to play in shaping our country's trajectory. As a result, the Commission must be vocal and public about its work and ideas, and the Council is rolling out a new, aggressive strategic communication plan to that end. In particular, Dr. Steven Ashby of Pacific Northwest National Laboratory shared his belief that the National Commission will be the first significant public policy initiative in the post-COVID world, making the publicization of its work even more crucial. Second, the Commissioners charged the Working Groups with elevating two issues to prominence. The inequality of opportunity and persistent social inequities in the U.S. are a hindrance to competitiveness, and addressing them must be a priority. Further, the current pandemic has exposed the lack of resiliency in the American economy, especially in our supply chains, and we must act swiftly and aggressively as a nation to remedy this. Third, the "rules of engagement" have changed. Arizona State University President and Council and Commission Co-Chair Dr. Michael Crow emphasized that conventional thinking will not provide the solutions the country needs, and other Commissioners warned that the policies that worked in the 1990s are obsolete in the 2020s. The Commissioners also exhorted the Working Groups to continue discussing and promoting U.S. leadership in platform technologies, addressing the disconnect between the conducting and commercialization of research, and thinking about new models for collaboration and public-private partnerships.

The Nine Pillars and the Road Ahead

Mr. Evans discussed the synthesis report that the Council created from the Phase I Working Group discussions, as well as the Nine Pillars that emerged as focal points for action following the eight weeks of conversations. These pillars include issues that appeared organically in all of the Working Group discussions, and were "strategic, urgent, and pivotal." Strategic issues are those relevant to the fundamental competitiveness of the U.S. economy and America's strategic and geopolitical interests, urgent issues are those that will cause significant damage to American society if not addressed, and pivotal issues are those that will play an outsize role in the scale, scope, and rate of America's innovation. Examples of these topics are the response to the COVID-19 pandemic and the need to improve American resiliency and shore up supply chains, diversity and equality of opportunity to participate in America's innovation economy, and training the workforce and innovators of the future in relevant skills and competencies. Mr. Evans also discussed renewed interest among federal policy makers in innovation, including bills such as the Endless Frontier Act and the CHIPS Act, which provides funding and incentives for renewed domestic manufacture of semiconductors and advanced microelectronics. Other important legislation includes multiple bills targeting long-term infrastructure investment. Mr. Evans described the Council's efforts to communicate the work and aims of the National Commission to policy makers, as well as members of Congress' interest in sharing upcoming legislation and initiatives with the Council.

Mr. Evans stated his aim for the first weeks of this phase of the Working Group sessions was to identify priority areas, aligned with the pillars identified in the synthesis report, for developing specific and actionable policy recommendations ahead of the National Competitiveness Forum in December. He also reminded the group that recommendations need to address specific issues, go beyond conventional wisdom, identify specific "champions" to support and advance the recommendations, and identify an audience, such as Congress, the Executive Branch, or the Private Sector. He noted that while the goal was to prioritize two to four topics for the current phase, the Commission is a multi-year initiative, and other areas that are not addressed in Year 1 remain viable topics for future discussions and recommendations. To that end, Mr. Evans asked the group members to send a list of topics they would like for the group to prioritize to the Co-Chairs to help them plan the next phase of calls. Finally, Mr. Evans discussed the Innovation Council, comprised of senior leaders in government who will review and provide feedback on the recommendations generated by the Working Groups and approved by the Commissioners. These officials represent many of the organizations that will be implementing the Commission's recommendations and will provide feedback on tailoring them to make them actionable and feasible.

Co-Chair Opening Thoughts

Five of the seven Co-Chairs shared their thoughts on their hopes for the group and its work. Dr. Laurie Locascio of the University of Maryland described her role as Vice President for Research and her previous experience at the National Institute for Standards and Technology (NIST). She praised the quality of the first phase of discussions and the synthesis report, and spoke about the need for a clear vision and strategy for the group. Using the example of Vannevar Bush's famous Science: The Endless Frontier call to action, Dr. Locascio said developing a similar inspirational vision, coupled with a cohesive strategy for realizing it, would be a valuable product for the Commission. She said that underlying this vision was the "How" of bolstering American competitiveness, and she identified addressing inequities in workforce development and access to innovation, building linkages among universities, industry, and the federal government, and addressing the structural vulnerabilities revealed by COVID-19 as important components of this goal. Dr. Locascio warned that a competitor developing a COVID-19 treatment or vaccine before the U.S. could jeopardize our long-term competitiveness, and urged the advancement of a "bio-agenda" to ensure continued U.S leadership in this field.

Mr. Toby Redshaw of Verizon discussed his work for Lawrence Livermore National Laboratory in trying to prevent America from being leapfrogged on critical technologies, and characterized the challenges the country faces as "hard, structural issues." He spoke of the importance of redefining the narrative around competitiveness in a way that captures public attention and encourages public "opt-in" to innovation initiatives. Mr. Redshaw emphasized the need to balance long-term goals with short-term impacts, and encouraged the group to find ways to tell the story about scaling disruptive technology while also addressing the inequalities in opportunity and talent generation that hold back America's workforce and innovation over the long term. Finally, Mr. Redshaw stressed the nexus of innovation and pragmatism. He warned that grand policy ideas were not enough, and that telling a different story to build a "coalition of the willing" was imperative for actionable policy changes. He closed by asking "if not us, then who?"

Mr. Mike Cassidy of Emory Biomedical Catalyst praised the synthesis report and the framing of the Nine Pillars as providing a valuable road map for the Working Groups during the second phase. He expressed excitement about the opportunity to drill down into refined ideas and concrete recommendations, and cautioned the group not to focus exclusively on COVID-19. He described his professional interactions with medical and public health experts who feel that COVID-19 will not be the last pandemic or catastrophe, and emphasized that the vulnerabilities this pandemic revealed need to be fixed for the long term, lest they emerge again during future crises. He called for a final set of recommendations that are durable and flexible for meeting future challenges. Mr. Cassidy also praised the Council's work in cultivating relationships with policy makers, which amplifies its reach and increases the potential audience for the Commission's final product.

Dr. Paul Hommert, formerly of Sandia National Laboratory, echoed Mr. Cassidy's sentiments, observing that the Council's non-partisan agenda and credibility were particularly valuable in the current political climate, and underscoring Mr. Cassidy's point that issues in supply chain resiliency, healthcare, and other dimensions of competitiveness will not disappear with the COVID-19 pandemic. Discussing the reluctance of citizens in his home state of Arizona to wear masks as a public health measure, Dr. Hommert said this disconnect illustrated the need for greater interaction between scientists and the general public. He also expressed interest in examining the roles and responsibilities of National Laboratories in the innovation ecosystem, but cautioned that he did not want to "boil the ocean" with too broad of a focus. Ms. Wince-Smith agreed that the National Laboratory system was vitally important and a "great treasure."

Finally, Mr. Andre Doumitt of the Aerospace Corporation discussed his experiences working on technological innovations at startups, large firms, and federal laboratories. He identified a lack of connection and synchronization between the components of America's innovation ecosystem as an impediment to progress, and urged the development of a "culture of adoption" in centers of innovation. He also asked whether it would be better for the Working Groups to remain organized along their current lines, or to focus on specific items out of the Nine Pillars identified in the synthesis report, and suggested creating a detailed plan for the December 17 release of findings, including which groups are responsible for each pillar.

Identifying Focus Topics

Mr. Evans said that each Working Group will touch on multiple, or possibly all, of the Nine Pillars, but that different groups were also encouraged to identify specific topics to prioritize. Mr. Cassidy suggested developing a matrix of the Working Groups and the Pillars in order to better coordinate efforts across the Commission community, especially as groups begin to have more focused discussions. Mr. Evans said that the Council could prepare such a document, and said that feedback from group members on priority topics would help the Co-Chairs better plan discussions and agendas for the second phase of calls. Dr. Locascio asked if group members could identify specific topics, such as AI or microelectronics, for prioritization in

addition to the Nine Pillars, and Mr. Evans said that more detail would enable help the group accelerate its generation of recommendations. Ms. Wince-Smith said that the group will not do deep dives on every pillar, but that all nine of them touch on the group's mandate in some way. She added that this Working Group is uniquely powerful in its focus on platform technologies that are foundational to all aspects of competitiveness, including improving the diversity of the pipeline of innovators versed in these platform technologies.

Mr. Dave Vasko of Rockwell Automation agreed that the group could not focus exclusively on the pandemic, but noted that COVID-19 was accelerating existing technological and societal trends, and that the Commission could build off of the pandemic to generate momentum for continuing these trends, including remote working and adaptable manufacturing. Dr. Hommert agreed, stating that the country could not return to the old way of doing things and that the pandemic provided an opportunity to make some of these shifts and innovations the new normal. Mr. Phil Weilerstein of VentureWell said his organization had prepared a document that would help the Commission community identify opportunities for cross-pollination and develop a cohesive "pipeline" strategy. Mr. Evans thanked him for sharing this document, said that it was a goal of the Commission to have cross-pollination as Working Group discussions continued. He added that the goal of the Commission during the Fall will be to create a holistic call to action that is tailored to different organizations and stakeholders, including Congress, the Executive Branch, state and local governments, workforce development and economic development boards, universities, labor unions, laboratories, and corporations. How many of these audiences the Commission specifically addresses will depend on the recommendations that emerge from the Working Group discussions.

Platform Technologies and Fusing Technological and Social Innovation

Mr. Mark Minevich of Going Global Ventures praised the Nine Pillars framework and the work the Commission had done during the first phase. He added that the group needed to combine this framework with a framework for an all-inclusive vision of society that addresses the needs of the whole population. He urged the combining of technological innovation with social innovation, harnessing the products and processes that emerge from labs, universities, and start-ups to engineer a revolution in healthcare, mobility, sustainability, transportation, and food and agriculture, among other crucial areas. He noted that countries such as Israel, Japan, and Denmark had embraced such a vision, and that U.S. leadership in this way of thinking could demonstrate to the world that the U.S. cares about the well-being of all of its citizens and the planet. Dr. Roland Stephen of SRI International agreed that inclusion and platform investments were critical to innovation, but warned that the country lacked the institutional and programmatic designs necessary for "team science" that addresses major challenges. Dr. Locascio echoed the importance of team science to finding innovative solutions.

Telling Compelling Stories and Strategic Communication

Mr. Redshaw underscored the importance of framing the story of the Commission's work in a positive way. He said it was easy to tell a scary story of American dominance receding the face of challenges from China, but that highlighting case studies of positive developments and successful innovations was the best way to secure broad public buy-in for the Commission's agenda, and to do so quickly. He encouraged the use of examples from innovation hubs like the biomedical complex around Emory University and the National Laboratories to show people how to transcend current barriers to innovation. Ms. Sara Lawrence of RTI International also agreed on the importance of telling a different story. Mr. Evans agreed and noted the Council was preparing a strategic communications plan to maximize the reach of the Commission and increase public awareness of its work. He said case studies provide important models for best practices and scaling of innovation, and that being creative in the Commission's products beyond standard reports was vital. He discussed the series of video Op-Eds the Council is preparing with Commission leadership to publicize the work of the Commission and its importance, and affirmed the importance of having a variety of end products to reach the largest possible audience in the most impactful way.

Concluding Thoughts

Ms. Wince-Smith reminded the group that the National Commission has a large scope as a three-to-five-year initiative, and drew on recent examples, such as widespread uptake of telemedicine during the COVID-19 pandemic, to highlight how crises and major events often prompt the adoption of existing technological innovations. She said the group had the opportunity to be very innovative going forward around critical technologies and initiatives. Ms. Wince-Smith also discussed the media coverage the Council's press release received following its announcement of the Nine Pillars and the highlights of the June 16 National Commissioners' meeting. Major media outlets, including Politico, covered the story, and Ms. Wince-Smith encouraged the Working Group members to augment this impact by publicizing the Commission's work in their own professional and social channels. Ms. Yasmin Hilpert encouraged the group to make use of the online portal for continuing discussions and starting new ones, and Mr. Evans reminded the group about next week's meeting, and of the request to send a set of priority topics to the Council team and the Co-Chairs ahead of next week.

Working Group 1 Calls June 30

Introduction

Mr. Bill Bates welcomed the group, and said that the focus of the day's conversation would be identifying topics for participants to discuss in greater detail in the coming months. Ms. Yasmin Hilpert shared an overview of the responses the Council team and Co-Chairs received regarding members' priorities and interests. Ms. Hilpert noted that a number of respondents expressed interest in topics that were a specific focus of another Working Group, and that these topics are addressed in the first section of the summary document she posted to the online portal. The second section of the summary document details broad, "food for thought" topics, including a characterization of the group's areas of focus as the "what" of critical or platform technologies, the

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"how" of reshaping the ecosystem to ensure U.S. leadership in these technologies, and the "why" of explaining the benefits to society from developing and deploying these technologies at scale. Another component of the "why" of disruptive innovation consists of anticipating the challenges, disruptions, and social dislocations that are inherent in rapid change, which also must be accounted for. This middle section also distinguishes between sector-specific technologies and cross-cutting technologies, which will require different policy interventions and solutions. The final part of the summary document enumerates specific topics that Working Group members identified for further investigation. These include the role of universities and laboratories in commercializing and transferring technology, greater engagement between academia and industry, artificial intelligence, biotechnology and synthetic biology, edge computing, and 5G technology. Other topics include the digital dollar, venture capital and alternate forms of financing long-term research in innovation, the scope and distribution of funds for government bodies like the National Science Foundation and National Institutes of Health, and focusing on innovation systems. Diversity and inclusion emerged as key topics among all four Working Groups.

Critical Technologies

Mr. Mike Cassidy of Emory Biomedical Catalyst discussed the background research he did on lists of critical technologies for American competitiveness and national security, and found that the federal government had not issue a government-wide list of such technologies since the Clinton Administration. He suggested the group recommend that the federal government create and maintain a list of critical technologies. Mr. Andre Doumitt of the Aerospace Corporation noted that the Endless Frontiers Act being debated in Congress establishes a list of critical technology, and Dr. Roland Stephen of SRI International flagged the Department of Energy's Critical Materials List as a helpful model, if narrow in focus. Senior Advisor to the Council Ms. Carol Ann Meares said that the federal government was developing a list of critical technology for the purpose of export controls as part of FIRRMA and the National Defense Authorization Act. Dr. Neil Thompson of MIT said that whole-of-government approaches to technology policy began to decline with the abolition of the Office of Technology Assessment during the 1990s.

Dr. Anthony Tether, former director of the Defense Advanced Research Projects Agency (DARPA) said that while lists of technologies were good to mention, it was more important to focus on what those technologies allow people to do. He said innovation was not technology itself, but using technology to create something new, and that without this focus lists of important technologies would not be very helpful. Mr. Doumitt agreed on the importance of focusing on problems and solutions, and discussed the aerospace industry's use of machine learning and AI to program satellites that could learn how to optimize their own orbits, along with new GPS technology and the use of digital printing to expedite the replacement of satellite parts. In particular, Mr. Doumitt said the Senate Armed Services Committee just announced its desire for alternative GPS technology by 2023 to prevent spoofing and jamming of satellite signals and to leapfrog more advanced Russian and Chinese technologies. Mr. Bates said that it was important to focus on the policy gap, and what funding, regulations, or other considerations, such as competitors outperforming the United States, were acting as barriers to competitiveness.

Forming Subgroups and the December Product

Dr. Laurie Locascio of the University of Maryland discussed earlier suggestions to break out into subgroups to investigate specific questions, and asked whether devoting groups to the topics that had already surfaced, such as problems or grand challenges, infrastructure, and the innovation ecosystem would be sufficient, or if this schema risked omitting key topic areas. Mr. Doumitt said that having a tactical game plan for the December release of the Commission's Year One findings was essential to optimizing the group's time, and asked if Commis-

sion leadership would be able to share its plans soon regarding an end product. Mr. Bates stated that while the December meeting was an important milestone, it was not the end of the work of the Commission, and that the Year One findings would be released a month after a presidential election whose outcome could drastically alter the landscape for the Commission and its recommendations.

Problems and Grand Challenges

Dr. Robie Samanta Roy of Lockheed Martin suggested developing a taxonomy for organizing the group's work around grand challenges, which he said would help the group identify a detailed roadmap for the next phase of work. First, Dr. Samanta Roy suggested identifying problems, including Infrastructure, National Security, and Demographics. These broad problem areas would have specific components, like 5G and Communications for Infrastructure, Economic Security for National Security, and Health and Education for Demographics. These sub-areas would then have specific topics, like Manufacturing for Economic Security. For each of these sub-topics, the group should focus on enabling and maintaining U.S. leadership in the field, along with the obstacles to that leadership, technologies that need to be developed, policies that need to be changed, and what different stakeholders in government, academia, and the private sector can do. Once the group develops solutions, these would be assigned to various stakeholders responsible for different aspects, like technology, funding, people, and processes.

Mr. Marcus Owenby of AT&T agreed with the challenge framework, and suggested identifying and addressing gaps in the economic factors required to sustain performance in disruptive technologies, including education, manufacturing capabilities, and the talent pipeline. Dr. Tether discussed the role specific problems have played in spurring innovation in the past, such as the development of integrated circuits (and consequently the semiconductor and microelectronics industry) out of a need to keep circuit boards on U.S. missiles from breaking apart during launch. He warned the group not to conflate inventing new technology with using existing technology to solve new problems. He suggested focusing on what problems the country is facing now or will face in the future, and determining whether the technology already exists to address them or if it needs to be invented. Mr. Doumitt added that not focusing on problems means that solutions will have no context and either disappear quickly or fail to catch on entirely.

Conversely, Dr. Paul Hommert, former director of Sandia National Laboratory, said that he did not think the group's purview was identifying problems, important as those problems were. He said that there were many underlying mechanisms in certain areas, independent of their ultimate application, that were not as strong in the United States as the could or should be. Dr. Hommert warned that without addressing these underlying ecosystem challenges, a problem-focused approach would not solve problems fast enough to maintain the U.S.'s economic strength and competitiveness. He also said that they key technologies the country must lead in will emerge organically, and that the emphasis of the group should be on how and what the U.S. must change to harness these technologies. This includes identifying legislative actions, administrative actions, coordination mechanisms in the public and private sectors, and human resource development that are essential to facilitating and unlocking innovation. Dr. Hommert also stressed that this latter set of topics was where the group members' expertise lay.

Ecosystems, Infrastructures, and Long-Term Plans

Dr. Stephen observed that the U.S. lacks the infrastructure to chase many of the problems amenable to a "grand challenge" approach, because research universities and national laboratories are not set up to coordinate in that way or orient around use-inspired research. He said that to be capable of addressing grand challenges, the country first needed to map technology platforms onto those challenges, and to build institutions for the implementation of the policies necessary to address those

challenges. Dr. Locascio agreed on the need for a long-term vision, which she said would encompass not only grand challenges, but structural issues as well. She remarked that the government has not planted a stake in the ground in terms of long-term science and technology vision and strategy, and that it was important to establish who owns and is responsible for implementing each component or stage of such a vision. Without firmly committing stakeholders to particular tasks in a grand challenge, the initiative will not be successful. Dr. Stephen also pointed to accumulating evidence that the bifurcation of the research ecosystem into academic institutions conducting basic research and corporations conducting applied research, stemming from the decline of large commercial research laboratories funded by industry, contributed to the disconnect between invention and scaling of disruptive technologies, and encouraged the group to think of institutional innovations to bridge this divide.

Dr. Arun Rai of Georgia State University suggested the division of topics for the group into Grand Challenges, Infrastructure, and Ecosystems. He characterized these categories as three distinct concepts, and suggested putting "guardrails" around the group's efforts by establishing grand challenges with a focus on resilience. He noted that the COVID-19 pandemic had exposed the lack of resilience in America's economy and society, and that supply chains and other systems that are more efficient during good times are also more fragile in a crisis due to the very same lack of redundancy. For infrastructure and ecosystems, Dr. Rai suggested focusing on a vision infrastructure without information lags that can respond and rebound from crises quickly, and of an ecosystem that does best in hard times due to advanced digital capabilities. Dr. Rai said devoting attention to infrastructure and ecosystems would give a new angle to the grand challenge approach, and would boost resiliency by focusing on how systems operate under uncertainty.

Dr. Thompson cautioned against getting caught up in debating the push versus pull factor of problems and technological innovation, arguing that causality could flow both ways. Acute problems spur innovation as researchers and policy makers try to solve them, while breakthrough technologies will inspire people to find uses for them if they have promising enough capabilities. He said it was more important to ask what kind of decisions the Commission hoped policy makers would be making on the basis of their recommendations. He observed that basic research has a larger payoff than applied research, but that the payoff is longer term and more uncertain. Dr. Thompson emphasized that the technologies providing the most bang for the buck on investment and the technologies it was essential for the U.S. to lead in did not necessarily overlap. Mr. Bates said that if the Commission feels that a technology is essential for U.S. competitiveness, then it must identify the roadblocks and policy gaps standing in the way of U.S. leadership in that technology, and what financial, legal, and other policies need to be put in place to remove those roadblocks.

Developments at the Manufacturing USA Institutes

Dr. Kelvin Lee of the University of Delaware and the National Institute for Innovation in Manufacturing Biopharmaceuticals (NIIMBL) shared developments among the Manufacturing USA institutes arising from conference calls conducted during the COVID-19 pandemic. Dr. Lee said that heads of the different institutes have been engaged in dialogues centering on resiliency in the face of crisis, and that they were finalizing a white paper for publication. Suggestions from the white paper include the establishment of a National Manufacturing Guard, a Technology Corps, and the incorporation of real time supply chain data exchange into manufacturing. The National Manufacturing Guard would, like the National Guard, consist of volunteers who trained regularly in disaster preparation, but would consist of members of private sector companies who would network with each other. These volunteers would then be in charge of implementing crisis responses during disasters aimed at quickly transitioning their enterprises for resiliency and pivoting to meet emerging needs. The Technology Corps would provide skills development

for 18- to 24-year-olds, and the development of real time supply chain data exchange would involve establishing a secure infrastructure for transmitting demand signals up and down supply chains and across business sectors in order to help manufacturers pivot to urgent needs. In the current crisis, such a data exchange system would be able to signal to manufacturers to adjust production of materials like masks, face shields, and other personal protective equipment in real time based on market data. Dr. Lee offered to share the white paper with the group when it became available.

Patents, Intellectual Property, and the Valley of Death

Dr. Rai asked whether discussion of intellectual property was within the group's purview, in particular the application of patents to digital technology. He noted that for many technological innovations, the ecosystem around a digital product is the key to competitiveness and the main focus of the inventor's protection efforts, rather than any single product or service. As an illustration, Dr. Rai discussed how the patent activity of software firms, along with the scope of the patents they did file, were declining, but innovation in the industry was not. Dr. Stephen agreed that patents and intellectual property needed to be discussed by one of the Working Groups, and Dr. Tether described patents as being useful for encouraging those with ideas to share them, even if their ideas did not have practical uses. By giving inventors an incentive to publish their ideas or designs, other innovators could then apply those ideas to a problem they were facing that the originator may never have thought of. Dr. Locascio observed that patent policy could play a key role in addressing the "Valley of Death" facing startups. Mr. Phil Weilerstein of the VentureWell Foundation suggested including intellectual property as part of a focus on systems, and said there were many "ditches of death" that stalled innovations before reaching the Valley of Death. He further suggested taking an integrated approach to pushing innovations forward, including supporting entrepreneurs through sensitive points and identifying where to place subsidies for key inputs in the early stages of technology development to prevent ideas from failing for the wrong reasons. Mr. Weilerstein also reported that there were existing best practices throughout industry and government programs like SBIR, but that they were not being applied in a systematic fashion. Mr. Bates said that while patents were especially relevant to the mandate of Working Group 3, they also had relevance to this group's work, especially because so many aspects of the patent process act as inhibitors to the proliferation of new technology.

Concluding Remarks

Mr. Cassidy thanked the group for its conversation, and said that the group would need to make decisions soon about priorities for future discussion. He added that he hoped to discuss the role of universities and labs in commercialization of research and technology transfer in more depth next time. Dr. Locascio told the group that although the Co-Chairs wanted to whittle down topics soon, there was still a chance for those who had not submitted priorities to make their interests known. Mr. Doumitt suggested using the Nine Pillars from the Phase I Synthesis Report as a guide for narrowing the group's focus to three major areas, and Dr. Hommert said he felt that the group had identified many key issues to work through. Mr. Bates said the Council team would continue to take in information from the group members and remain in conversation with the Co-Chairs about developing a schedule for the rest of the summer and fall, and that the group would also continue discussing the end product to be released in December. He also reminded the group that it would meet again next Tuesday, July 7th.

Working Group 1 Calls July 7

Introduction

The Honorable Deborah Wince-Smith and Mr. Chad Evans welcomed the group. Mr. Evans introduced the leader of the day's discussion, Dr. Laurie Locascio of the University of Maryland. Dr. Locascio summarized the previous week's conversation, and mentioned several key takeaways. First, she noted that many group members raised issues that fit within the purview of other Working Groups, but noted that while those groups will be the primary focal point for discussion of those issues, the group can and will touch on those topics as well. She also described Dr. Arun Rai of Georgia State University's grouping of the group's mandates into three "buckets": Grand Challenges, Infrastructure, and Ecosystems. Grand challenges included both overarching strategies for future American competitiveness and specific technologies that are essential to maintaining that competitiveness. Infrastructure includes the development of new agencies that could help implement the group's recommendations, new public-private partnerships and methods of partnering, and new public policies designed to foster innovation. Ecosystems

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refers to linkages between stakeholders, including tech transfer from universities and laboratories to the private sector, venture capital and investment in innovation, and government policies designed to facilitate these things. Dr. Locascio asked if the group felt this schema was the best framework for the group's future discussions, and suggested the formation of breakout groups organized around those three buckets if they were. Mr. Bill Bates added that this was intended to be the last week for members to raise topics for further refinement, with next week's call marking a focus on specific issue areas.

Human Capital and the Nexus with Other Working Groups

Mr. Marcus Owenby of AT&T asked how addressing human capital questions interacted with the group's mandate. He characterized the greatest challenge from for disruptive technology as the inability of the current educational system to prepare Americans for the changes disruptive technologies will bring or provide them with the skills to harness that disruption for greater prosperity. Mr. Evans said there was room to talk about education in the group, but that the issue of human capital more broadly was the focus of the fourth Working Group. He added that members of the group were welcome to join other Working Group calls and share thoughts on topics within those groups mandates on those calls, provided they gave advance notice of their interest. Mr. Owenby said he wanted to make sure the Commission as a whole was addressing the issue, noting that his company faced challenges in recruiting the skilled workforce it needed. Dr. Locascio observed that recent immigration restrictions had heightened the importance of domestic human capital cultivation, and Dr. Roland Stephen of SRI International pointed out that a grand challenge centered around technological connectivity would help address the challenges facing the education system. Dr. Kelvin Lee of the University of Delaware suggested identifying connections between the group's conversations and the mandates of the other Working Groups and sending summaries of the group's discussion on the topic.

Grand Challenges

Mr. Toby Redshaw of Verizon identified Immersive Participative Audience Education (IPAE) as a crucial disruptive technology. He said that it was the future of education and skills training, as it offered a three- to four-fold improvement in effectiveness and a five- to ten-fold improvement in cost compared to conventional education and training. With overall cost-per-unit improvement of up to twenty times the status quo, Mr. Redshaw said IPAE could help bridge many of the gaps in the educational system and in workforce preparedness. Ms. Sara Lawrence of RTI International said that all deployment of technology at the regional level is hindered by fundamental breakdowns in education access and quality. While supportive of connecting the group's work to educational access, she cautioned against making it a grand challenge of its own, and further called for the clarification of what "grand challenge" meant in the context of the discussion to help the group stay in its lane.

Dr. Stephen distinguished between strategies that pursue goals and challenges, and technologies that enable stakeholders to solve those challenges. Ms. Lawrence said that it was important to help the group focus, and to develop a platform for the very distributed set of organizations represented in the group to focus and collaborate. Ms. Wince-Smith said it was essential to identify technologies that are crucial for continued U.S. competitiveness and necessary actions to remain ahead of the curve technologically. She warned that it was not sufficient for the United States to lead in basic research or academic papers published, but to use technology to transform the economy, ensure American national security, and improve the standard of living of all Americans. Dr. Paul Hommert, former director of Sandia National Laboratory, asked what the threshold was for a "grand" challenge, and whether cross-cutting issues, including competing with China, represented challenges of their own. Dr. Locascio suggested a technology focus for grand challenges, and Ms. Wince-Smith said that China tied in to nearly every aspect of the Nine Pillars outlined for the Commis-

sion following Phase I of the Working Group calls. As examples, she cited China's use of antitrust policy to disadvantage "champion" U.S. firms in key technologies, and China's attempt to set or manipulate ethical, safety, and other standards and specifications for new technologies to its advantage.

Metrics and Alignment

Dr. Campbell cited the UN's Sustainable Development Goals as a model for developing grand challenges for the group. He noted that the seventeen goals were very lofty and time bound, with a deadline of 2030. He suggested that establishing clear targets to meet by a specified date could expedite buy-in from the U.S. government and help secure funding. Ms. Lawrence expressed support for this idea, and Dr. Campbell added it would be essential to talk to policy makers when designing the goals to ensure they are feasible. He said many of the UN's goals are very ambitious, including eradicating global poverty and securing the world's food supply, and have been set back by the pandemic. He elaborated by suggesting a "stretch goal" for each technology the group identifies as crucial, to be achieved by 2035. Ms. Maggie Hallbach of Verizon stressed the need to establish the objectives behind scaling disruptive technologies, and recommended doing so in a way that differentiated the U.S. and its allies from China. As examples, she mentioned using technology to make the planet sustainable, use technology to benefit humanity, or to train the workforce of the future. Ms. Lawrence echoed the need to connect technologies to the benefits that would accrue from them, and cautioned against recreating the work of other groups. She suggested taking existing goals and connecting them with the Commission's focus, including how technologies can help America achieve those goals and how achieving those goals makes America more competitive. Ms. Wince-Smith and Mr. Evans noted that the Council's sister organization, the Global Federation of Competitiveness Councils, aligns all of its goals and recommendations to the UN Sustainable Development Goals.

Goals and Technologies

Mr. Redshaw said it was essential to focus on the innovation supply chain from ideation to realization, and that the U.S. was at risk of no longer being world-leading. He said that disruptive technology could change this, and that the group should develop guideposts and yardsticks to ensure that the ideas it develops advance the group's mandate. He recommended to the group the book Loonshots by Safi Bahcall, which discusses the key determinants of the success of grand challenge initiatives. Dr. Stephen observed that "The Moonshot" had a clear, measurable goal: landing on the moon. Dr. Hommert added that it also had a clear impetus: checking the threat to U.S. military dominance posed by the Soviet Union and nuclear weapons. He said it would be more difficult to identify a clear-cut imperative for similar efforts in a more complex geopolitical and economic landscape, but that it could be useful nonetheless. As another example of specificity, Dr. Stephen cited the Defense Advanced Research Projects Agency (DARPA) and its mission-driven goals, which are carefully designed to be clear and simple while mobilizing a broad and inclusive coalition. This clarity is made possible by DARPA's larger background aspirations. Dr. Locascio said that the Sustainable Development Goals were technology-agnostic, but forced the rapid development of new technology as stakeholders strove to meet them. Dr. Campbell was cautious about "cherry-picking" technology, noting that it was impossible to identify crucial technology that has yet to be invented.

Dr. Locascio asked the group if the focus should be on specific end goals or challenges, or on technologies to prioritize in service of a variety of grand challenges. Dr. Neil Thompson of MIT said it would be necessary to pick specific technologies that would have the biggest impact and ensure the United States led in those fields. Ms. Lawrence suggested first identifying grand challenges to solve, and then priotiziting the technology necessary to meet those challenges. Dr. Rai suggested bringing together the technology, ecosystem, and infrastructure components, giving as an example the pause by companies

like IBM on facial recognition technology. He said that while concerns about racial bias in facial recognition programs had been raised before, it took the unrest following recent protests to force action on this equity issue. Dr. Rai said that without an assessment of risks and blind spots with new technology, disruptive innovations like AI could exacerbate grand challenges like inclusion rather than solve them.

Mr. Redshaw predicted that crucial technologies would be combinations of things, like AI and Machine Learning fused with 5G and edge computing. He listed IPAE and next generation big data platforms as examples of this combination, noting that IPAE involved eight different core technologies. Mr. Owenby added that in the telecommunications industry, these platform technologies were viewed as key components for deploying advanced technology in general, and Dr. Stephen echoed this, observing that many technologies are general purpose and could help address grand challenges in a variety of ways.

Infrastructure vs. Ecosystems

Dr. Locascio asked for the group's opinion on whether ecosystem and infrastructure should be distinguished going forward, and if so by what criteria. Mr. Owenby described infrastructure as tangible parts and components that facilitate technology development, and the ecosystem as the interactions between these parts that produce value in excess of their inputs. Dr. Stephen characterized ecosystem as institutional design, and emphasized that the chief problem for the U.S. was in shepherding discoveries through the institutional gaps in the U.S. innovation ecosystem. Dr. Locascio asked if the infrastructure and ecosystem bins should be kept separate, and Mr. Owenby and Dr. Stephen suggested separation. Dr. Hommert also questioned whether infrastructure was a useful organizing tool because of its vagueness, and suggested the group could have a bigger impact focusing on the ecosystem.

Scaling

Dr. Stephen said that we was working on a memorandum he hoped to share with the group on the importance of realigning America's institutions, including universities, industry, and laboratories, to better scale technologies. Mr. Redshaw identified scaling as the hardest part of innovation, and said the U.S. had set up its ecosystem to fight the last war, not the current one. He noted that historically, breakthrough technologies had appeared with advance warning that gave firms and market actors time to prepare and adjust, but that in the next six to eight years the economy would see disruptions of unprecedented speed and magnitude from big data, edge computing, the internet of things, and other innovations. He urged the identification of two to four key supply chains for technologies and a road map to incorporating them into the national innovation ecosystem. Mr. Redshaw praised President Macron's revamping of the French venture capital system for its rapid response to coming changes, but said institutional barriers made it impossible to replicate here. He warned that China was ten times as effective at onboarding innovations and putting them to practical use in its firms and government, and spoke of massive potential gains from better synergy between the academic and commercial sectors in the U.S. Dr. Stephen suggested moving backwards from grand challenges into discrete tasks that could be addressed by technologies, and said that the current crisis was accelerating the development and deployment of immersive technology for education and service delivery, even as innovation slowed in some other fields.

Public-Private Partnerships

Ms. Wince-Smith asked what could be done to expedite the development of new test beds and pilot projects, as well as to encourage the investment of hedge fund capital into disruptive technologies. Dr. Anne Marie Knott of Washington University in St. Louis noted that China has an advantage for financ-

ing technological scale-up by virtue of its size as a buyer, and Mr. Evans wondered if there was a connection between the decline in federal R&D spending and the ability to scale technologies due to the lack of a "first buyer" for U.S. innovations. Dr. Knott said that the major source of the decline was federal spending on development, and Dr. Stephen said the U.S. needed to commercialize and disrupt much more than it currently was. Mr. Dan Armbrust of Silicon Catalyst warned that if the U.S. did not address the end of Moore's Law with a new microelectronics platform, there would be no private incentive to invest in new technologies because of the risk. However, developing the ecosystem necessary to de-risk innovations in this space requires a public-private partnership and coordination among sectors. Dr. Hommert said that Department of Energy Labs are mission-defined, and that collaboration with stakeholders outside of that mission can be very difficult. He encouraged, and offered to help with, the development of new mission statements for labs that recognize the complementarity between labs' traditional goals and the commercialization of technology. However, he warned such rewriting would need to be done carefully.

Dr. Locascio asked the group for examples of improved public-private partnerships to build upon for recommendations. Dr. Thompson said that it was a misconception that most university-industry collaboration centers around patents, and that cooperative research is the biggest and most important endeavor. He added that the number of firms seeking to work with universities was growing rapidly. Dr. Stephen agreed that collaboration was increasing, but warned that many research universities are still not as well-equipped to partner with the commercial sector as they believe themselves to be. Dr. Kelvin Lee of the University of Delaware said that one of the drivers of the success of the National Institute for Innovation in Manufacturing Biopharmaceuticals (NIIMBL), part of the Manufacturing USA institutes and an initiative he leads, has been its sponsorship by the Department of Commerce. Since the institutes are sponsored by particular government agencies, the institute's mission has meshed well with its sponsors, as the Department of Commerce is focused on improving competitiveness. However, he warned that the institute had only recently begun bridging the divide between academic and corporate cultures in research orientation and goals.

Concluding Thoughts

Dr. Locascio thanked the group for its discussion and said she felt they made great progress. Mr. Evans thanked Dr. Locascio for leading the discussion and said the Council would circulate a summary afterward. The next meeting of the group will be next Tuesday, July 14th.

Working Group 1 Calls July 14

Introduction

The Honorable Deborah Wince-Smith and Mr. Chad Evans welcomed the group. Ms. Wince-Smith discussed the highlights of her recent Congressional testimony on the importance of funding research and development, and their intersection with the Working Group's mandate. Ms. Wince-Smith discussed the importance of moving beyond basic research funding and providing federal support in collaboration with other stakeholders for accelerating the deployment and scaling of key technologies to maintain American economic and political leadership. She also discussed the need to increase the dispersion of innovation and economic dynamism throughout the country, not just on the two coasts, and the imperative of balancing an inclusive immigration policy with the obligation to better train our own citizens for the economy of the future. She also advocated several of the recommendations the group had discussed during the first phase of calls, including more pre-competitive partnerships between government,

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industry, and academia, and the development of test beds for new technologies. Mr. Evans then turned to one of the Co-Chairs, Mr. Mike Cassidy of Emory Biomedical Catalyst, for opening remarks. Mr. Cassidy stressed the need for the group to move beyond discussing its purpose and into developing concrete recommendations. He said that regardless of what technologies or grand challenges the group identifies, it must begin developing plans for implementing.

Framing for the Way Ahead

Mr. Evans gave a presentation to the group outlining its progress, its charge, and a road map for future discussions. He said that the group had become stuck on classifying and naming key technologies, and offered the paradigm of "general enabling technologies." In spite of their general applicability, these technologies have key characteristics. These technologies are transformative, producing exponential improvements in productivity and capability, are critical to national security and continued economic productivity, and have many uses and applications, including serving as the basis for subsequent innovations relevant to particular fields. An example of the convergence of some of these technologies is evident in the development of COVID-19 vaccines, as revolutions in biotechnology and high-performance computing have enabled researchers to design vaccine candidates in three hours, and move from gene sequencing to human trials within 66 days. Mr. Evans also noted that there have been many lists codifying "key technologies" over the years, from the first government list in 1979 to the present, where the Industries of the Future Initiative, the Foreign Investment Risk Review Modernization Act (FIRRMA), and the Endless Frontiers Act (EFA) all outline critical technologies. Mr. Evans noted that the White House Office of Science and Technology Policy pioneered these lists under Ms. Wince-Smith's leadership, and that subsequent lists had been influenced by the Council's work.

Given the consensus around the importance of technologies like Artificial Intelligence and machine learning, quantum computing, big data, biotechnology, nanotechnology, advanced materials, autonomous systems, advanced manufacturing, advanced microelectronics, and the Internet of Things, Mr. Evans recommended the group focus on what investments and ecosystems will be needed to support the large-scale deployment of these technologies in way that generates value for society and prosperity for all Americans. These technologies will profoundly disrupt the economy, creating new jobs and firms while destroying or radically altering others and changing social patterns, consumption habits, regulations and rules, and societal norms. These technologies also have the ability to address grand challenges facing the nation and the world, including healthcare and public health, clean water, clean energy, adequate food supplies, and sustainable consumption. Mr. Evans stressed the importance of selling the public on the benefit and importance of these technologies.

Finally, Mr. Evans emphasized that while some technology enablers are technology-agnostic, other important recommendations will need to be tailored to particular technologies, including ethical and safety concerns. He asked the group to consider: whether the country's R&D investments are adequate, and if not how and where to expand them; whether we should assess our capacity relative to our competitors; if we need new models, research institutes, initiatives, and incubators; how to optimize the vertical integration of regional, state, and federal efforts to accelerate innovation; how to expedite technology transfer and commercialization from national laboratories and universities; and how do address the "Valley of Death" in investment in new technologies. Mr. Evans also identified pillars from the Nine Pillars released by the Commission as the culmination of its Phase I work that were especially relevant to the group, including technology for resiliency, supply chains for critical technologies, competition with China, the Valley of Death, technology transfer and commercialization, and the concentration of R&D and venture capital funding in particular industries and areas of the country.

Institutions, Interactions, and Convergence

Dr. Paul Hommert, former director of Sandia National Laboratory, remarked that since many lists of key technologies exist and are relatively consistent, the group could have the biggest impact by improving the efficiency of the nation's system for developing and scaling these technologies, including getting entities to do something differently and changing the way different institutions interact. Dr. Roland Stephen of SRI International echoed Dr. Hommert's call for institutional change, characterizing the arrangements within and between institutions as a kind of "institutional technology." Mr. Marcus Owenby of AT&T characterized this "institutional technology" as a form of factor endowment, and asked what economic or ecosystem factors of innovation were critical to advancing technology, including public policies, research institutes, capital, and education. Dr. John Sarrao of Los Alamos National Laboratory noted that the biggest benefits and disruptions from new technology will come from the multiplicative impact of several different technologies converging, rather than any one innovation. He also expressed interest in seeing the discussion road maps for the other three Working Groups to help the group narrow down its discussion paths. Dr. Thomas Campbell of FutureGrasp, LLC also expressed a desire to focus on the convergence of multiple technologies in areas like healthcare, and Mr. Mark Minevich of Going Global Ventures proposed both focusing on key "vertical pillars" like health, national security, and transportation and creating a "maturity model" for different phases of deployment for key technologies.

The Problems to Solve

Dr. Anthony Tether, former director of the Defense Advanced Research Projects Agency (DARPA) asked whether the group had reached a consensus on which problems it wanted to solve. Ms. Wince-Smith suggested that the three cardinal challenges were improving the productivity gap and returning U.S. productivity growth to historical norms, addressing the economic and security threats posed by China, and improving the environment, sustainability of production and consumption, and other challenges facing America's standard of living. She warned that if the country did not accelerate its productivity growth, the standard of living would decline and inequality would increase, and cited Dr. Tether's work at DARPA in highlighting the importance of computing power for economic productivity by American firms. Above all, Ms. Wince-Smith warned that if China beats the U.S. to the development of the next generation of advanced microelectronics, the United States, and the world, will be dependent on the graces of the Chinese Communist Party for access to all the technology of the digital future and the innovation and prosperity it supports. Mr. Andre Doumitt of the Aerospace Corporation added that China has already formulated concrete goals for space-based industrial and commercial facilities, space power generation, lunar and asteroid mining, and the development of the advanced spacecraft

required for these functions within the next 20 years. He further warned that China was trying to dominate in AI and cybersecurity. To this, Dr. Campbell said that his firm's research showed that 64 countries have already imported Chinese technology with AI surveillance capabilities.

Mr. Doumitt suggested a national, flagship initiative on accelerating the development of a handful of key technologies. He described the "Taco Bell Model." The restaurant chain produces its entire menu from only a handful of ingredients, and Mr. Doumitt said that the future of innovation followed a similar model, with a handful of advanced technologies combining to produce an enormous variety of new products, processes, and capabilities. These could in turn be used to address grand challenges. Mr. Dan Armbrust of Silicon Catalyst agreed with Ms. Wince-Smith on the need to develop the next generation of microprocessors in the United States, while Dr. Hommert suggested using microelectronics, healthcare, and other technologies or sectors as a model for the ecosystem changes needed to disrupt America's ability to lead in these and other fields. Mr. Gregory Morin of Argonne National Laboratory warned that atomization of federal research was hamstringing federal efforts to support technology development. He noted that the federal government's Office of AI was a "hot potato" with no department or agency clearly claiming ownership and no coordination between different branches of the government.

AI, Jobs, and the Speed of Transformation

Mr. Toby Redshaw of Verizon warned that advanced technologies, and in particular the convergent effects of advanced technologies, were going to profoundly disrupt the American economy within three to six years, and that if the country was not prepared to harness them the right way, the effects on employment, standard of living, and GDP per capita could be devastating. Dr. Tether echoed these concerns, predicting that many jobs would disappear because of artificial intelligence. Ms. Wince-Smith observed that jobs had disappeared in large numbers during previous iterations of the industrial revolution, but that those workers were absorbed into new, more productive jobs, and that the standard of living continually increased, in spite of painful short-term adjustments. She argued that the U.S. needs to invest significantly more in both trade adjustment for those displaced workers and in preparing the workforce for the jobs and skills of the future. Dr. Tether and Mr. Redshaw noted that this transformation was happening at an unprecedented speed compared to previous revolutions, and Mr. Redshaw also acknowledge the risks of insufficient adoption of disruptive technologies in the form of being outcompeted by China. He warned that the U.S. needed to rapidly address the mismatch between workforce needs and worker skills, but that his experience in workforce development efforts in Latin America offered promising lessons for a rapid upskilling of American workers. Ms. Wince-Smith added that the fourth Working Group was focused on improving workforce training and workforce development.

Mr. Minevich discussed the research coming in from consulting firms like Boston Consulting Group and McKinsey that found AI alone would produce $70 trillion in added value for the United States, including many new jobs. He emphasized the need to focus on maximizing automation and retooling the workforce in order to compete with China in the adoption of new technologies. He said that AI would allow firms to speed up tasks and expand productive capacity, freeing workers to do more creative work and making them far more efficient and productive, and warned against falling for the media narrative of widespread unemployment.

Job Creation and Training the Workforce

Mr. David Vasko of Rockwell Automation warned that the United States could not harness AI or other advanced technologies unless it developed a workforce prepared to work with them. He said that companies right now were struggling to find the skilled workers needed to re-shore manufacturing efforts, and that increasing worker productivity was paramount. He also predicted that AI would have the same ratio of jobs created to jobs displaced as the

computing revolution- a ratio of roughly 5.5 jobs created for every 1 destroyed. He noted that even now there were 50,000 unfilled truck driver jobs, and said it was just as likely that new technologies merely alter the tasks performed by workers as it was they would displace them. Mr. Vasko noted that many people working on autonomous vehicles expressed doubt that they would end the need for professional drivers, and Mr. Minevich discussed a new initiative by Daimler Chrysler to upskill its driver workforce for new, technology driven jobs with the advent of net-generation automotive AI. He said many new jobs would be created in data-driven technological fields, and that companies like Chrysler and Nvidia were ready to create them, but lacked the workforce needed to fill them. Ms. Sara Lawrence of RTI International observed that her organization had found workforce skills to be the greatest obstacle to building regional innovation systems as well. Dr. Tether said it was imperative for the government to invest in preparing displaced and future workers, asking who else could. Mr. Vasko said that AI policy should focus on using AI to make the U.S. more productive, addressing fear and uncertainty brought about by AI, and identifying where there will be real disruptions requiring an overhaul of the workforce's skill set.

The National Laboratory System

Dr. Hommert stressed the need to change the mandate and operations of the nation's National Laboratories to include a mandate to help accelerate the development, commercialization, and deployment of advanced technologies, and to help boost U.S. competitiveness. He said that without an organizational overhaul, the nation's labs would not be able to fulfill their full potential as engines of innovation. Dr. Hommert noted that a small-scale effort to do so in the 1990s led to the development of Extreme Ultraviolet Lithography (EUVL) technology, which is just now entering the market, and has led to the planned opening of a TSMC fab in Arizona. He suggested using this example as a precedent for expanded lab involvement in such initiatives going forward. Ms. Wince-Smith said she recommended such a role for the Labs going forward at her testimony, and that Under Secretary of Energy for Science The Honorable Paul Dabbar also endorsed greater involvement of the National Laboratories in enhancing American competitiveness. Mr. Doumitt said it was crucial to identify how the Labs fit in among accelerators and startups on one end of the system, and large companies and systems integrators on the other, and making the case for their value to the public. He also said it was important to find ways to enhance their ability to provide value and deliver more utility.

Setting Up the Next Session

Mr. Cassidy said he felt that Mr. Evans' presentation had provided needed direction to the group, and that the group should focus on what the country needs to do to dramatically accelerate the deployment of technology at scale. He suggested taking each bullet point question from Slide 11 of the presentation and devoting one sessions to answering that question, beginning next week. Dr. Sarrao. Mr. Doumitt, Dr. Laurie Locascio of the University of Maryland, and Dr. Hommert all agreed with this plan of action, and Mr. Evans asked which order the group wanted to proceed in. Mr. Cassidy suggested that the Council team develop an agenda each week and send material ahead of time to help group members prepare their thoughts for the discussion.

Concluding Thoughts

Mr. Evans reminded the group that on Thursday the Council will be hosting a Competitiveness Watch dialogue as part of its Technology Leadership and Strategy initiative, featuring The Honorable Michael J. Kratsios, Chief Technology Officer of the United States and Deputy Assistant to the President, White House Office of Science and Technology Policy. He has also been nominated to serve as Under Secretary of Defense for Research and Engineering, and will discuss the administration's AI efforts, COVID-19 response, and other priorities. He also asked the group members to send any additional thoughts on the schedule for the months ahead to the Council staff ahead of the next meeting, which will be on Tuesday, July 21st.

Working Group 1 Calls July 21

Introduction

The Honorable Deborah Wince-Smith and Mr. Chad Evans welcomed the group, and Mr. Evans said that he would go over the four priority areas the group had identified for further discussion, in order to provide questions and discussion topics to catalyze recommendation generation and focus conversations within each area. Ms. Wince-Smith said that the group was making excellent progress in its conversations and that she was looking forward to the increase refinement and focus of the next few weeks.

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Government Leadership and Strategies for Innovation

The first issue Mr. Evans highlighted during his presentation was the question of a national strategy for innovation policy. He pointed out that rather than having a single federal focal point for innovation, competitiveness, and capabilities strategy, the federal government has many siloed missions. Although there are federal initiatives for whole-of-government investment in certain key technologies, including the just-announced Quantum Leap Centers initiative, this lack of central coordination influences the extent and efficacy of research and development and capital investment, among other competitiveness-relevant factors. Mr. Evans asked the group if there should be a national leadership structure or entity focused on impacting innovation in an integrated way, and if so, what such a body would look like. Other questions for consideration include whether the U.S. should follow a national strategic planning process to guide our R&D, and how that effort would coexist with America's free market system.

Assessing U.S. Competitive Strength Relative to Competitors

A second major area for exploration is assessing America's capabilities in key technologies and in innovation ecosystems relative to our competitors. Many countries, in particular China, have strategies to build innovation capacity and boost competitiveness in targeted industries and technologies. The United States does not have any systematic effort to monitor what other nations are doing to advance their technological capabilities, increasing the lag time for the U.S. to develop a response to a competitiveness threat. Questions for the group's consideration include whether there is a risk of China overmatching the U.S. in certain key technologies, as well as if China currently possesses any such advantages.

Investment in Research and Innovation

The United States, once the unquestioned world leader in investment, has now fallen to 10th internationally in R&D spending as a percentage of GDP, and investment as a share of the economy has declined continually since its 1964 peak. Were the U.S. to increase federal support for research and development to those historic ratios, annual expenditure would increase from $130 billion to $400 billion. Another trend that has emerged in recent decades is the bifurcation of investment in early stage basic research by the federal government and end-state development research done by private business. Mr. Evans asked the group to consider whether the U.S.'s current spending levels on R&D were sufficient for our size and ambition, if there were areas needing more investment, and if we are spending existing investment at the right pivot points.

U.S. Innovation System Structure and Components

Mr. Evans broke the final topic area, U.S. Innovation System Structure and Components, into six focal points: the concentration of innovation assets and high-tech industry, research and technology national initiatives, regional innovation efforts, the "valley of death" in startup funding, technology transfer, and venture capital.

Currently, 10 states account for two thirds of all research activity in the U.S., and 20 states account for 86 percent. Hubs of innovation are also concentrated on the two coasts, especially in venture capital-backed innovation. Three states, California, New York, and Massachusetts, account for 75 percent of venture capital invested in the U.S. in 2019. While there are regional efforts to spur innovation, how can these be integrated with national innovation programs, and be leveraged into a more potent force for development? Mr. Evans asked the group to consider how to spread innovative activities outside of these regions and generate widespread prosperity and

dynamic economic growth. He also discussed existing initiatives in research and innovation, including the just-announced Quantum Leap Institutes, and asked if this was a sign of new thinking on national innovation efforts, and how the private sector should engage. Mr. Evans also asked the group to consider how the country can make more effective use of existing R&D centers and programs, and whether we need even more. Similarly, Mr. Evans discussed the ongoing industrialization of space, and raised the question of whether the country needed new infrastructure to seize upon this transformation.

Technology transfer from laboratories and universities to industry is another major friction point facing the innovation system. Mr. Evans asked the group to consider how to improve and accelerate this process, and how to make partnering with universities and National Laboratories more attractive for industry. Similarly, what can industry bring to the table to enhance these efforts that it isn't currently bringing? A related bottleneck in the innovation system is the "valley of death:" startups and small companies lack the capital to prototype, test, and validate their innovations, and thus cannot reduce the risk to investors by providing quality control data and performance testing, preventing them from scaling their inventions. Mr. Evans characterized this challenge as one of the highest priorities in order to raise the rate of U.S. innovation, but added that the country would need to increase its overall R&D investment in order to direct more funding to bridging this gap. Finally, Mr. Evans said that the U.S. global share of venture capital has eroded sharply, from 90 percent of the world total in the early 1990s to less than half in 2019. Further, 40 percent of venture capital is invested in megadeals worth $100 million or more, and 50 percent goes into the software and life science industries in a pattern similar to its geographic concentration. Mr. Evans observed that most venture capital investments are not patient, and asked the group to think about how to encourage longer-term investments in disruptive technologies.

Mr. Evans concluded his presentation by reiterating that the goal was to tease out questions for each of the four subgroups to address, in order to pivot them towards recommendation generation.

Using End States as a Guide

Dr. Paul Hommert, former director of Sandia National Laboratory and Distinguished Fellow with the Council on Competitiveness, said that he felt the group was ready to move to specific topics, but wanted to secure consensus from the group before moving ahead. Dr. Laurie Locascio of the University of Maryland said It was time to drive towards getting written recommendations on the table for group members to debate, and urged anyone who felt the group had failed to address a crucial topic speak up now. Mr. Mike Cassidy of Emory Biomedical Catalyst agreed, saying it was time "put verbs in front of" many of the ideas the group had discussed and begin drafting recommendations. Mr. Toby Redshaw of Verizon said that while the early, less focused discussions were important for idea generation, the group needed to being pursuing narrower paths. However, he urged the group to remain open to changing if a path proves nonviable, and suggested the group self-assess every few months to ensure it is making progress on impactful and actionable recommendations.

Mr. Andre Doumitt of the Aerospace Corporation recommended the group develop a set of end goals to aim for, as this would focus recommendations and provide a measuring stick for progress. He suggested identifying flagship areas for focus, similar to the efforts in many countries to establish a "Vision" for a particular year in the future outlining performance indicators in given technologies or for the overall economy. Mr. Doumitt said that if the group painted such a picture, it could work backwards into identifying the people, organizations, and resources that need to be deployed. Similarly, former Defense Advanced Research Projects Agency (DARPA) director and Distinguished Fellow at the Council on Competitiveness Dr. Tony Tether said that the group

needed to define "innovation." He said that innovation requires problems to solve, and asked which institutions and organizations were defining problems. He said the group would make faster progress once it defines needs and what solutions to those needs constitute innovation. Dr. Anne Marie Knott of Washington University in St. Louis echoed the need for targets to aim at, and discussed her work on R&D productivity as the key driver of the link between R&D spending and economic growth. She cited an example goal of trying to increase productivity by a certain amount, or to reach a certain threshold of research activity or economic output. Dr. Thomas Campbell of FutureGrasp LLC, a Senior Fellow at the Council on Competitiveness, suggested binning recommendations into "push" and "pull" categories. The first would consist of information and ideas policy makers need to be made aware of for action, and the second would consist of dialogue on what policy makers need. He urged against pushing recommendations before ensuring policy makers have the capability and the interest to enact them.

Issues in Investment in Innovation

Dr. Roland Stephen of SRI International shared a memo he is working on dealing with challenges facing the U.S. innovation landscape. In particular, he discussed the decline of corporate research laboratories, which provided a vertically integrated innovation system for many companies in the middle of the 20th Century. By creating an environment where an idea could move from discovery to application to scale up all within the same ecosystem, these labs enabled continual innovation and economic growth. However, with the decline of these laboratories, companies no longer engage in basic research at the same scale, and do not finance the scaling of innovations "in-house" to the same degree. Dr. Stephen encouraged the group to think about ways the country could recapture the benefits of these labs, particularly through the development of new institutions and partnerships. Mr. Edward Agne of Communications Strategy Group shared a related challenge facing investment: the decline in returns on venture capital. Mr. Agne discussed his conversations with venture capital investors in the life sciences space, who shared that venture capital firms used to receive twenty- or twenty-five-fold returns on life sciences investments, which in turn gave them more capital to "play" with riskier or longer-term investments. However, with returns falling well below ten-fold, firms have become much more risk-averse, and inclined to focus on short-term investments in relatively low-risk sectors. Mr. Evans agreed that it was important to explore ways to get more productivity out of investment, and to address the shortfall in funding for long-term patient capital created by changing conditions in the venture capital world.

The Importance of Model and Process Innovation

Mr. Dave Copps of Worlds Enterprises noted that technologies are not inherently disruptive, but become so when they solve problems. Mr. Doumitt agreed, defining innovation as "utility delivered." Mr. Redshaw said that "innovation" is rooted in the Latin words for making new things, but that the biggest impacts from innovation have come from taking existing technologies and rethinking the model for the production of goods and services with them. This is especially true for services like healthcare and education, but also has historical exemplars in Standard Oil's revolutionizing of the refining process, Sears' pioneering use of mail-order catalogues, and even the military innovations of 19th Century Prussian General Helmut von Moltke. Mr. Redshaw said that because of the expertise and experience in the group, it should periodically step back from discussing new technologies and focus on new models. Within sectors like healthcare and education, which he described as "force multipliers" for the economy, this group was one of the few that could look at the models for these processes and disrupt them to find new uses for technology. Mr. Evans noted that a similar concept of "inverting" the business model had arisen in Working Group 2's discussions on sustainability, and that future cross-pollination was important to ensure groups delivered recommendations in harmony with each other.

The Productivity Lens and the Imperative of Keeping Pace

Dr. Stephen noted that stagnant productivity in healthcare and education was dragging down economic growth, and that these fields had also been slow to adopt new technology. Ms. Wince-Smith reminded the group that the Commission was formed in the aftermath of a joint report by the Council and Gallup finding that productivity in the United States was stagnating, and that without a return to 3 percent economic growth rates, the country would not be able to maintain its standard of living. She also discussed Mr. Redshaw's remarks in an earlier Co-Chair session regarding the short timeline and rapid acceleration for the incorporation of platform technologies. She said the end point for the Commission was to embed capabilities into the industrial infrastructure of the country and the world, and warned that in key fields like microelectronics, the United States lacked the companies, manufacturing capital, and supply chains to do so. Ms. Wince-Smith called for the creation of something to match the 20th Century's "machine" of vertical integration and wealth creation.

Mr. Redshaw warned that if the United States fell behind on industry-changing technologies, its industries could be come obsolete. He cited the example of British Steel failing to adopt the innovations that German and American steel companies did, and added that for medical devices, robotics, and other key technologies, there is a two- to two-and-a-half-year design cycle. The incorporation of 5G, AI, and other key technologies into products like medical devices can provide a ten- to fifteen-fold improvement in unit value, but American firms risk falling behind. If other countries outpace the U.S. in R&D on these innovations, there will be no North American companies with domestic leading-edge manufacturing capabilities. Ms. Wince-Smith asked Mr. Redshaw about the obstacles in the way of universal 5G deployment in the United States, another critical enabling technology. Mr. Redshaw said that thin-bandwidth commercial 5G would be widespread within a year, and fat-bandwidth commercial 5G in two years, and that more fiber optic cable was needed to ensure universal 5G access, especially in rural areas.

The Road Ahead

Mr. Evans asked the group its thoughts on which topic to prioritize for the first weeks of detailed discussions. There was broad consensus around the fourth issue, U.S. Innovation System Structure and Components, with Dr. Tether arguing that the fourth issue encompassed all the others, and lack of progress there would make progress impossible in the other three. Dr. Locascio agreed, and Mr. Cassidy suggested there was a natural path to follow, in which working on the fourth issue leads to a competitive assessment of America vis-à-vis competitors, which then leads to a focus on America's investment levels and directions, which then necessitates identifying leaders and national strategies for deploying those investments. Dr. Hommert suggested that the first issue of national strategies could be seen as an adjunct of the fourth, and Mr. Doumitt recommended defining goals for key aspects, including numbers of new partnerships, leadership in particular technologies, investment levels, or revenue generated in key industries.

Concluding Remarks

Mr. Evans said that following the day's conversation he felt the group had identified a path forward. He said he would re-connect with the Co-Chairs to get their thoughts on the day's conversation, and that we would send Dr. Stephen's memo out to the group today for their feedback and consideration ahead of next week's discussion. Once the group agrees on a road map, the Council team can produce primers to help focus participants ahead of each session. He added that he felt the group was on track for December recommendations, and that he would provide further insight in the weeks that follow on when the group will pivot to drafting recommendations. The next meeting will be on Tuesday, July 28th.

Working Group 1 Calls July 28

Introduction

The Honorable Deborah Wince-Smith and Mr. Chad Evans welcomed the group. Mr. Evans provided an overview of the discussions and agenda for the other three Working Groups. Working Group 2, which met yesterday, discussed innovation for the circular economy and sustainable production and consumption, and in particular Dr. Albert Pisano of the University of California, San Diego's idea of a network of innovation centers focused on developing platform technologies for achieving sustainability goals. Mr. Evans noted there was significant overlap between this concept and many of the ideas discussed in this Working Group. Working Group 3, which meets on Tuesdays, will be discussing its road map for addressing its four "swim lanes": global competitiveness and existential threats, the national regulatory

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environment, systems infrastructure, and fueling and financing innovation. Working Group 4, which meets on Fridays, opened last week with a discussion of regional and geographic innovation and inclusion, and this week will open discussions on the displaced workforce and Main Street entrepreneurship. Next week, Working Group 4 will open its discussion of cultivating the innovation talent pipeline. Next, Mr. Evans provided a brief overview of the component issues of the day's topic, the structure and components of the U.S. innovation system, along with nascent policy recommendation ideas for each that have arisen from the group's discussions to date.

U.S. Innovation System Structure and Components

The first topic under the umbrella of innovation system structure and components is the concentration of innovation assets and high-tech industry in the U.S. Ten states account for 2/3 of U.S. R&D spending, and 20 account for 86 percent, with innovation hubs largely concentrated along the coasts. Venture capital is similarly concentrated, with 73 percent of spending by venture capital firms going to California, New York, and Massachusetts in 2019. Sample recommendations for this topic include providing grants of $2.5 million each to 1,000 cities in the Midwest, Southwest, Southeast, and Northwest to use as seed funding and spread financing beyond current concentrations, as well as creating an exchange that would match venture capitalists with entrepreneurs outside of traditional hotbeds.

The second topic, research and technology national initiatives, institutes, and programs deals with challenges facing America's National Laboratories and other research centers. These institutions face deteriorating infrastructure and are constrained in their ability to assist industry and startups. Recommendations in this space include expanding the Manufacturing USA institutes to 40 institutions, incorporating platform programs within the Manufacturing USA institutes to help share facilities and reduce the cost and complexity of demonstrating innovations, and establishing AI industrial consortia on topics like trust and ethics, hardware development, applications, machine learning, and data analytics.

The third issue area concerns integrating the myriad state and local innovation efforts with each other and with national efforts. Suggested recommendations in this space include establishing a competitive federal process to turn cities into innovation hubs that would receive financial and regulatory support for 10 years to become self-sustaining, creating vouchers to enable startups and small- and medium-sized companies to gain access to national laboratory facilities, and creating a state financial support program or other financial entity for Phase 3 SBIR companies.

The concentration of venture capital is another major challenge facing the U.S. innovation system. By 2019, the U.S. share of global venture capital spending had fallen to 50 percent from 90 percent in the 1990s. In the U.S. in 2019, 40 percent of all capital invested went into megadeals worth $100 million or more, and 51 percent of all funding went into soft-

ware or life sciences companies. In addition, venture capital investments in all industries are not "patient" and investors are not willing to wait long for returns. Ideas the group has discussed in this space include developing a "one-stop shop" database for firms looking to invest and entrepreneurs looking for funding, a clearinghouse containing information on I-Corps and other grant recipients that would allow venture capital funds to find "validated" ideas, and crowdfunding platforms for innovators who cannot attract venture capital funding that would act as a signal to venture capital investors.

Technology transfer is the fifth topic area in the innovation systems umbrella. There is a time-consuming gap in technology transfer caused by the separation of research performers at universities and labs and end users in industry. Technology emerging from federal or academic research also often needs significant further investment in order to advance for application in the private sector, and existing incentives for universities to advance technologies out of their research labs have under-delivered. Suggestions in this space include a plan for transfer, prototyping, and TRL 5-7 at the beginning of federally-funded and university research and technology development projects. Other ideas are changing faculty incentives to promote industry engagement, technology transfer, and commercialization as conditions for tenure and promotion, simplifying IP agreements between universities and industry, and connecting more university research to private sector users and problems.

Finally, the "Valley of Death" represents a major bottleneck in the U.S. innovation system. Startups and small firms lack the capital to prototype, demonstrate, test, and validate their innovations, making them unable to lower risk and gather performance data to attract commercial financing. This often occurs when technologies arise from the startup sector or "spin out" of university research. Solutions in this space include developing a National Initiative on Prototype Development, increasing entrepreneurs' access to Federal research and test facilities to validate prototypes. Others include establishing incentives for corporations to open up their operations and production to serve as test beds and demonstration sites for technologies developed at startups, and requiring SBIR grant recipients to devote 5 percent of the award towards tech-to-market activities.

Institutional Innovation and Industrial Research Labs

Next, Dr. Roland Stephen presented a draft of a paper on the importance of institutional innovation to the U.S. innovation ecosystem, and in particular the importance of recapturing the innovation capacity once possessed by the industrial research labs of the mid-20th Century. Dr. Stephen said addressing institutional deficiencies was essential if our investments in scaling new technologies are to come to fruition, and that problems must remain the focus of research efforts, even when those efforts are aimed at developing platform technologies or clusters of related technologies. Dr. Stephen said that the distributed research activity that has proliferated since the decline of industrial labs has not generated the same level of substantive innovations. He identified problem-driven research, multidisciplinary teams, integrated capabilities, and the ability to scale innovations easily as the drivers of this innovation. He discussed how Claude Shannon made pioneering discoveries in information theory based on work he conducted at Bell Labs to solve problems in radar, signal technology, and cryptography. Having multidisciplinary teams made it easy to exchange information across areas of expertise and barriers, and integrated researchers with experts in product design and the production process. These laboratories operated on a scale that made them more effective than even promising current initiatives like the Manufacturing USA institutes, and having research, scaling, and production occur under the aegis of one company made it much easier to transfer technology from the lab to the market.

Dr. Stephen said that while it might not be possible to literally recreate these industrial labs, it was crucial to replicate their capabilities, and he argued solutions would require ambitious goals, diverse teams, and high levels of investment. He called for institutions

or arrangements that were freestanding and had autonomy, and said that if greenfield construction of such institutions was not possible, it was vital to build on existing assets and retrofit them. To that end, Dr. Stephen identified components of the U.S. innovation system that could be combined to replicate these capabilities. National labs, the Manufacturing USA institutes, technology companies like Apple, Google, Samsung, and Daimler-Benz, and research universities all possess capabilities that could be leveraged, but they also all face challenges. The national labs need changes in their mandates and cultures to eliminate constraints on innovation and technology transfer, the Manufacturing USA institutes need to be scaled up and improve coordination with each other, tech companies need protection from antitrust violations and a financial return to show investors, and research universities need to weather the financial hardships caused by the ongoing pandemic.

Key Factors in the Success of Industrial Labs

Dr. Paul Hommert, former director of Sandia National Laboratory and a Distinguished Fellow with the Council on Competitiveness, agreed on the need to replicate the success of the industrial labs with different institutions, and added that he was working on a paper on the national lab system that he would soon share with the group. He added that when he began work at Sandia, it was managed by AT&T's Bell Labs, and the company was able to partially replicate its industrial lab model for Sandia's work on nuclear weapons. Dr. Hommert agreed that vertical integration and multidisciplinary research were critical components, but noted that discussion around "technology transfer" understated the level of refinement and adjustment technology requires before it can be applied in the private sector. He also argued that there was already substantial investment in the "Valley of Death" and that the problem was not funding but alignment. He suggested the group would be most effective in developing recommendations for creating end connections between different bodies and aligning and integrating their efforts. He discussed by way of example his attempts to involve Sandia in a major university-led research park, which foundered when it encountered the Department of Energy's bureaucracy.

Dr. Anthony Tether, former director of the Defense Advanced Research Projects Agency (DARPA) and a Distinguished Fellow with the Council on Competitiveness, argued that the industrial labs were successful because of their problem-driven research. He noted that the Commission aims to make the United States the world's most competitive economy, and asked if leadership in education, technology, and the cultivation of talent were sufficient for achieving that goal. Dr. Tether asked if the group was sure there was no "missing ingredient," and what connection those factors had with competitiveness. Mr. Marcus Owenby of AT&T echoed these questions, specifically emphasizing the need to clarify the link between education, technology, and talent and productivity.

Mr. Daniel Armbust of Silicon Catalyst attributed the success of industrial labs to their ability to view problems from a "systems" level, and noted that as industries mature, they become stratified and less integrated. As a result, different stakeholders control different parts of the system, and often the investments with the greatest long-run benefit for the entire system are not worth the cost-benefit ratio from the perspective and time horizon of an individual stakeholder. He said that reassembling that vertical stack and recreating the holistic, long-run approach were the chief challenges facing attempts to replicate the industrial labs' innovation track record. Dr. Laurie Locascio of the University of Maryland argued that the industry-led nature of the labs kept them focused on research with applicability for end users and geared towards solving real-world problems, in contrast to modern lab- or university-led consortia. Dr. Hommert said that some entity would need to lead any consortium, and that recent attempts at industry-led consortia had run into issues of "picking winners and losers." Ms. Sara Lawrence of RTI International asked if there were instructive

examples from around the world that could be combined with prior U.S. experience to develop a new model for consortia.

Ms. Wince-Smith discussed the ways that Los Alamos, Sandia, and Lawrence Livermore National Laboratories developed advanced computing systems out of the need to use simulations and modeling to verify the effectiveness of nuclear weapons once actual testing became impossible. Dr. Tether said these examples highlighted the importance of problem-driven research, and Dr. Hommert said that there were no shortage of problems. He continued by noting that in these successful cases, the labs had the ability to deploy and redirect resources as they saw fit in response to problems, without needing to answer to other stakeholders. In addition to this autonomy, he reiterated the importance of industry leadership and called for it to be strengthened. Mr. Mark Minevich of Going Global Ventures, a Senior Fellow at the Council on Competitiveness, reminded the group of the importance of developing new skills and models for entrepreneurship as technology transformed the economy. Dr. Neil Thompson of MIT expressed caution in touting the example of Bell Labs, noting that their research led to successful technology diffusion in large part because of government requirements that they license royalty-free patents to other telecom companies.

U.S. Leadership in Microelectronics and New Challenges

The group discussed the recent news that Intel announced a one-year delay in the unveiling of its 7-nanometer computer chip, signaling a falling behind by the last leading-edge chip manufacturer in the United States, along with its implications for U.S. leadership in microelectronics. Mr. Armbrust noted that Intel went from having a 2-3 year head start on competitors to being potentially 2-3 years behind TSMC in developing leading-edge fabs, and said it was a "tragedy." He added that there were no signs the company could rapidly recover, and that this news made it all the more imperative to find a replacement for Moore's Law, less the United States lose not just domestic manufacturing capabilities, but a large part of its computing supply chain. Of further note is Intel's investment in vertically-integrated design and production facilities, as well as its exceptional concentration of innovative talent. Dr. Thompson added that in addition to falling behind in computing power, this development meant the U.S. would lose the productivity advantage it gained from incorporating information technology more quickly and effectively than other countries, and this would lead to a productivity slowdown throughout the economy. Further, Intel's delay of its new chip means it will see a reduction in revenue that could fund further research and improvement. Mr. Eric Cylwik of Sundt Construction asked if Intel's challenges were part of a broader problem of talent retention in the industry, and Mr. Armbrust and Ms. Candace Culhane

of Los Alamos National Laboratory said they were "self-inflicted," including the dismissal, retirement, or resignation of a significant number of executives in recent years.

Mr. Toby Redshaw of Verizon echoed Mr. Armbrust and Ms. Culhane in emphasizing leadership as the driver of Intel's slowdown, and drew on his work with former Bell Labs personnel, and the rollout of Verizon's 5G network, in emphasizing leadership and commitment from executives as the key to innovation success, rather than a commercial focus. He said vision from leadership was the most important component to replicating the work of industrial labs, and discussed an ambitious investment by the German government to build a massive technology innovation center in Berlin focused on 5G and beyond in the telecommunications industry. Mr. Redshaw asked what the next big vision would be for the U.S.

Technology-Led and Vision-Led Innovation

Dr. Thompson agreed with Mr. Redshaw on the importance of technology-led innovation, and Dr. Stephen stressed the importance of bold, visionary thinking, He noted there was a Manufacturing USA institute dedicated to developing a smart grid in response to the threat posed by global warming and the need for more energy efficiency, and that there have been proposals to fuel school buses with renewables rather than diesel fuel. Dr. Stephen said these ideas were not bold enough, and that we need to begin at least trying or thinking about even bigger transformations, like replacing grids entirely with a fully-distributed electrical system that can make use of a variety of energy sources, and immersive technology that transforms education and renders school buses obsolete. Mr. Armbrust said investment in developing a replacement for CMOS computer circuit technology and developing a new "S-Curve" would be extremely valuable for U.S. tech firms like Intel, AMD, and Nvidia. Dr. Hommert said there would be dire national security implications if the U.S., and especially the government and national labs, had to rely on Chinese firms for their supply of advanced computing hardware.

Dr. Arun Rai of Georgia State University emphasized the importance of AI in innovation. He called for a reconceptualization of "teams" in workplaces to include AI in addition to human efforts, and noted that AI excels in accelerating the recombination of existing knowledge, which is a key driver of innovation. He noted that the use of AI to accelerate this recombination during COVID-19 vaccine research provided a real life test case for augmenting human research capabilities with AI. Mr. Evans said that the U.S. innovation system's strength is the speed of its "creative destruction," and that the ability of AI to recombine knowledge was a key component of competitiveness, along with research and talent. Mr. Redshaw suggested that exponential improvements in big data would have a profound impact even sooner than AI, and that the U.S. needed to match China in focusing on the future.

Mr. Armbrust said that AI advances were due to a combination of hardware improvements and software improvements, and that the need to reduce precision requirements in algorithms may drive the search for a CMOS replacement technology. Error-tolerant algorithms would allow for more freedom of construction and operation of devices. Dr Thompson said that further AI improvements depend on improved computing power, which in turn requires better semiconductors, and Ms. Culhane noted that quantum computing was not sufficient to make up this shortfall. Mr. Andre Doumitt of the Aerospace Corporation suggested the group focus on goals or requirements rather than problems, as problems were simply obstacles on the road to achieving a goal or meeting a requirement. Mr. Owenby agreed and suggested that "requirements" made it easier to direct stakeholders' focus on getting things done than "problems." Mr. Dave Copps of Worlds Enterprises warned that the end of CMOS technology was a problem

Cross-Pollination Opportunities: Innovation Centers

Ms. Wince-Smith said that Dr. Albert Pisano's presentation to Working Group 2 on a network of innovation centers that combined existing resources, including industry, universities, and national laboratories, should be shared with the group because of the overlap in relevant subjects. She characterized his discussion of the MOSIS program to develop circuits for CMOS technology, which at the time was seen as less promising than its competitors, could offer valuable lessons for this group as it works on ways to replicate the capacity of industrial laboratories. She noted in particular his discussion of MOSIS's open-source approach that allowed them to cultivate ideas from unexpected sources, leading to a massive wave of new ideas and opportunities. Dr. Pisano's proposal involved centers dedicated to platforms like quantum information sciences and 6G technology, and she suggested that these centers were in the wheelhouse of this group rather than Working Group 2. Ms. Wince-Smith said the group had the expertise necessary to further develop this idea, and warned against the dangers of ceding leadership to China in advanced microelectronics.

Concluding Remarks and the Road Ahead

Ms. Wince-Smith noted that the group had a large set of problems to focus its energies on, and encouraged the group to focus on developing new types of systems integration to better channel existing investments towards something new at a large scale. Mr. Evans said that the Co-Chairs would meet to discuss next week's discussion, including whether to have Dr. Pisano present to the group in the coming weeks. The group's next meeting will be on Tuesday, August 4th.

Working Group 1 Calls August 4

Introduction

The Honorable Deborah Wince-Smith and Mr. Chad Evans welcomed the group. Mr. Evans shared an overview of the progress of the other three Working Groups. Working Group 2, which meets on Mondays, discussed recommendation ideas concerning best practices and efficiencies in the circular economy, and next week will return to the topic of innovation in the circular economy. Working Group 3, which meets on Tuesdays, will discuss international regulations, norms, and "rules of the road," as well as the emerging competitiveness challenge posed by China. Working Group 4, which meets on Fridays, spent last week's session discussing the displaced workforce and Main Street entrepreneurs, and developing recommendations for the group to further refine. This week, Working Group 4 will discuss cultivating the

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innovation talent pipeline. Ms. Wince-Smith said she was pleased that this group and the other Working Groups are moving on the path to concrete solutions and recommendations.

Featured Presentation: The National Laboratory System

The first featured presentation of the day came from Dr. Paul Hommert, former director of Sandia National Laboratory and a Distinguished Fellow with the Council on Competitiveness. His presentation focused on the National Laboratory system, and was intended to provide a baseline of knowledge to the group on the structure and operations of the national labs, especially those features that could be leveraged in support of a national competitiveness agenda. He noted that his presentation did not stand alone, and should be considered in the context of the overarching mission of the national labs and of the National Commission. Dr. Hommert further clarified that many of the themes and recommendations in his presentation have relevance for other federally funded laboratories, but that the particular circumstances of the national labs must be taken into account because of their size, capabilities, and influence.

Dr. Hommert gave an overview of the current national lab landscape. Of the 17 official National Laboratories operated by the Department of Energy, nine of them (Lawrence Berkeley, Lawrence Livermore, Los Alamos, Sandia, Oak Ridge, Idaho, Argonne, Pacific Northwest, and the National Renewable Energy Laboratory) have annual budgets in excess of $750 million. The nine largest labs have 56,000 FTE workers, including 30,000 advanced degree scientists and engineers. They also possess some of the most advanced engineering, manufacturing, and computational facilities in the world. Many major breakthroughs in fields spanning human genetics to renewable energy began with national lab research projects, and Dr. Hommert argued that the lab system can be leveraged even more effectively to meet the competitiveness challenges facing the nation.

Dr. Hommert argued that the key to understanding the national labs lies in their origins, with the exception of the National Renewable Energy Laboratory, in the Manhattan Project during World War II, along with the Endless Frontier Act passed immediately after the war's end. There are three key tenets for the national labs' operation: mission, federally-funded R&D centers (FFRDCs), and the government-owned, company-operated (GOCO) model. He said that understanding these tenets was key to identifying opportunities for greater leveraging of national laboratory assets.

Each national laboratory has a broad mission statement, but within the scope of that statement, each lab has a "primacy" mission that links to how it is engaged with the Department of Energy. Since all labs are operated by federal agencies, their work must pertain to their mission, which is the nuclear program for Los Alamos, Livermore, and Sandia, basic science for Pacific Northwest, Argonne, Oak Ridge, and Lawrence Berkeley, and renewable energy at NREL and Idaho. While the three weapons labs have the most specific primacy mission, the nature of their work requires an enormous commitment to background basic science research in computing, materials science, and other fields, that actually gives them great flexibility within their narrower umbrella. Dr. Hommert recommended augmenting the Department of Energy Mission Responsibility to support the overall national competitiveness and innovation agenda, and to require the DOE to establish an office accountable for the effective use of its national laboratories to engage with and support the partnerships necessary to the national competitiveness agenda.

Beyond the National Laboratories, there are 44 total Federally Funded Research and Development Centers. These institutions are sponsored by a federal agency, but are able to leverage private resources to accomplish tasks that are integral to the mission of their sponsoring agency. In order to provide continuity, long-term relationships between the government and FFRDCs are necessary to attract talent to the FFRDC. FFRDCs must also maintain currency in their fields of expertise, maintain objectivity and inde-

pendence, preserve familiarity with sponsor needs, and provide a quick response capability. With this construct applied to facilities the size of the National Labs, there is tremendous opportunity to leverage their capabilities for the benefit of the national competitiveness agenda, including a set-aside of between 2-6 percent of their annual budgets for Laboratory-Directed Research and Development (LDRD). Dr. Hommert recommended that DOE and Laboratory leadership be required to apply their existing capabilities through partnership with industry and academia to national competitiveness challenges and further deepen their expertise to advance the industrial adoption of key disruptive technologies.

Finally, with the exception of the NREL, all of the DOE labs operate under the government-owned, company-operated (GOCO) system, which was developed to blend private sector best practices in business and human resources with government funding and mission. Industry and academic consortia operate these labs, but over time more decision making power has shifted towards federal oversight, reducing the flexibility needed for creative partnerships with industry and academia, such as exchanging or embedding personnel across institutions to allow for cross-pollination of ideas and knowledge. Dr. Hommert recommended that the national laboratories be provided with appropriate flexibility to actively participate in and further invigorate lab, industry, and academic environments that accelerate technology adoption and innovation.

Featured Presentation: Centers of Innovation

Next, Dr. Albert Pisano of the University of California, San Diego, a Co-Chair of Working Group 2, shared his idea for a national network of innovation centers devoted to research on developing and scaling platform technologies. Platform technologies involve leveraging interrelated technologies, skills, and abilities as a bloc to enable a host of applications in a particular field, such as wireless communication serving as the basis for everything from the internet to app-based businesses. Dr. Pisano said that there was a ready-made model for these centers in the form of the Defense Advanced Research Projects Agency's (DARPA) MOSIS project, which focused on developing new CMOS circuits for computers. MOSIS was a large public-private partnership involving both federal and private sector funding that developed wafers that participants could use to design integrated CMOS circuits and submit back to the participating institutions. These wafers used a common software interface designed to provide easy virtualization, and the wafers were shipped to anyone who wanted to participate. Participants could design circuits on the wafers using the software interface and submit their designs back to the company.

There were several advantages to the MOSIS project that enabled it to succeed. It was open-interface but not open-source, meaning corporate participants did not need to cede their competitive advantage in order to open up their operations to allow outsiders to work on designs. Creating an easy-to-use virtualization layer also meant that people did not need specialized expertise or equipment to participate, and the wave of students and faculty who submitted circuit designs gained valuable skill in building them that they were able to leverage when the CMOS industry took off, creating a skilled workforce for firms in the field. Dr. Pisano advocated using an open-source model to encourage innovators from around the country to participate in the development of platform technologies, like 6G wireless communication, enabling anybody with internet access to collaborate on the project. These centers would involve corporations, labs, and universities, and with enough simplifying of the virtualization software, could even allow participation by K-12 students. While Dr. Pisano initially surfaced this idea in Working Group 2 focused on developing technology for sustainable production and consumption, he said that the concept could be extended to include the critical technologies for U.S. competitiveness that the group identified.

Laboratory-Directed Research and Development

Ms. Wince-Smith asked Dr. Hommert to elaborate on the role of LDRD in national laboratory output. Dr. Hommert said that while federal appropriators resented the lack of control over part of the labs' budgets, many of the most important recent breakthroughs out of the national labs, including biological research in the 1990s and hypersonic research at Sandia, came via LDRD initiatives. He said that while the labs have had to defend the resource many times on the Hill to preserve it, LDRD could play an even stronger role in furthering the Commission's efforts were labs to receive a broader mission definition. Dr. Robie Samanta Roy of Lockheed Martin said that DOD labs that have adopted the LDRD model have also seen great success in pursuing interesting lines of research that have proved fruitful, along with allocating funding for capital and facility improvements. Dr. Neil Thompson of MIT asked how laboratory and government personnel responded to the prospect of engagement with industry, and whether there would be pushback that many of the activities encompassed by a broader mission could be undertaken by the private sector. Dr. Hommert said it was important to draw a boundary between pre-competitive collaboration and "picking winners and losers," but noted there was pressure to be overly cautious in maintaining that boundary. He suggested being proactive in engaging industry, being transparent about IP challenges and committed to working through them, and finding successful models of pre-competitive collaboration to emulate. Dr. Laurie Locascio of the University of Maryland noted that the National Institute of Standards and Technology (NIST) was already competitiveness- and industry-oriented, and what was intended by augmenting or expanding the mission of the national laboratories. Dr. Hommert said such an expansion would entail defining national competitiveness as a valid mission for institutions to pursue, and as a valid area in which institutions could be brought to bear in partnership. As an example, he discussed the strategic dimensions of continued U.S. leadership in the advanced microelectronics industry, and the need to create partnerships to enhance domestic production capabilities.

Getting Technology to American Entrepreneurs

Mr. Mark Minevich of Going Global Ventures, a Senior Fellow with the Council on Competitiveness, asked if there was a way to make laboratory technology more easily accessible to American entrepreneurs, including augmented reality, renewable energy, and other innovations of particular interest to startups. Dr. Hommert said that while he didn't have a detailed answer and felt that existing models of "technology transfer" understate the work needed to adapt technology for commercial purposes, finding ways to enable laboratory staff to participate in venues with startups and research parks and making it easier to integrate people at national laboratories and access their experimental and computing resources were examples of potential solutions. He added that integrating people was more important than integrating licensing or intellectual property in bridging these gaps. Mr. Minevich said that tech companies like Google and Apple benefited from being able to leverage the last generation of cutting-edge technology, but startups today lack a way to do so, and that there needs to be a clear and efficient process that reduces the bureaucracy between innovators and access to technology.

Dr. Hommert noted that there are concerns around classified information for many of labs' most groundbreaking research, and Dr. Locascio suggested spinning out a separate entity as part of the national laboratory system devoted to deploying technology in industrial settings, similar to the role Bell Labs formerly played. Mr. Marcus Owenby of AT&T agreed that industrial laboratories had great potential, and Dr. Bogdan Vernescu of Worcester Polytechnic Institute echoed calls for consortia, which he said were ideal for collaboration. Dr. Vernescu suggested the recent Army Research Laboratory model of regional nodes and an open campus as a template for future consortia. Dr. Roland Stephen of SRI International

said that sanctioning the application of lab capabilities to national priorities will require adjustment within their DOE oversight. Mr. Dan Armbrust of Silicon Catalyst noted that many national labs offer access to startups and entrepreneurs, and that these programs could be enhanced and expanded. Mr. Greg Morin of Argonne National Laboratory agreed, and noted that his lab turns away dozens of applicants to these programs every year due to lack of funding. He advocated tripling the budget of these programs under the auspices of the DOE's Advanced Manufacturing Office (AMO) program. Mr. Armbrust said AMO was a great complement to basic science capabilities because of its focus on scale-up and industry transition, but Mr. Morin said it needed more prioritization from the Department of Energy. Mr. Evans noted that the HPC4 energy program at Lawrence Livermore National Laboratory, which has expanded to manufacturing, could also be extended to advanced materials and transportation. He noted that the Council's Building University-Industry-Laboratory Dialogue (BUILD) initiative discusses scaling the HPC4 and similar high performance computing programs to other agencies and departments. Mr. Evans also discussed AMO's role in driving the Council's Advanced Energy Manufacturing Consortium (AEMC) project in which the HPC4 initiative was announced, and that AEMC also called for embedding entrepreneurs in lab facilities.

Structural Obstacles to Greater Collaboration

Dr. Anthony Tether, former director of DARPA and a Distinguished Fellow with the Council on Competitiveness, warned that MOSIS was effective because it was heavily subsidized by DARPA, and that without this subsidy, which was politically contentious, the marginal cost for participation would have been too high to attract enough participants. He further added that some of the national labs he worked with as DARPA director were reluctant to transfer their technology, and that often private companies did not want to make the large expenditures necessary to scale the technology the labs were willing to part with. However, he noted that many of the rules that provide obstacles to technology transfer also provide valuable national security protections. Dr. Tether urged the group to figure out ways around these challenges in order for national innovation centers or expanded national lab missions to bear fruit. Ms. Wince-Smith said this challenge illustrated the importance of streamlining and simplifying regulations, and Ms. Sara Lawrence of RTI International added that turf battles between different federal agencies also provided an obstacle to collaboration, except in times of urgency when national interest required they set aside their differences.

Dr. Samanta Roy asked Dr. Hommert if there were lessons learned from Sandia's decision to shut down the tech ventures corporation there, as he felt there were many promising initiatives taking place. Dr. Hommert said the concept was good, but that there were many reasons it didn't reach its full potential, and that he would be happy to discuss them further offline. Ms. Wince-Smith said there is a continuum for industrial engagement with laboratories, from technology licensing to collaborative research to large-scale strategic partnerships that deliver benefits to the core mission of the lab and provide capability to the industrial infrastructure of the country. She noted that previous attempts at partnerships between labs and venture capital ended with venture capital firms engaging in predatory behavior. Another major concern with industry-lab partnerships is the risk that a startup that has been engaged in partnership on critical technology is acquired or sells its IP to firms that wind up in the hands of America's competitive rivals or adversaries. She called for new models to scale up technology through carefully thought-out strategic partnerships.

Managing Consortia Effectively

Ms. Wince-Smith said it was essential to maintain awareness of the time horizons for consortia and other recommendations. She said that while the hydrogen economy will be essential as a long-run solution to sustainable production and consumption questions, the U.S. must begin working now to make

up ground on the EU, which is significantly farther ahead in developing an integrated strategy. Dr. Arun Rai of Georgia State University suggested both that AI be incorporated as a collaborator in the innovation centers model, as it can make connections between data faster and more effectively than humans, and asked how such a consortium would be governed. He said the platform could not become a vehicle for constriction of participation or scope. Dr. Pisano said that during the MOSIS project, the Information Sciences Institute of the University of Southern California coordinated the project and helped secure corporate participants. He said a neutral third party with no direct financial stake in the outcome of the consortium will be needed to connect the different participants and adjudicate disputes. Dr. Pisano added that a benefit of the MOSIS model is that it relies on innovations using existing technology, meaning that any solution that demonstrates proof of concept can be scaled very quickly.

Concluding Thoughts and the Road Ahead

Mr. Evans said that a next step for the group would be the sharing of the beginnings of a recommendation around the innovation centers concept presented by Dr. Pisano that incorporated the unique capabilities of the national labs as outlined in Dr. Hommert's presentation. He asked that participants iterate and engage on the initial recommendation ahead of the next discussion on this topic, and said he would get back to the group with more details on next week's conversation. The next meeting of the group will be on Tuesday, August 11th.

Working Group 1 Calls August 11

Introduction

The Honorable Deborah Wince-Smith and Mr. Chad Evans welcomed the group. Mr. Evans said that the day's discussion would be focused on the upcoming strategic writing period during the next two weeks, and that after this time the would pivot to other "swim lanes" having devoted the past few weeks to discussing the structure and components of the U.S. innovation system. Ms. Wince-Smith said the Council team had received comments from group members asking for "white space" to reflect and put into writing the recommendation ideas that have been discussed so far. She noted the potential applicability of the concept of a national network of innovation centers for platform technologies, developed in Working Group 2 by Dr. Albert Pisano of the University of California, San Diego and discussed as part of this group's work, to the Working Group 1 mandate, and reminded the group that the Council had sent out a template to guide the recommendation writing process. Next, Mr. Evans introduced a new member

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Dr. Charles Riordan
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Dr. Gene Robinson
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of the Working Group, Dr. Ramamoorthy Ramesh of the University of California, Berkeley. Dr. Ramesh discussed his background, in particular his work with the University of California and with Lawrence Berkeley National Laboratory on advanced microelectronics. He said a significant part of his work involved pushing for a larger national strategy around microelectronics to address the competitive challenges facing the United States.

Overview of Other Groups

Mr. Evans provided an overview of the agenda and progress of the other three Working Groups. Working Group 2, which meets on Mondays, spent yesterday further discussing Dr. Pisano's proposal for a national network of innovation centers, and has conducted in-depth sessions on swim lanes focused on innovation and on best practices and efficiencies in sustainable production and consumption. Working Group 3, which meets on Tuesdays, will continue its discussion from last week around international "rules of the road" concerning regulations, standards, and antitrust policy as they pertain to innovation capacity. Working Group 4, which meets on Fridays, discussed the innovation talent and workforce development pipeline last week, and will return to the topic of regional and geographic innovation and inclusion this week. The other swim lane for Working Group 4, which it will revisit after the writing period, pertains to the displaced workforce and Main Street entrepreneurs.

Strategic Writing Period

Mr. Evans and Ms. Wince-Smith discussed the upcoming strategic writing period, during which there will be no weekly Working Group calls. During this time, members of the different swim lanes will write recommendations relevant to their chosen swim lane, and discuss and iterate on them with their fellow group members. Working Group Co-Chairs may organize swim lane-specific meetings to discuss policy recommendations or assign particular recommendations to group members, and the Council team will provide logistical support for these efforts as needed. The Council team will also use this time to collate and draw out recommendation ideas that emerged during the first phase of Working Group calls and during discussions in this phase. When the full group discussions return after two weeks, the group will identify areas where there are a critical mass of policy recommendations to develop into Year One deliverables ahead of December, as well as areas that are lacking in recommendations. Mr. Evans said he would re-share the list of potential recommendations that emerged from the first phase of Working Group discussions this Spring, and encouraged the group to expand upon and deepen those ideas as well as generating new ones. He added that while most of the group had expressed a preference for swim lanes, he encouraged everyone to examine the contact spreadsheet the Council team had created, listing members by swim lane to facilitate communication during the writing period. He said that if members wished to join a swim lane or change swim lanes, the Council could send around an updated contact database. Mr. Evans also said the Council was working on creating a Google Doc or other shared document to enable members to collaborate virtually on recommendations, including adding to and commenting on other recommendation ideas.

Co-Chair Remarks

Mr. Mike Cassidy of Emory Biomedical Catalyst said that as the group needed to begin fleshing out recommendations and putting them down in writing, the strategic reflection period came at an ideal time. Dr. John Sarrao of Los Alamos National Laboratory said it was good to move from discussion to writing and developing of recommendations, and welcomed the opportunity presented by the reflection period. He also suggested the Council team send a reminder message halfway through the writing period to ensure that group members use the time productively. Mr. Toby Redshaw of Verizon said he

was happy to fill in whatever swim lanes needed personnel, and encouraged the group not to get bogged down trying to overthink the recommendations. Instead, he urged members to get ideas down in writing to begin the iterative process. Dr. Anthony Tether, former director of the Defense Advanced Research Projects Agency (DARPA) and a Distinguished Fellow with the Council on Competitiveness, noted that the recommendation writing template listed goals, which he categorized as a "what." He said recommendations needed to focus on the "how" of accomplishing goals. Mr. Evans said that the writing period was intended to provide members time to think about and put down in writing steps for the "how" of policy recommendations.

Sharing Across Swim Lanes

Dr. Arun Rai of Georgia State University said that many recommendation ideas would be relevant to goals across multiple swim lanes. He asked if there would be a subsequent coordination process to identify these overlapping goals, and Mr. Evans said there would be. Dr. Rai asked if members should flag recommendation ideas they develop or that others develop that they feel would be relevant to another swim lane, and Mr. Evans said that in those cases members should share the recommendation idea with that swim lane, or with the whole group. He added that the Council team and Co-Chairs would be monitoring all of the swim lane discussions. Ms. Wince-Smith noted that the group had begun assembling a critical mass of experts on advanced microelectronics, and encourage the generation of recommendations in this space. She added that members should feel free to consult with external experts on microelectronics to help develop recommendations, and that the Council was open to adding more expertise in this area to the Working Group.

Concluding Thoughts and the Road Ahead

Mr. Evans said he would send something out to the group later today, including another copy of the recommendation template and a contact sheet for each of the swim lane. He added that he would send a reminder email at the end of next week letting group members know they had reached the halfway point of the writing period, and thanked the group in advance for its thoughts and ideas. The next meeting of the group will be on Tuesday, September 1st.

Working Group 1 Calls September 8

Introduction

The Honorable Deborah Wince-Smith and Mr. Chad Evans welcomed the group. Mr. Evans said the goal of the day's discussion would be to get an overarching perspective on the recent strategic writing and reflection period, and to share areas where the Council staff felt there was still opportunity for deeper conversation. Ms. Wince-Smith thanked the participants for their energy and attention, and Mr. Evans said that he had sent around the recommendations from all four Working Groups generated during the strategic reflection period.

Co-Chair Remarks

Mr. Mike Cassidy of Emory Biomedical Catalyst said that it was great to have time during the reflection period to think more deeply about concrete recommendations, but also noted that two of the Swim Lanes for the Working Group had not put down any recommendation ideas. He added that some of his recommendations might fit better in one of the empty sections of the Google Doc, rather than their current location. Dr. Laurie Locascio of the University of Maryland clarified that her swim lane had worked extensively on developing a draft statement outlining a national strategic vision, but had not put anything down on the document yet. Mr. Toby Redshaw of

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Verizon also indicated his group had had extensive discussions that hadn't yet translated into entries into the Google Doc, noting that the group's discussions had led members to realize the topic was extensive and complex and that a large gap remained to be overcome before they could turn their thoughts into finished recommendations. He said the execution path would require rigor and discipline to whittle down. Mr. Andre Doumitt of the Aerospace Corporation also felt there was a large gap between his group's work and the reflection of that work on the Google Doc, and said he frequently self-censored in pursuit of consensus. Mr. Doumitt suggested capturing all of the "brainstorm" ideas from group members on the Document and whittling them down later, and Dr. Locascio agreed. Mr. Evans urged the group not to let the format of the Document inhibit anything, and said the Council team was happy to help facilitate the addition of ideas to the Document.

Areas for Deeper Discussion

Mr. Evans outlined six areas where the Council team identified a need for deeper conversations. On the question of national leadership, he expressed the need to develop a recommendation around a strategic, visible national leader for innovation. For the question of R&D funding at the federal level, Mr. Evans said the group needed to clarify a target level for federal investment, especially in light of new challenges to U.S. dominance unprecedented since the Cold War. Mr. Evans urged the group to develop more specific ideas around technology transfer, especially pertaining to the role of universities and the National Laboratory system. He also noted there was little concrete conversation around the future of work, even with the rapid transformation of workplace norms in the past six months, with solutions that ordinarily would have taken years to apply having occurred organically in months. A fifth issue for deeper discussion is the "China challenge," especially regarding specific measures to guard against intellectual property theft and guidelines for joint R&D efforts with Chinese scientists. Finally, Mr. Evans urged the group to develop more ideas regarding resiliency, as the pandemic and other issues have driven the issue to the fore of the national policy debate. He emphasized that resiliency was a key component of an innovative call to action.

Ms. Wince-Smith added that the Council has a proud history of articulating aspirational and critical ideas for the country's future, many of which would only be implemented years later. She said it was incumbent on the National Commission to recognize and articulate paths towards the major structural, investment, and operational changes the country requires to maintain prosperity. In particular, she warned that the lack of coordination and systems integration in the leadership of the federal government was hindering America's competitiveness on the scientific and technological fronts. Besides insufficient federal investment in scientific research, there is no formal entity within the executive branch that could focus the nation's resources around grand challenges. In particular, nobody in the White House Chief Technology Office, Office of Science and Technology Policy,

or the Departments of Defense, Energy, Justice, Commerce, and Treasury is addressing critical issues of antitrust and capital formation. Ms. Wince-Smith also said the Council needs to be prepared to offer concrete ideas about how much the government should invest in basic research and how it should be deployed.

New Models

Dr. Paul Hommert, former director of Sandia National Laboratory, said that the list of topics for further discussion enumerated by Mr. Evans would be a useful organizational schema for the current slate of nascent recommendations. He also said that the R&D funding question required careful consideration of how to bring in universities and laboratories, balancing basic with applied research, and facilitating both innovation and maturation of nascent technologies. He added it was important for the Commission to show a path to this system, as similar coordination failures affect the research enterprise as those impacting the federal government. Mr. Redshaw also endorsed the six topic areas discussed by Mr. Evans and said they were interrelated. He added that the U.S. needs to look not just at its current stock of innovation assets, including its universities, laboratories, and venture capital communities, but project the state of its assets in five years. He said a crisis was on the horizon and it was imperative for the U.S. to manage it before it arrives. Mr. Redshaw also suggested developing a 9x9 matrix for recommendations, divided into small, medium, and large changes and short, medium, and long-term changes. Finally, he stressed the importance of changing the model of innovation. If the U.S. feeds more inputs into the same "sausage machine" it will not get the large-scale improvements it seeks. Dr. Locascio suggested that having a national strategic vision for whole-of-government investment in solving grand challenges could help spur structural change.

Mr. Mark Minevich of Going Global Ventures said that the country needed to move quickly and efficiently to keep the American Dream alive for future generations, and noted that China was creating a national system linking research, nominally private companies, the strategic arm of the military, and the Ministry of Finance to develop and scale advanced technology. In Europe, the focus is on creating an economy driven by ethics, sustainability, and responsibility, but with tremendous resources available for innovation. Entrepreneurs in Europe are able to go the EU and receive funding for their business plan. Mr. Minevich said the U.S. needed to look to best practices abroad in order to maintain its leadership in innovation, and that the government needed to coordinate with the private sector, especially large asset management companies. Noting that In-Q-Tel was founded with $50-100 million and had success developing technologies for the CIA, Mr. Minevich urged the replication of this model, as well as the development of new organizations and consortia to run such ventures. However, Mr. Minevich said that the U.S. should also rely on its advantages vis-à-vis competitors, and adopt a network-specific structure for managing these investments, rather than a hierarchical one.

Dr. Roland Stephen said that one of the virtues of the U.S. system is experimentation, and that the U.S. should keep that approach to fostering innovation. He further noted that while some ideas, such as changing the management structure at the national labs, may seem "small ball," they can have a large cumulative impact on innovation. He further stressed the need to include the entire country in innovation efforts, not just existing technological hubs. The rest of the country is an asset just like Silicon Valley is an asset, and it needs to be incorporated into the U.S.'s strategic thinking. Mr. Evans noted there was an opportunity here for cross-pollination with Working Group 4's Swim Lane on Regional Innovation and Geographic Inclusion.

Investment in Research

Dr. Neil Thompson of MIT encouraged the group to develop a target level of investment as a share of GDP, and today something quantitative about the impact of scientific research funding on competitiveness. He noted that over time increasing investments are needed to make steady progress on the frontiers

of science, and that it is easier to catch up to the leader than to forge ahead. In particular, Dr. Thompson suggested attempting to quantify the magnitude of investment needed to maintain a 20 percent standard of living advantage relative to the rest of the world. Mr. Evans observed that if federal investment as a percentage of GDP remained at its late-1960s peak, that would amount to an additional $400 billion per year, and Ms. Wince-Smith said the U.S. had slipped to 9th internationally in scientific research as a share of GDP. Dr. Thompson suggested discussing some of the proposals submitted by Dr. Anne Marie Knott of Washington University in St. Louis, and Mr. Evans said he would try to facilitate those discussions. He also emphasized that scaling up U.S. investment in research to historic highs would necessarily be a long-term goal.

National Radar

Dr. Arun Rai of Georgia State University discussed his idea for a national "radar" for innovation, discussed in the Competitive Assessment Swim Lane during the reflection period. Dr. Rai noted that this national radar was a cross-cutting endeavor, touching on numeric targets for research and the previous omission of large regions of the country. He added that most discussion of innovation is focused on measuring outputs, but that greater focus on the input side of innovation, including the talent pipeline and how it is being developed across the country, would yield substantial benefits. An input-focused approach would go to the heart of development of talent and complementary resources. Dr. Rai also asked where the group should go with domain-specific thinking, including recommendations centered around AI, biotechnology, or microelectronics, and how these ideas would cross-cut with other Working Groups and Swim Lanes.

Strategic Thinking

Mr. Redshaw advocated including a social responsibility dimension into each technology or domain for targeted investment, arguing it would not require additional work to do so. He also discussed his experiences working with Lawrence Livermore National Laboratory and the intelligence community on a strategic exercise in which his group assumed the position of Chinese government strategists, identifying potential threats posed by U.S. assets. He said during these exercises the "Chinese government" continually identified the development of innovation hubs throughout the country and the expansion of the talent pool by incorporating disenfranchised and underrepresented groups into the innovation pipeline as threats. He suggested that anything that would concern our rivals should be a top development goal for the U.S. Mr. Evans noted that the South Korean Minister of Trade had previously expressed concern to the Council about the U.S. harnessing shale gas and other domestic energy sources to become a manufacturing powerhouse again.

The China Challenge and Universities

Ms. Wince-Smith urged the group to spend time considering the challenges posed by the reliance of U.S. universities on Chinese graduate and postdoc students, noting that many faculty were hostile to the concept of reducing the number of international students, and the perception from outside academia that schools were selling slots to Chinese students for money. Dr. Locascio said that this conversation is prominent within academia, and that graduate schools are very concerned because between 40 percent and 60 percent of their students are international. She noted she was involved with discussions and task forces on this issue with both APLU and the NIH, and that the academic world was preparing for a new normal regarding international students, but that it was important to address the issue without alienating an entire country. Dr. Locascio added she would be happy to lead discussions within the Commission on the topic. Dr. Bogdan Vernescu of Worcester Polytechnic Institute said that the rise of Chinese graduate students at U.S. universities was a symptom of other problems, including a poor job market for U.S. PhDs and declining state funding for universities necessitating other ways to make up the shortfall. He said that addressing these underlying issues would resolve the problem. Dr. Stephen

agreed and suggested harnessing technology and innovation to accelerate and otherwise alter graduate programs to make them more affordable and enticing to U.S. students.

Mr. Minevich expressed concerned about the number of Chinese nationals working with university-associated startup accelerators and incubators, and the transfer of intellectual property developed by the startups, especially in AI and the Internet of Things, to China. He called for more opportunities for American students, especially those from disadvantaged backgrounds, to become involved in these programs. Mr. Redshaw said that developing the domestic talent pool and protecting against the transfer of IP were separate issues, and that the U.S. needed to be precise in protecting its property, as the country has historically benefitted from attracting the best and brightest talent from around the world and keeping them here. He expressed concern that efforts to protect U.S. innovation could discourage the movement of skilled talent from abroad to the United States. Dr. Rai agreed that domestic inclusion efforts were not connected with international protection efforts, while Dr. Thompson said the question was whether U.S. universities were accepting international students based on ability to pay full tuition rather than merit.

Concluding Thoughts and the Road Ahead

Mr. Evans said that the next week's discussion would focus on diving deeper into specific recommendations developed by the different Swim Lanes, and Dr. Locascio volunteered the Government Leadership and National Strategies for Innovation Swim Lane to begin proceedings, adding that her group would add recommendations to the Google Doc during the week. The Competitive Assessment Swim Lane will also prepare for a discussion of their recommendations. Finally, next week's session will include a discussion about the longer-term timeline for the Working Group and the rest of Phase II, ahead of the release of Year One findings at the National Competitiveness Forum in December. The next meeting of the group will be on Tuesday, September 15th.

Working Group 1 Calls September 15

Introduction

The Honorable Deborah Wince-Smith and Mr. Chad Evans welcomed the group. Mr. Evans said the focus of the day's call would be discussing recommendations in detail, especially those pertaining to centralized national leadership on innovation and competitiveness challenges.

The Need for a Coordinating Body for Innovation

Dr. Paul Hommert, former director of Sandia National Laboratory, said that having a central hub for planning innovation policy would address many of the gaps the Council team identified in the Working Group recommendations following the strategic writing period. He noted there was a consensus among the group that a new organization was needed, but asked whether it should consist of restructuring existing bodies like the Office of Science and Technology Policy and the President's Science Advisor, or whether it should be a new group entirely. Mr. Evans said that this question tied into the second major topic to address, the appropriate federal role in R&D investment. He added that a central innovation body could advocate for and manage that increased investment. Dr. Hommert said that if the country does not get the structure of its organizing body right, all the component pieces of innovation

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policy, and game-changing transformations of those pieces, will not come to fruition. As an example, the National Laboratories will not be able to improve their role in transferring technologies without a high-level national strategy that reorients their mission. Dr. Hommert said the Council does not need to lay out all of the pieces of such a body, but the rationale for its existence. Dr. Laurie Locascio of the University of Maryland discussed the work of the Government Leadership swim lane in identifying components of a national innovation strategy. These included a new organizational structure, a redesign of executive branch institutions to enable better coordination, new and accelerated funding targets, enhanced partnerships with academia and industry, grand challenges for the country to catalyze innovation, tools to close the gap between research and application of technology, workforce development, investment in America's scientific infrastructure, and enhanced American international leadership on science and innovation policy.

Placement of a Coordinating Body

Dr. Ramamoorthy Ramesh of the University of California noted that the National Laboratories were created during the Manhattan Project, and that the closest analogue in terms of national importance was the need to maintain U.S. leadership in advanced microelectronics. He identified three axes: global competitiveness vis-à-vis China in a trillion dollar space, energy consumption and its impact on climate change under CMOS technology, and national security given the reliance of the power grid and military technology on microelectronics. Dr. Ramesh argued for a central point of contact for microelectronics policy as a guiding principle in the creation and placement of a coordinating body. Dr. Locascio suggested housing such an institution in the Department of Defense, as DOD already convenes multiple stakeholders to coordinate response to national security threats. Dr. Ramesh argued that any central body would need its own spending authority, and Dr. Roland Stephen of SRI International emphasized that the location of a new organization was critical. Dr. Hommert said OSTP would be a non-starter as a location unless the Office of Management and Budget coordinated tightly with the new organization. Dr. Stephen echoed the need for OMB coordination, as their setting of the Presidential budget exerts significant influence on the budget developed by Congress. Ms. Wince-Smith said that because OSTP's power waxes and wanes with administrations, it lacks the ability to compel policy changes in the agencies. She argued for the creation of a new entity with power and status inside the White House, that operated at a Cabinet level even if it lacked budget authority.

A National Innovation Council

Ms. Wince-Smith suggested the creation of a National Innovation Council, modeled after the National Economic Council and the National Security Council within the Executive Office of the President. Mr. Andre Doumitt of the Aerospace Corporation suggested having such a council headed by a Director of National Innovation, analogous to the Director of National Intelligence. Ms. Wince-Smith added that the National Innovation Council would handle more than just science and technology policy, branching out into other areas like regulation, finance, and antitrust that are vital to competitiveness but are beyond the scope of existing bodies like OSTP. She noted that the last major restructuring of the Executive Branch was the creation of the Department of Homeland Security following the September 11th attacks, and that a similar transformation was needed to address the current challenge. Dr. Hommert noted that the National Security Council has real power, and interacted frequently with the weapons program at Sandia, and Dr. Ramesh noted that the National Economic Council was heavily involved in solar energy policy initiatives he had worked on. Dr. Ramesh also asked what role the President's Council of Advisors on Science and Technology should play in a National Innovation Council, and Ms. Wince-Smith said that PCAST primarily produces reports that, while important, do not involve operational authority. She added that OMB has many "hidden" powers and the ability to intervene on a host of domestic policy issues. Dr. Stephen noted that within OMB there are also many siloes that prevent effec-

tive policy coordination. Mr. Mike Cassidy of Emory Biomedical Catalyst noted that there have been calls in the policy world for a National Innovation Foundation modeled after the National Science Foundation.

Drawing on Organizational Examples

Mr. Daniel Armbrust of Silicon Catalyst asked if there were examples of similar organizations, including in other countries, that could serve as a model for the National Innovation Council's structure and responsibilities. Dr. Hommert suggested the National Security Council as a model, and Ms. Wince-Smith noted the United Kingdom, Japan, Australia, and China as examples of countries that had coordinated innovation bodies. Dr. Ramesh noted that China has been very open about its desire to secure market share and dominate in microelectronics. Ms. Wince-Smith also suggested the example of the United States Trade Representative, a powerful office with Cabinet-level standing. The USTR sits on both the National Security and National Economic Councils, and over the years has assumed responsibility for conducting and leading trade negotiations from the Department of Commerce. Dr. Neil Thompson of MIT noted that a National Innovation Council would be an ideal place to house a revived Office of Technology Assessment. Dr. Locascio asked if there should be separate recommendations or plans for the National Innovation Council itself and for its budgetary authority, and Ms. Wince-Smith said that the OSTP should still play an important coordinating role, and its director should sit on the National Innovation Council, along with the head of OMB. Dr. Stephen said it would be crucial to get alignment with the relevant Congressional committees to ensure alignment, and Ms. Wince-Smith agreed.

Technology Statecraft

Ms. Wince-Smith brought up an idea surfaced by Working Group 3 Co-Chair The Honorable Olin Wethington of Wethington International LLC, that of "technology statecraft." She noted that the State Department does not have a formal policy on microelectronics in spite of the national security implications, and drew on her experiences negotiating trade deals with Japan in underscoring the harm caused to America's foreign policy agenda when there is no orchestrated strategy for addressing technological innovation and its diffusion internationally. Dr. Thomas Campbell of FutureGrasp LLC, a Senior Fellow with the Council on Competitiveness, noted that his firm had recently published a paper arguing for a technology-oriented foreign policy agenda, and that similar ideas were emerging in the international political community. Ms. Wince-Smith expressed concern about relying on the United Nations to mediate technological disputes, as the Chinese government increasingly seeks to influence its decision making. Dr. Locascio added that China is trying to shape international standards around technology to control trade as well. Ms. Wince-Smith said that international trade and standards would be a major focus for the second year of the National Commission.

Using Stories to Convey Need for a National Innovation Council

Dr. Ramesh suggested identifying examples of technologies where U.S. leadership is faltering to demonstrate the need for a National Innovation Council rather than leaving management of those issues to existing agencies. He noted challenges in healthcare, information technology, and manufacturing as potential examples. Mr. Evans said that with the emerging consensus on the need for a National Innovation Council, it would be easier to identify stories that show the importance of a body that goes beyond R&D issues and addresses all of the critical enablers for prosperity. Dr. Thompson suggested highlighting examples of the U.S. falling behind would be more compelling than success stories, and Mr. Evans agreed, as this would signal that the problem was already upon us and required immediate action. Dr. Hommert noted there were retrospective examples in the form of solar panels, current examples in microelectronics, and prospective examples in China's plan to dominate in AI. Dr. Locascio noted that the Government Leadership Swim Lane consistently returned to microelectronics and AI as key technol-

ogies for U.S. leadership, and Mr. Armbrust said the combination of the two was especially compelling. Microelectronics hardware is essential to continued AI improvement, and AI has major applications across virtually every industry.

Dr. Ramesh added that AI machinery will be driven by further hardware innovations, as CMOS technology cannot be scaled to the necessary degree without prohibitive energy expenditures. He warned that the American microelectronics industry is now in the position the solar industry was in circa 2005, where its lead was slipping but it remained on top. The U.S. still has giants like Intel and Nvidia, but it will need symbiosis between the private and public sectors to avoid falling behind. Dr. Ramesh further stressed that the government should not be the primary funder in a public-private partnership, but the orchestrator and convener. He also urged an update of Bayh-Dole governing the transfer abroad of technologies developed with taxpayer funding, noting the act was writing in 1981 and is not set up for current needs. Currently, too many firms that received taxpayer funding are setting up operations in other countries.

Financial Linkages to the Innovation Ecosystem

Dr. Ramesh also expressed concern regarding the lack of coordination with major financial institutions in investing in key technology, from AI to energy storage. He noted that with the breakup of the link between equity and debt financing, or venture capital and commercial banks, by the SEC in the 1960s, they became disconnected, and major banks are not interested in these important projects because of the low return on investment. Dr. Ramesh said this was part of the reason for the offshoring of the solar industry. Ms. Wince-Smith said that Working Group 3 was developing a recommendation for a National Infrastructure Bank that would be able to provide financing for these kinds of projects.

Solar and Nuclear Energy

Ms. Wince-Smith expressed approval at the Biden campaign's push for nuclear expansion in its platform, noting that solar panel production is increasingly dominated by China. She asked if the group should take an official position on nuclear expansion. Dr. Ramesh said that nuclear power plants take so long and cost so much to build that the learning curve is poor and innovation is much slower, but that smaller modular reactors could make it less costly and expedite the innovation process. Dr. Hommert said reinvigorated nuclear energy will be essential to meeting decarbonization goals, but that the current model of large-scale investment in nuclear is dead. With a need for innovation in both the front and back ends of the fuel cycle, Dr. Hommert said government would need to play a major role in this process. Dr. Thompson said that the economics of solar panels were improving to the point that nuclear would not be competitive or cost-effective soon, and that investment in nuclear expansion must be done for other

purposes besides cheap energy. Dr. Hommert said that the primary purpose of nuclear would be for auxiliary functions such as peaking loads and backup generation. Dr. Ramesh noted that the only challenge remaining for renewables was storage, and that solar will take off if it becomes cheaper than natural gas with 80-90 percent of its storage capacity. Ms. Wince-Smith asked if solar innovation could enable the U.S. to leapfrog China there, and Dr. Ramesh said that transforming the way solar panels store energy was the key to competing. Dr. Thompson agreed that U.S. leadership in energy storage would be transformative, and noted that innovations were currently in development like thin film-solar panels. Dr. Hommert said that the U.S. cannot offshore production if it gains the lead in energy storage, and Dr. Ramesh warned that Chinese firms will try to invest in U.S. companies that received funding from the federal government to scale up their innovations. Ms. Wince-Smith said that solar, nuclear, and hydrogen energy questions would be an important part of the Commission's Year 2 agenda.

Concluding Thoughts and the Road Ahead

Mr. Evans said that the rest of September would focus on continued deep dives into recommendations developed by the different Swim Lanes, but that during the October and November period the Council would begin prioritizing, collating, and combining recommendations across the four Working Groups to draft the Year One findings. During this time, the Working Groups will function as a vehicle for feedback and commentary on the initial set of Year One recommendations, and would likely meet less frequently than once per week. Working Group meetings may also become more specialized and focused on soliciting feedback on discrete issues from those with particular expertise. He added that the Council team would coordinate with the Co-Chairs to determine next week's agenda. The next meeting of the group will be on Tuesday, September 22nd.

Working Group 1 Calls September 22

Introduction

Mr. Chad Evans welcomed the group, and said the day's discussion would focus on the recommendations developed by the Competitive Assessment Swim Lane. He also discussed the logistics of the group's meetings heading into the October and November timeframe. Next week's meeting will continue as usual, but after that the Council will move into the prioritization and drafting stage for the Year One Call to Action. During this time, calls will move to every other week, and from one hour to half an hour. The meetings for this group will be on October 13, October 27, and November 10, and will be focused on providing updates and feedback from the National Commissioners, Advisors, and Outreach and Engagement Committee. These sessions will also be used to solicit assessments from the Working Groups. During this time, Swim Lanes are free to self-organize and hold meetings, and the Council will provide logistical support should they choose to do so. Co-Chair calls will also continue during the Fall, but likely at a new time. There will also likely be crossover sessions with all of the Working Group Co-Chairs to allow sharing of knowledge and ideas across the different Working Groups.

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Tracking Movement of Innovation Talent

Dr. Neil Thompson of MIT discussed his recommendation idea for a data set that would track the movement of STEM doctorates in the United States, based upon the National Science Foundation's Survey of Earned Doctorates, but more extensive. Dr. Thompson said that the U.S. has long benefited from an advantage in information technology, but that advantage is rapidly eroding, with the competition for talent increasing between the U.S. and its competitors at the same time that talent is more essential than ever for U.S. competitiveness and continued innovation. He said it was essential to see where the U.S. was losing top STEM professionals, as it competing for top innovators requires having a handle on both the stock and flow of top STEM talent. Dr. Roland Stephen of SRI International said that the Survey of Earned Doctorates has a high response rate, but does not track doctorates beyond their initial post-doctorate positions. He suggested using resumes and administrative data to track the movement of PhDs over time, and agreed with Dr. Thompson's assessment of the importance of talent, which he said was crucial to leading in any technology.

Dr. Anthony Tether, former director of the Defense Advanced Research Projects Agency (DARPA) and Distinguished Fellow with the Council on Competitiveness, said that gathering data was only one part of the equation, and that policy makers needed to take actions in response to the data they received if the U.S. is to make use of it. He asked which agency would be responsible for gathering the data, and which agencies would be responsible for acting to try and encourage top STEM talent to remain in the United States. Mr. Evans said this role would be well-suited to the National Innovation Council concept the group discussed in the previous week, and Dr. Thompson said he welcomed suggestions as to where both the data collection and response enterprises would be housed. He noted that there were many potential stakeholders, including the Departments of Defense, Energy, and Commerce, the National Science Foundation, and even academia. He suggested centralizing the gathering of data and distributing relevant information to these stakeholders. Dr. Laurie Locascio of the University of Maryland suggested giving Congress authority to oversee data collection, while Dr. Tether expressed skepticism that Congress had the capacity to enforce any policies dedicated to retaining personnel. Dr. Thomas Campbell of FutureGrasp, a Senior Fellow with the Council on Competitiveness, said that the Department of Defense would be especially interested in the dataset Dr. Thompson proposed, as it is struggling to find and retain to AI professionals, but Dr. Tether said the agency would struggle to obtain the necessary funding.

Dr. Paul Hommert, former director of Sandia National Laboratory and a Distinguished Fellow with the Council on Competitiveness, said that while higher quality data was of limited use in isolation, if included as part of a package of recommendations aimed at strengthening America's innovation capabilities and competitiveness, the information it provided could spur policy improvements in other areas, which would

go a long way towards creating a vibrant innovation economy in which top talent chose to remain in or come to the United States. Dr. Thompson suggested framing the "enforcement" challenge as twofold. In the short term, individual interventions would be necessary to encourage top scientists to stay in the United States, while in the long term general policy changes would create a more enticing environment for top scientists from around the world.

A National Innovation Radar

Dr. Arun Rai of Georgia State University discussed his proposal for a national "innovation radar" that would allow for solid measurement of innovation activity. He said this would provide substantial benefits to both describing and predicting innovation, and very useful in informing policy as predictive measures of innovation are used for proactive interventions. He added that AI-based technology would have a large role in predicting innovation trends, and that any data collected by the "radar" would be assessed against competitive benchmarks to illustrate America's position with respect to competitors. Dr. Rai said that while the U.S. Patent and Trademark Office collected data on patent fillings, innovators were increasingly using other means to protect their intellectual property, meaning this data is not capturing the full extent of innovation in the marketplace. He added that an innovation radar could have domain- or vertical-specific trackers for innovations in AI, microelectronics, and other key areas, as well as trackers for innovation activity at different stages of the value chain from basic research to commercialization. This information could be conveyed to relevant stakeholders, and could also be used to measure diversity and inclusion and track the effectiveness of policies designed to promote them.

Dr. Campbell said that his company, FutureGrasp, had also outlined the need for a tracker of innovation activity in a report in 2018, and Mr. Evans said that the Competitiveness Decoder, developed by the Council and the Global Federation of Competitiveness Councils, provided a model. The Decoder contains hundreds of different metrics for countries around the world over an extended period of time, and allows users to weight different metrics and understand the implications of different policies.

Owning Innovation Policy

Dr. Stephen said that integrating the metrics discussed by Dr. Thompson and Dr. Rai would provide a valuable general resource, but that this information would need an institutional home and dedicated funding source. Dr. Tether said policy makers could not simply look at the data and "wring their hands," but needed to establish procedures for acting to retain and attract top talent. This could include industry sponsorships, government-funded salaries for top researchers, or other interventions. Mr. Evans suggested using the proposed National Innovation Council to fund talent recruitment and retention efforts, as well as track innovation talent and output metrics, and Dr. Locascio added that gathering such data would be useful not just for measuring the activity of innovation hotspots like Silicon Valley, but for identifying and encouraging innovation in other regions. Dr. Hommert agreed that a National Innovation Council would be an ideal place to house both data collection and response functions for measuring innovation and innovation talent. Dr. Locascio echoed this, and said a designated National Innovation Council would take into account all parts of the innovation ecosystem, including industry, government, and academia, and by acting as a distributor of information to all of them could better feed the entire innovation ecosystem than one of the existing cabinet agencies with another focus.

Gathering and Tracking Data

Dr. Thompson said that the U.S. Patent and Trademark Office has been remarkably productive in innovation research in recent years, but that overall there was poor data on innovation. Most innovation research has historically relied on one ad hoc dataset that takes a narrow view of innovation. On the other hand, patent records can allow for the tracking of the filers across institutions. He also discussed the work of economist Raj Chetty on economic mobility,

compiled from patent and census data, which has informed a host of policies designed to promote economic inclusion and upward mobility. Dr. Thompson cited this as an example of better data enabling and informing better policy. Dr. Campbell said that a consolidated tracker of innovation data would be a "holy grail" for technologists, and that there was a wide variety of information already available on the open source internet, but it has never been aggregated into one place. Dr. Stephen said that when the National Science Foundation tried to machine-read SEC filings for firms and connect them back to patents and licenses to see what innovations make it to market, the data was very noisy. He said there were opportunities to be much better at measuring innovation from administrative data. Mr. Evans said that Mr. Sridhar Sudarsan, one of the National Commissioners, had offered to help the Commission think through the use of AI and machine learning to collect metrics and improve data collection. He suggested connecting the group with Mr. Sridarsan, and suggested a session exploring the Competitiveness Decoder for Working Group Co-Chairs.

Dr. Rai said that, in light of incoming National Science Foundation Director, Dr. Sethuraman "Panch" Panchanathan's goal to have "AI in every state," there would be opportunities to partner with NSF and other entities to work on connecting the measurement and predictive functions of AI, enabling a "turbocharging" of the innovation ecosystem. Dr. Robie Samanta Roy of Lockheed Martin warned that gathering and integrating all of the data needed for an innovation radar, and making sure it is timely and accurate, would be an enormous task, especially given the lack of resources small businesses and startups have to report such detailed data. Dr. Thompson suggested creating a mandate in organizations, like the Patent and Trademark Office and the Census Bureau, to gather data that measures U.S. innovation and competitiveness, in order to create the institutional scaffolding needed to gather this data. Dr. Stephen said that while valuable, creating these mandates would be a time-consuming and politically challenging process that would meet with resistance.

Developing Entrepreneurs

Mr. Andre Doumitt of the Aerospace Corporation said not enough attention was paid to developing the entrepreneurs needed to take innovative technologies to market, and suggested an entrepreneur training program that would cultivate the skills, knowledge, and personal attributes needed to successfully innovate. He said that developing this program would churn out entrepreneurs who were equipped to solve the country's biggest innovation challenges, and that pointing them in the direction of those challenges would lead to a flowering of innovation. He further suggested developing a package for companies, labs, and government agencies on spinning out technology, including training, dealing with company formation and equity, measuring value, and illuminating the path forward for moving science and technology research into the marketplace.

Concluding Thoughts and the Road Ahead

Mr. Evans said he would send and update on the path forward for the group, reiterating that calls during October and November will continue to be held at the same time, but every other week and for shorter durations. He added that he would work with Co-Chairs to find a new time for Co-Chair calls, including combined sessions with the Co-Chairs from all four Working Groups. One of those calls would be devoted to sharing and explaining the Competitiveness Decoder, as an example of a significant, multiyear visualization tool that could serve as a basis for data gathering and competitive assessment. He closed by thanking the participants for their recommendations and contributions. The next meeting of the group will be Tuesday, September 29th.

Working Group 1 Calls September 29

Introduction

Mr. Chad Evans welcomed the group and reminded participants of the new schedule for calls, moving from every week to every other week and from one hour to half an hour. He said the next several calls would focus on prioritizing and strengthening the assembled recommendations ahead of the Year One Call to Action to be released in December, as well as establishing a pathway for continuing conversation and development of recommendations into Year 2. This week's call would serve as a reflection on the process so far, and Mr. Evans added that the Council team would be sending out a survey in the coming days to ask participants to rank existing recommendations for prioritization. He also singled out establishing ownership of the national innovation agenda and developing plans for fueling and funding that innovation in a way that avoids repeating the mistakes of the past as valuable topics for continued engagement.

Instilling a Vision and Sense of Urgency

Dr. Laurie Locascio of the University of Maryland said she loved the idea of a National Innovation Council, and asked if the concept of a national strategic vision for innovation would be integrated into that concept. Mr. Evans said that any National Innovation Council would be bolstered by a compelling vision or formal case presented to the country for its creation. Dr. Ramamoorthy Ramesh of the University of California and Lawrence Berkeley National Laboratory said that one thing the discussions had not yet

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captured was a sense of urgency. He emphasized that the challenges facing the country could not be addressed "tomorrow," and said instilling an honest sense of urgency would be one of the most powerful contributions the Commission could make. Mr. Evans agreed that the urgency of jumpstarting innovation needed to be reiterated, and that the Call to Action would reiterate the case made in the Commission's initial concept paper and Working Group Charters. He also asked participants to share any stories, examples, or data that would punctuate this urgency.

Dr. Paul Hommert, former director of Sandia National Laboratory and a Distinguished Fellow with the Council on Competitiveness, agreed with Dr. Ramesh and said that the Working Group conversations had produced many compelling examples to make the case for urgency. He added that the Commission needed to elevate this challenge inside the government in terms of both strategy and construct to respond to these urgencies, and that there needed to be governmental sanction for an expanded mission for the National Labs in order to deploy them in a fundamentally amplified way. Dr. Hommert said that if the Call to Action makes the case for governmental reorientation around innovation and competitiveness and broadens the National Laboratories' mandate. It will have made a substantial contribution. Mr. Evans said that while the Commission's primary focus is on recommendations that are best for the country and transcend any one administration, the Council would be taking into account the opportunities and spaces opened up by the outcome of the Presidential election.

Structural Challenges

Dr. Roland Stephen of SRI International said that getting the design of a National Innovation Council right at the highest level needed to be married to a vision and strategy that embodied a sense of urgency. He said he recently re-read Science: The Endless Frontier by Vannevar Bush and emphasized the need to fill in the gaps in the research-to-commercialization pipeline left by the decline of large industrial labs. He called for experiment with more than one solution, and Mr. Evans connected this gap to the proposal by Dr. Albert Pisano of the University of California, San Diego in Working Group 2, who suggested a series of university-industry consortia focused on platform technologies. Dr. Locascio said there were two kinds of structural changes needed in the innovation ecosystem: governmental structural change and industry and partnership structural change. She said that even the Manufacturing USA centers were not focused on competitiveness in the way industry-led consortia truly needed to be to innovate, and asked if there was a way to build that focus into existing consortia. Dr. Stephen said the U.S. benefitted from the number of distributed efforts in its innovation ecosystem, and that the Commission needed to recommend something at scale that would pull partners together in a tight way, creating a virtuous circle. He suggested developing one or more "straw designs" to prototype these partnerships. Council Senior Advisor Ms. Carol Ann Meares cited the Interuniversity Microelectronics Centre as a model for such collaboration,

and Mr. Evans noted that Dr. Stephen had already outlined many of the characteristics these centers would need.

Funding and Value Propositions

Dr. Ramesh said that microelectronics could serve as an example to highlight the importance of sectoral collaboration and a national innovation strategy, as well as energy storage. He noted that the investment costs and scale for hardware innovations were enormous, and that banks are traditionally not interested in providing the funding needed to get through the second Valley of Death in hardware development because there are larger and less risky returns in Brazil, India, China, and other developing countries. He said manufacturing capability needs to be woven into the fabric of microelectronics initiatives. Dr. Stephen said there was a good case to be made, and Mr. Evans noted that Dr. Ramesh and several other experts in microelectronics were involved in discussions on microelectronics policy with the Council team. Dr. Ramesh added the Congress has taken action on chip manufacturing, and that bringing together industry, the national labs, and universities would require converting chip manufacturing into a national value proposition.

Dr. Locascio asked how quantum computing fit into the microelectronics discussion, as it did not rely on semiconductors. Mr. Daniel Armbrust of Silicon Catalyst said benefits from computing need to accrue at the systems level, and that the goal is the development of a new "S-Curve" as CMOS technology reaches its limits. Ms. Meares noted the current administration was investing heavily into quantum computing, and Dr. Ramesh said it was important to work on both. He added that most computer users will not use quantum computing, so finding a CMOS replacement is extremely important, and the Commission should not ignore a substantive part of the changing economy by pursuing "fashion statements."

Mr. Mark Minevich of Going Global Ventures, a Senior Fellow with the Council on Competitiveness, championed the idea of a sovereign wealth fund focusing on innovation. He said that countries like Saudi Arabia, Norway, and the United Arab Emirates deployed sovereign wealth funds to invest in startups and transformative technological innovation, and that a fund dedicated to moonshot projects would put the world on notice and make the U.S. competitive with China in funding large-scale investments. Dr. Stephen endorsed the idea of a sovereign wealth fund and noted that only the government has the deep pockets and time horizons needed for these large, risky investments.

Concluding Thoughts and the Road Ahead

Mr. Evans thanked participants for their conversation, and said it was helpful for the Council team as it prepares its initial outlines and thoughts. He affirmed the Council would focus on making the case for urgency, and said more details about the next meeting would come following next week's conversation with the Co-Chairs. He also reminded the group that the Council would send out a survey and/or matrix to help participants provide feedback on prioritization of recommendations. The next meeting of the group will be on Tuesday, October 13th.

Working Group 1 Calls October 13

Introduction

The Honorable Deborah Wince-Smith and Mr. Chad Evans welcomed the group. Mr. Evans said the day's discussion would focus on the initial results of the survey sent out to Working Group members to gauge their priorities for which recommendations to flesh out for inclusion in the Year One Call to Action. He noted the recommendations in Swim Lane 1 on Government Leadership and National Strategies for Innovation received the most support, and that many of the other recommendations were embedded or flowed from the recommendations in this Swim Lane. He provided an overview of the recommendations and asked group members to share any other topic areas they felt were critical and being missed.

The Five Leading Recommendations

The recommendation with the highest prioritization was for a bold new national vision and strategy. This would encompass developing an organizational structure to lead the mission space; redesigning executive branch institutions to achieve coordinated strategy and collaboration; new and accelerated funding targets for scientific investment; enhanced partnership models between labs, academia, industry, and government; a set of grand challenges for the country; tools to close the gap between research and application; workforce development investment; investment in America's scientific infrastructure; and investment in America's continued international leadership. The second highest priority recommendation

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called for overall educational structural improvements to match talent to competitive needs; pulling top talent into key areas and attracting the best talent from other countries; optimizing the innovation and ideation process inside educational institutions; and developing the next model for education to match work demands.

The third highest priority recommendation was for greater national laboratory flexibility to allow labs to participate in the collaborative acceleration of technology adoption and innovation, followed by a recommendation to shift AI research from "2nd Wave" to "3rd Wave" technologies, including sense-making and human machine interfaces. Finally, the fifth recommendation was to identify sectors where U.S. technology leadership and supply chains are critical, and secure manufacturing capabilities and access to supply chains and talent for these technologies. This recommendation also calls for a bold approach to investment, development, and deployment of these technologies. Mr. Evans added that the Council team would alert participants if there was a dramatic reordering of priorities as more responses came in, and Ms. Yasmin Hilpert said that the survey would remain open for several more days as only 15 Working Group members had responded. She added that a link to the survey would accompany the meeting summary.

AI Investment

Dr. Neil Thompson of MIT clarified the recommendation around AI investment, emphasizing that a focus on third-wave AI should not be accompanied by de-investment in second-wave AI like deep learning and big data, as third wave AI primarily consisted of meta-learning and other process improvements to second-wave AI that would enable more efficient and targeted data input and analysis. Mr. Evans said that the recommendation could be re-worded, and noted that other key ideas, like a national initiative in microelectronics, were included in the grand challenges discussed in the first recommendation. Mr. Toby Redshaw of Verizon said that AI investment needed to be increased generally, and that investment in third-wave AI was essential to America's long-run competitiveness. However, he also stressed that the short- and medium-term boosts to productivity from AI would come from the democratization and "Lego-ization" of AI through the development of cheap big data infrastructure, cognitive video, next-generation pattern matching, and other technologies where ubiquitous deployment of existing capabilities was the bigger issue. Dr. Thompson and Dr. Thomas Campbell of FutureGrasp, a Senior Fellow with the Council on Competitiveness, both endorsed rewording the AI recommendation.

Tiering the Recommendations and National Labs

Dr. Ramamoorthy Ramesh of the University of California, Berkeley and Lawrence Berkeley National Laboratory encouraged the group to focus on the first recommendation, as the second and third recommendations around education and the national labs were means of enabling the first, and the fourth and fifth recommendations on AI and supply chains were details in the implementation of the first. He added that there had been, by his county, 58 recent studies across the political spectrum urging a new, expanded role for the national laboratory system, and said that the National Labs were non-negotiable linchpins of the innovation system, and that the U.S. needed to being using them in a similar fashion as it did during the Manhattan Project. Dr. Paul Hommert, former director of Sandia National Laboratory, said that while there were many details around the labs that should not be tampered with, sanctioning a broadening of the labs' mission space to deal with competitiveness and piloting a successful test case could unleash transformation across the system.

Ms. Wince-Smith said that the Council would weigh in strongly on the side of expanding the role of the National Labs, and that providing specific tools and changes to enable this flexibility would be essential for making this recommendation actionable. Dr. Hommert said that the recommendation would

need to begin with mission broadening, and that the Commission's National Lab-affiliated personnel could begin discussing the development of a detailed series of ideas for making changes to lab operations to enable them to participate more in the innovation ecosystem.

International Comparisons

Mr. Evans said it was unsurprising that the recommendation for a national vision and strategy was the top priority, and that it helped provide a powerful case to the incoming administration for investment in competitiveness. He noted that the preamble to the recommendations in the Call to Action would touch upon both the domestic and international rationales for this agenda. Dr. Campbell said providing a comparison of the U.S. with rivals like China would provide a strong justification for investment, and Mr. Evans said that the United States needed to rise to the challenge posed by China within the next five years or else the country's long-term productivity pathway would look very different. Dr. Ramesh urged the Council to highlight in the preamble that the country is at a crossroads and our choices now will have an effect for generations. Dr. Campbell said that FutureGrasp conducted a survey of countries' investment and progress in AI in July of 2019, and that he was happy to provide that information, especially concerning China, to use as a baseline for comparisons.

Concluding Thoughts and the Road Ahead

Mr. Evans said the Council team would come back to the group for input and feedback in the coming weeks as it works to make recommendations as specific and impactful as possible. Ms. Wince-Smith noted that there were many opportunities for cross-pollination with the recommendations emerging from other Working Groups, including the Innovation Centers concept developed in Working Group 2 and discussions in Working Group 3 around financing investment in scale-up of innovative technology and alternative sources of capital. In particular, she highlighted Australia's use of a sovereign wealth fund to invest in life sciences, biotechnology, and other advanced industries as an idea the United States could learn from and a parallel to recommendations developed in Working Group 3 with cross-cutting relevance to this group. Mr. Evans also noted the connection between robust and universal telecommunications infrastructure, energy, and sustainability as a potential overlap with Working Group 2. He added that the Year One Call to Action might present the recommendations and findings thematically rather than organized by Working Group. He closed with a reminder to participants to fill out the survey if they had not done so, and said the Council would be in touch regarding the topics of discussion at the next meeting, which will be on Tuesday, October 27th.

Working Group 2: Exploring the Future of Sustainable Production and Consumption

Working Group 2 Summary

The virtual Working Group sessions began on March 31st and completed this first phase on May 22nd. This 'Phase I' of the Working Group sessions yielded insights and areas for further assessment ahead of the National Commissioner's meeting on June 16th, 2020. Below are highlights and themes from the Working Group.

This Working Group examined two aspects of sustainability: "hard challenges," such as material innovation and supply chain transformation, and the use of sustainable products throughout the supply chain; and "soft challenges," defined as related to consumer behavior and culture, as well as sustainability thinking. Solutions for these challenges generally take longer to implement and require multiple stakeholders such as industry, regulatory bodies, individuals, to succeed.

Working Group members focused on workforce challenges, including conversations related to: education, non-degree credentialing and training, reinvention of recruitment to engage more diverse and under-represented minorities—and retention strategies.

Areas for further discussion in the next phase of the Working Group dialogue include: the use of sustainable products in manufacturing; changing consumer behavior and shifting corporate strategies to value and prioritize sustainability actions; and determining how innovation can improve lives, with a particular focus on vulnerable groups across the country. The Working Groups explored a wide range of additional topics, including but not limited to the following:

- The Working Group began by focusing on ways to strengthen entrepreneurship and increasing entrepreneurial opportunity. Working Group members explored concepts and the beginnings of recommendations to: cultivate the talent pool for entrepreneurship; make the entrepreneurial environment more inclusive; prioritize attention (and funding) around innovation-based firms and industries.
- Working Group members discussed the tenets of sustainable production. They suggested policies to benefit U.S.-based manufacturers that produce sustainably and provide U.S.-based jobs (e.g., tax subsidies). Instead of more protectionist policies—such as increasing taxes on imported goods by "climate offenders"—this could create incentives for companies to settle in the United States, create jobs and make products available even to a wide-breadth of consumers.
- Regarding production, Working Group members agreed that a stronger, national emphasis on the importance of adopting smart manufacturing technology is essential to long-term innovation. Partnerships in this space could be vital, but Working Group members recognized there are challenges in execution. For example, they cited the challenges the Manufacturing USA Institutes are facing as they transition from a pubic-private partnership model to one that is self-sustaining.

- The Working Groups explored how to think about upskilling the workforce and aligning workers' capabilities with future industry needs, including skills in digitalization, artificial intelligence, and high performance computing.
- Working Group members discussed the evolving perspective on supply chains—in light of longer-term trends toward nationalism across the world, as well as the unexpected challenges posed by the global COVID-19 pandemic. In this context, the concepts of supply chain resiliency and the relocation of supply chains emerged here as well as in the other Working Groups.
- The Working Group also discused the pros and cons of focusing less on effiiciency and more on resiliency in the production equation—trading some of the cost gains from globally dispersed, production-sliced supply chains, to more redundant (perhaps more localized) supply chains. For example, as a risk hedge—a supply chain "inoculation"—several Working Group members promoted a rethink of the U.S. dependency on China and Southeast Asia—accepting perhaps higher prices for more secure/local (U.S.-based; Western Hemisphere-based; North America-based) access to critical supplies and parts for the nation's production enterprise.

In Phase Two 2020 of the Working Group process, this Working Group will split. First, a new Working Group has established to focus on the "Unleashing the Capabilities of Work and Entrepreneurship." This Working Group will seek to identify the key challenges and opportunities reshaping the future of work—such as demographics, geography, changing skills needs and organizational models—and, in understanding those, spark entrepreneurial activity, enhance innovation and drive competitive advantage through the productivity and resilience of the American workforce. Working Group 2 will focus squarely on "Exploring the Future of Sustainable Production and Consumption," and will identify long-term, productivity and prosperity-enhancing recommendations that harness the nation's abundance of natural resources, energy, talent and ingenuity to power and unleash the most productive economy in the world.

To view video and read full transcripts of each Working Group session, log in to the National Commission Community Online Portal. Video and transcripts are available within Working Group Rooms.

Working Group 2 Calls April 1

ASU Launch Conference Recap

Ms. Yasmin Hilpert summarized the Working Group's proceedings at the January Launch Conference at Arizona State University. The group identified three kinds of sustainability challenges. Hard challenges involve businesses choosing more sustainable production and packaging methods and striving to reduce their environmental impact and resource use. Many companies are beginning to incorporate these considerations into product design, but issues such as product durability and planned obsolescence remain. Soft challenges, like encouraging more sustainable behavior by consumers, take longer to implement and require both education about sustainable choices and efforts to make sustainability convenient for consumers. Finally, systems challenges, such as the policy environment and the incentives built into the American economy, have the longest time horizon. Here the United States should look at initiatives around the globe, such as in the European Union, to use tax and subsidy policies to incentivize sustainable production by firms. American specialization in high value-added manufacturing also means the U.S. economy faces a landscape of increasing manufacturing output and productivity but a declining manufacturing workforce, which has implications for the future of work.

The group also decided how to structure discussions after the Launch Conference. Each subsequent discussion would focus on one of the topics featured in the conference book: sustainability of production and

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consumption, changing models of work and workplace organization, increasing entrepreneurship and entrepreneurial opportunity, and the development and allocation of human capital in a world transformed by disruptive technological innovation and global competition. Each discussion would be preceded by issue papers providing kickoff questions to begin the session, and Ms. Hilpert expressed a goal of having three to five draft recommendations following each call. Noting the disruption of the COVID-19 pandemic, she said the group will address COVID-19 related topics when it is relevant, but will not make it the sole focus of the Working Group's discussions.

Scheduling and Organization

Participants in the discussion expressed a variety of preferences for the organization and scheduling of future calls. Several members of the group suggested moving to Friday calls, while other members expressed a preference for the current schedule of Wednesday calls. Ms. Trimble suggested possibly breaking the weekly call into two different one-hour sessions to allow the maximum number of participants to contribute. She offered mid-morning and mid-afternoon Eastern time slots to accommodate both coasts. Mr. Chad Evans recommended conducting an online poll to determine how many weekly sessions to have, and at what days and times.

Entrepreneurship

Dr. Carol Dahl of the Lemelson Foundation and Dr. James Stock of the University of South Florida shared with the group a paper they co-wrote identifying areas where the United States can better leverage its entrepreneurial potential and provide support to entrepreneurs, which they also posted to the online collaboration portal for comment. They identified four major issue areas related to strengthening entrepreneurial opportunity. First, they called for starting the entrepreneurship pipeline in the educational system at an earlier age, which would help address inequities in the entrepreneurial system. Second, they called for the identification of missing elements in the system to support entrepreneurs. Third, they advocated for an increased focus on human capital and the inclusivity of the entrepreneurial system. Finally, they urged that innovation-focused businesses be recognized and prioritized as the key to productivity growth, as the importance of these businesses is typically not recognized by local and regional programs to promote entrepreneurship.

Dr. Stock expressed the importance of learning from existing best practices in entrepreneurial development that could be scaled up and replicated elsewhere. He cited the example of the Angel Network of programs in the North Carolina Research Triangle, with the cooperation of the University of North Carolina, North Carolina State University, and Duke University. These programs have succeeded in nurturing entrepreneurs and have expanded to other institutions, such as the University of Miami. He also noted the variety of successful programs under the auspices of the Small Business Administration that could be scaled up with increased funding. Dr. Dahl discussed the success of the National Science Foundation's I-Corps Program, and "Invention Education" programs at the K-12 level as programs to be scaled and made more robust. In the chat, Dr. Michael Goodman of the University of Massachusetts-Dartmouth mentioned successful initiatives in the Boston metropolitan area, such as the Greentown Labs and Mass Challenge programs, but noted they had yet to successfully scale to other parts of the state.

Mr. Evans concurred with the idea of replicating and scaling best practices, citing the example of the Council's work on High Performance Computing with the National Laboratories. Beginning as a project in the energy sector, the High Performance Computing initiative has been expanded to other subjects, such as manufacturing and transportation. The governance structure, funding, and division of responsibilities for these later projects were informed by the example of the initial initiative. He also agreed that the paper could serve as a launching point for the Working Group's deliberations on this topic, especially since it is viewable via the online collaboration portal.

COVID-19, Sustainability, and Resiliency

A major theme of the discussion was the impact of the COVID-19 pandemic on the sustainability of the American economy and the resiliency of its supply chains. Some of the most prominent themes in the discussion were community resilience and innovation, reuse and sustainability, reshoring and relocation of supply chains, the need for national coordination of crisis responses, and the response of industry to new demands in crisis periods.

Dr. Maya Trotz of the University of South Florida highlighted the resiliency and innovation communities have demonstrated in response to the crisis, including creating face masks, face shields, and other personal protective equipment to aid medical workers. She also noted a renewed appreciation for sustainability emerging from the need to find local suppliers of goods and services due to supply chain disruption, and the observed drop in pollution due to reduced economic activity during the pandemic. She stressed the importance of ensuring these innovation-focused mindsets remain at the community level after the pandemic passes, unleashing greater community empowerment. Mr. Evans noted the parallels between innovative community responses and "shared infrastructure" like High Performance Computing consortia. He characterized the grassroots responses to the pandemic as a potential next generation of shared innovation infrastructure.

Dr. Dahl expressed the importance of "redundancy" in supply chains and resources in responding to crises, but was concerned about the impact on sustainability of having duplicative structures and systems. Dr. Trotz believed that communities being left to determine their own COVID-19 responses has created demand for reusable resources, including face masks that can be sterilized via autoclave and reused. The crisis will spur the general public to find ways to reduce waste, which could be scaled up to industries looking to improve resiliency as well. Mr. Evans discussed the Council's work with Caterpillar on sustainability and reuse in industry, which offers a blueprint for companies looking to minimize waste, especially for difficult-to-acquire inputs like advanced materials and rare earth minerals.

Participants also discussed the relocation of supply chains. Dr. Tommy Gardner of HP Federal brought up the requirement in the CARES Act for the National Academies to study America's medical supply chain resiliency, and gave an illustration of the dangers of unsecured supply chains. Following the 2008 financial crisis, many small businesses that acted as sub-suppliers for multiple competitors in different industries went bankrupt. This included the sole supplier of heated coils for car seat heating systems, leaving every major car manufacturer scrambling to develop their own technology. He expressed concern that many small businesses will not survive the current economic recession, and that this will jeopardize operational sustainability for many companies. The Honorable Deborah L. Wince-Smith asked if the crisis will prompt companies to seek greater vertical integration to secure their supply chains, and Dr. Gardner said it was likely, but not necessarily the best solution. He advocated for ensuring that small suppliers for companies exist in competitive industries, and called for companies to identify vulnerabilities in their supply chains and work together to fix them. He also pointed to his experiences in a Threat Evaluation Working Group comprised of representatives from 120 firms, where they identified 283 distinct threats to their business models. He said that firms must be mindful of the "broad" variety of supply chain threats.

Dr. Stock projected that in the coming decade American firms would engage in substantial reshoring of their products due to the fallout from the COVID-19 crisis and concerns about relying on foreign production of rare earth minerals and other essential components. Citing defective ventilators shipped to Italy during the COVID-19 crisis, he predicted firms would begin manufacturing things domestically for quality control purposes, and to avoid the worries of dealing with a managed economy and unpredictable governmental responses to crises and natural disasters. He

further predicted that some companies would relocate production from China to countries like Thailand, Vietnam, Indonesia, and Mexico. Dr. Goodman noted that he had not seen significant evidence of reshoring by American firms thus far.

The group expressed significant concerns about the lack of a nationally-coordinated response to the pandemic, and expressed urgency over the need to develop plans for future crises. Dr. Trotz questioned why there was no nationwide effort to coordinate among universities researching COVID-19 vaccines. Dr. Dahl added that having a plan for coordinating research and innovation in response to crises will be important in the future, and Dr. Trotz suggested devising one now for the coming months would be beneficial. Dr. Goodman described the efforts of universities in Massachusetts to coordinate with the state government and each other in their COVID-19 response, as well the coordination efforts among local manufacturers. Academia and industry in Massachusetts are "dividing and conquering" to address research on vaccines and treatments and manufacture of personal protective equipment, respectively. However, Dr. Goodman said the country was "paying the price" for a lack of national coordination. Dr. Helene Dillard of the University of California, Davis echoed this sentiment. She noted that universities across California have been much more willing to collaborate and share data than in normal times but that it would have been much better to coordinate a national response in advance. Ms. Ciannat Howett of Emory University also noted substantial academic coordination on vaccine research, but added that the crisis illustrated the importance of specifically including public health in plans to address global challenges. She said that both COVID-19 and other threats such as climate change require coordination and have public health elements, and argued that the United States should strive to be a global leader in both planning and intervention in the face of crises.

Finally, The Honorable Deborah L. Wince-Smith broached the topic of industry retooling to produce goods and services needed during crisis. She noted the reactivation of the National Defense Production Act, which allow the government to direct industry to make products crucial to ongoing crises, and expressed interest in industry leaders' thoughts on COVID-19 response and supply chain vulnerability, especially pertaining to pharmaceuticals and medical devices. Dr. Noel Kinder of Nike described efforts by the company to retrofit domestic factories to produce face shields, but noted that their factories overseas are suffering from government-imposed shutdowns, rendering them unable to make use of them. Ms. Wince-Smith noted that China has nationalized 3M's plants located in the country, and asked if this was a concern at Nike. Dr. Kinder said that Nike had not experienced this issue, but acknowledged it may be a concern for other companies. He also noted that China, along with Japan and South Korea, had permitted the reopening of Nike stores and factories more quickly than in other countries. Ms. Stacy Lippa of Target described her company's efforts to minimize disruption via reallocating production across different locations and implementing contingency plans. She stressed the importance of flexibility in manufacturing for emergencies because of the time and expense of relocating production. Ms. Trimble also noted the significant variation in time frames for retrofitting factories and relocating production. Some manufacturers have been able to convert to producing protective equipment in a matter of weeks, but other transformations, such as retooling information technology, can take years.

Moving Forward

Ms. Hilpert reminded the group that she and Ms. Trimble would formulate a schedule of calls and topics from the results of the upcoming poll, and added that next week's call will focus on the first issue area (sustainability of production and consumption) outlined in the Launch Conference program. Ms. Trimble reminded the group about the online collaboration platform.

Working Group 2 Calls April 10

Setting the Stage

The Honorable Deborah L. Wince-Smith and Ms. Kathy Trimble welcomed the group and introduced the kickoff speakers, Dr. Carol A. Dahl of the Lemelson Foundation and Dr. James Stock of the University of South Florida. They introduced their paper on identifying ways to strengthen entrepreneurship and entrepreneurial ecosystems, and asked for feedback on which sections to modify and expand, as well as which solutions to prioritize in future iterations of the paper.

Background

Dr. Dahl identified four questions that she and Dr. Stock sought to answer. These are how to cultivate the talent pool for entrepreneurship, how to ensure enterprises receive the support they need to be successful, how to make the entrepreneurial environment more inclusive, and how to get the government and the entrepreneurship community to recognize and prioritize innovation-based business, as opposed to mainstream or lifestyle businesses, in fostering entrepreneurship. She also identified key studies and recommendations that helped inform their work, including the Council's reports Work (2016) and Transform (2017), as well as the work done by Stanford economist Raj Chetty and colleagues on innovation and inclusivity. She further cited programs that provide prototypes for scaling due to their success, such as the National Science Foundation's I-Corps program, and urged earlier exposure to innovation and entrepreneurship in schools. Dr. Dahl noted that most students choose their general career path by middle school. Dr. Stock echoed the importance of drawing on previous successes and "not reinvent-

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ing the wheel." He established a goal of identifying which recommendations for program adoption and scaling were most important.

Teaching Invention

Dr. Mike Goodman of the University of Massachusetts-Dartmouth asked if there was evidence supporting the efficacy of innovation curriculum in fostering greater entrepreneurship and invention, as such efforts seemed to founder at the state level in Massachusetts. Dr. Dahl noted that the effects of such programs can take years to manifest, and that it is important for any invention curriculum to involve experience of invention, rather than just learning about it. She emphasized that students need the opportunity to identify problems to solve rather than being assigned them, and need to actually go through the process of opening a business to learn firsthand the "soft skills" necessary for successful entrepreneurship. She added that this process has the further benefit of enabling students to see themselves as entrepreneurs, especially girls, students of color, and low income students. Dr. Stock added that students need to "catch" the spirit of invention through formative experiences, and that bringing in successful entrepreneurs to explain and demonstrate their work is far more valuable than "textbook" learning.

Inclusivity

Ms. Ciannat Howett of Emory University noted that women enter the corporate world at the same frequency as men, but that men are 142 percent more likely to reach the C-Suite level. She urged the promotion of universal pre-K education to help support women in the workplace and address this discrepancy in career advancement. Dr. Carlotta Arthur of the Luce Foundation worried that absent efforts to reduce bias, credentialing for entrepreneurial skills might disadvantage students from underserved backgrounds. Mr. Tommy Gardner of HP federal noted the importance of diversity in background, thought patterns, and viewpoints in fostering innovations. He noted how the discovery of DNA was aided by combining scientists' expertise in biology and chemistry. Dr. Dahl also stressed the importance of bringing inclusion from the educational system and into the corporate world. Mr. Evans discussed the Council's previous work, including Transform, that identifies programs with success in increasing the diversity of the innovation landscape. In particular, he identified the efforts of the University of California, Riverside as a model that could be scaled elsewhere, as it combines clear metrics with proven results in fostering innovation, especially by underserved students. Dr. Dahl further suggested making use of the nonprofit Venture Well, which has a wealth of resources on successful and inclusive programs. Dr. Mike Cassidy of Emory University also suggested the Junior Achievement and First Robotics programs as models.

Cultivating and Measuring Skills

Ms. Erica Volini of Deloitte described the difficulty corporate recruiters have in trying to discern applicants' innovation skills from their resumes, and wondered if there was a way to provide a credentialing program that would enable employers to find job applicants with the best soft skills to become entrepreneurs and inventors. She further added that providing students with a tangible asset for their job searches could motivate them to participate in innovation. Dr. Goodman further suggested using paid internships as an incentive for students to enter the entrepreneurial world in high school and college. Dr. Dahl suggested that such credentialing involve portfolio evaluation, as it would better capture the qualitative distinctions that soft skills present. Dr. Goodman worried about the challenge of conducting portfolio evaluations, because the skills in question are "know them when you see them," and Ms. Volini wondered if artificial intelligence could help identify these skills. Ms. Stacy Lippa of Target asked if specifying traits, such as autonomy, risk-taking, and proactive thinking, could help with evaluations. Ms. Wince-Smith brought up the Smithsonian's efforts to develop badging and credentials programs for both

STEM competencies and experiential learning and entrepreneurship skills. She also suggested modifying the Baldrige criteria developed by the National Institute of Standards and Technology, originally developed to certify quality in corporate manufacturing and production, to develop evaluation criteria for entrepreneurship.

Structures to Foster Innovation

Dr. Stock discussed existing institutions that could be leveraged to foster entrepreneurship, in particular to help companies cross the "Valley of Death" after initial funding has run out and before they have developed a scaled, marketable product. He said the U.S. landscape contains pockets of innovation and creativity, but that these need to become more widespread. He also warned that the COVID-19 pandemic, with its slowing of economic activity, could endanger cash-strapped startups. Among suggestions in his paper with Dr. Dahl, Dr. Stock suggested building upon the Small Business Administration, which he characterized as helpful to startups but with room for improvements in allocating funding and rates for loans, among other issues. He also urged combining the SBA's programs with the SCORE program where retired executives act as mentors to entrepreneurs, and called for scaling up the SBA's regional innovation cluster program. Finally, he suggested public-private partnerships in which firms could fund entrepreneurship programs at high schools and colleges, in a similar manner to their funding of research grants, endowed chairs, and professorships. He also noted that some of these programs would require no public money, and some would require no new funding at all, but instead a reallocation of existing funding.

Dr. Dahl echoed Dr. Stock's call for mentorship programs, noting that studies have found mentorship to be one of the most important components in successfully establishing innovation ecosystems. Dr. Stock was hopeful that companies would respond to calls for these programs, since the COVID-19 pandemic has led to companies engaging in social responsibility efforts not tied to their bottom lines.

Moving Forward

Drs. Dahl and Stock asked for feedback on future discussions. Dr. Goodman suggested identifying the problems the group would like to solve first, and then "dividing and conquering" on solutions. Dr. Dahl noted that some issues, like inclusivity, were cross-cutting, and Dr. Goodman suggested addressing these cross-cutting issues within each distinct issue that emerged. Dr. Stock noted Michael Porter's research on value chains in businesses from the 1980s, and that this work separated out unique and cross-cutting issues in such a fashion. Ms. Trimble and Ms. Wince-Smith noted that the other working groups were experiencing similar challenges, and discussed plans for creating task forces to address cross-cutting issues that featured participation by members of all three working groups. In particular, Ms. Wince-Smith noted the importance of identifying ways to secure long-term, patient capital for investments in key technologies, and the need to approach policy makers with solutions that went beyond simply increasing research funding. Mr. Chad Evans noted that the discussion had illuminated the need for very extensive discussion of many of these issues, and Dr. Dahl suggested the group broaden its scope first to ensure it was not neglecting any topics before honing in on key issues. Ms. Trimble reminded the group that the next call will be on Monday, and will continue discussion of Dr. Stock and Dr. Dahl's paper.

Working Group 2 Calls April 13

Recapping Last Week

Dr. Carol Dahl of the Lemelson Foundation opened the discussion with a summary of the previous call, in which she and Dr. Jim Stock of the University of South Florida discussed the first two pillars they identified as key to strengthening entrepreneurship and entrepreneurial opportunity: cultivating a pipeline of innovative talent and the role for education, and ensuring a robust ecosystem to help entrepreneurs turn ideas into businesses. Dr. Dahl discussed the importance of having a pathway for turning ideas into reality, generating dynamism and job creation and sparking further ideas for innovation. She described this virtuous circle as characterizing successful innovation economies in places like San Francisco, Seattle, and Boston, and also characterized the discussion as a starting point. She added that she and Dr. Stock would love further input and feedback on other topics to consider and useful studies and information.

Responding to the COVID-19 Crisis

Members of the group discussed whether the Working Group, or the Commission as a whole, should issue a statement related to the government response to the COVID-19 stimulus bill, specifically pertaining to the guidelines for Small Business Administration assistance to distressed firms. Dr. Kathleen Merrigan of Arizona State University noted that many small businesses felt confused about the amount of assistance they are eligible to receive, as well as the timing of that funding, and Dr. Dahl observed that the rules around venture- and angel-funded businesses discriminate against the kinds of

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innovative startups that are most important to driving economic growth. Mr. Chad Evans characterized these concerns as falling under the purview of the third Working Group, but he emphasized that the Council as a whole would issue a response to the COVID-19 pandemic and to economic relief efforts, as it was important for the response to come from the highest level possible. He also framed such a response around the idea of embedding resilience into innovation ecosystems, both for this crisis and for future events. Dr. Merrigan highlighted entrepreneur Mark Cuban's call for "America 2.0", and Mr. Evans agreed with this framing for rethinking the economy. He also encouraged members of the Working Group to see what other stimulus packages emerge from Congress, as some of them may target startups and innovative firms.

Inclusivity

The first major issue the participants discussed was inclusivity in innovation. Dr. Dahl referenced Harvard economist Dr. Raj Chetty's work on inclusivity, which found that if women, low income Americans, and minorities participated in the innovation ecosystem as high income white men, America's innovation rate would quadruple, with substantial impacts on economic growth and dynamism. She also discussed the problem of underrepresentation of marginalized communities in leadership positions in the entrepreneurial world, and added that people from low-income backgrounds face particular disincentives to innovate, even with access to higher education. This is due in large part to lack of access to networks and the unwillingness to take on financial risks to start a business. Dr. Dahl stressed the need for solutions that would reach all parts of society, and that the public school system was the best way to ensure innovation-supporting policies reach everybody. She called for greater access to mentorship, funding, business incubators, and other support for entrepreneurs from underrepresented groups. She also urged providing social services, including health insurance and student debt relief, to underrepresented groups in order to de-risk the process of innovation and reduce financial stress.

Dr. Carlotta Arthur of the Luce Foundation characterized the issues facing people of color, especially women of color, as systemic and said they would require major changes due to structural inequalities and unconscious bias. She noted that such bias manifested in the disparate impact the COVID-19 pandemic is having on African Americans. Dr. Arthur added that data focused on comparing outcomes along gender lines does not break out the discrepancies between white women and women of color in achieving parity and representation, and that there is also insufficient attention to achievement gaps between white men and men of color. She said that she would look for existing literature on best practices for addressing these inequalities. Ms. Stacy Lippa of Target asked whether "inclusion" by itself was sufficient for addressing inequity, or whether "diversity and inclusion" was a better framing. She asked how to build an educational and entrepreneurial environment around diversity and inclusion. Dr. Dahl said that people differ on whether inclusion is the "linchpin" for diversity.

Ms. Ciannat Howett of Emory University identified universal pre-K education and childcare as a key to improving the representation of women in leadership in innovative STEM disciplines. She said data now show that women are achieving parity with men in the educational system and at the junior ranks of the professional world in STEM fields, but that a persistent gap remains at senior positions. The data also indicate that this disparity is driven by women taking time out of the workforce when their children are young, which hinders their career advancement, and that better access to childcare would allow them to remain in the workforce and continue to advance at the same rate. Ms. Howett also shared that countries like the UK, France, and Germany have gender pay reporting requirements for large firms, and that this appears to impact pay disparity between men and women. She suggested such a policy would be especially useful in high-tech hubs like Silicon Valley and Seattle, where pay disparities are larger than for the United States as a whole. Dr. Merrigan suggested widespread adoption of the EU's requirement that companies have gender diversity on their board

of directors, which the state of California has already implemented. Dr. Dahl and Mr. Evans both encouraged more input on this topic, and urged Ms. Howett and Dr. Merrigan to share any useful literature on the online platform.

Ms. Amy Lientz of Idaho National Laboratory echoed Dr. Dahl's concerns with de-risking entrepreneurship. She noted that her laboratory frequently hears from startups that want to collaborate, and entrepreneurs that want to spin out technologies developed in the lab, but they face barriers due to concerns about benefits. The lab is not legally allowed to provide them with health insurance, 401(k) benefits, or other benefits that would provide them with financial security and reduce the risks of innovating. Dr. Dahl noted that some universities have addressed this issue by allowing students who develop intellectual property while researching at the university to remain affiliated as fellows while they purse spin-off opportunities. Some schools also provide debt deferment and relief to help student entrepreneurs.

Dr. Dahl suggested that different dimensions of the inclusion issue may have different solutions, and emphasized that for many people from underrepresented communities, lack of access to innovation ecosystems begins early on. She said that many children from low-income backgrounds begin receiving negative messaging about their potential for achievement by middle school, preventing them from following the pathway to becoming innovators and entrepreneurs. Dr. Mike Goodman of the University of Massachusetts-Dartmouth stressed that assistance to underrepresented groups would need to be targeted and emphasized in innovation policy, and he encouraged searching for best practices in this regard that could be scaled up. Mr. Evans mentioned the University of California, Riverside's effort to boost diversity in innovation as an example of such a model.

Prioritizing Innovative Businesses at a National Level

The other principal issue the group discussed concerned properly prioritizing innovative firms in the entrepreneurial space. Dr. Stock warned that insufficient investment in innovation would harm national competitiveness, and he called for a return to higher R&D spending, with a target of 2 percent of the federal budget. He also expressed concern about the federal government's preference for "spreading money around" to small businesses, rather than providing strategically targeted assistance to the biggest drivers of economic growth. In this vain, Dr. Stock suggested the development of a nonpartisan think tank to identify the most promising and innovative firms and startup ideas, and to encourage federal prioritization of those firms and ideas. He also called for more and better data, as companies and federal agencies often don't have the data on key performance indicators that is essential to identifying the best innovations. Dr. Stock further emphasized that more than 50 percent of ideas never make it

to prototyping, and that those that do often suffer from a lack of available investment. He urged more funding for research, and he also discussed the state of education funding in Florida. While state lottery revenue continue to flow into education funding, other funding sources had decreased, leaving no net increase in funding. Dr. Stock also lamented that the state government no longer matched donations to endow chairs or professorships at universities.

Participants identified particular avenues for greater funding of innovation. Dr. Stock suggested the Veterans Advantage program within the Small Business Administration (SBA), arguing that veterans were less risky to invest in compared to other entrepreneurs due to their work ethic and experience. He also urged more funding for the Small Business Innovation Research (SBIR) program. Dr. Merrigan encouraged participants to think beyond the SBA. She noted that the Department of Agriculture also operates small business programs, and that small farms will be especially hard hit by the COVID-19 pandemic because up to 50 percent of restaurants, their chief customers, will not survive the economic crisis. Dr. Stock expressed a desire for more input from the business community, alongside health experts, in shaping COVID-19 response, as there are important tradeoffs to consider between public health measures and economic relief, and because groups with more diverse stakeholders are more open to compromise and creativity.

Conclusions and Framing Further Discussion

Dr. Stock encouraged the group not to "reinvent the wheel," and to make use of successful policies that could be scaled up to the national level. He described the University of South Florida's efforts to boost diversity in its programs, noting that a majority of supply chain management majors at the business school were women, and that racial and ethnic minorities were also well represented, because the school made an effort to be inclusive. He further suggested that organizations and institutions outside the group's nominal scope might have ideas that could be usefully scaled for the work of the Commission. Dr. Dahl wondered if the group should focus only on high-innovation firms in strengthening entrepreneurship, or if they should include more "mainstream" businesses' concerns as well. Dr. Tommy Gardner of HP federal encouraged a focus on both kinds of businesses. He noted that the economist Joseph Schumpeter had found that both small and large firms were essential for innovation. He also urged members of the group not to hesitate in voicing their true feelings on discussion items, as a diversity of opinions generates better solutions and ideas. Drs. Dahl and Stock concluded by asking the group to help determine two or three priorities for policy solutions from each of the four sub-issue areas they identified in their paper.

Working Group 2 Calls April 17

Introduction

Ms. Kathy Trimble welcomed the group and introduced the opening speaker, Mr. Leslie Boney of North Carolina State University. She said that the discussion would focus on very broad questions of human capital, skills, and the future of work.

Opening Remarks

Mr. Boney opened with a discussion of the massive rise in unemployment from 3.5 percent to 16 percent as a result of the COVID-19 pandemic, and how NC State's Centennial Campus had rapidly retooled its textile production facilities to make personal protective equipment for healthcare workers. He explained how both of these rapid changes foreshadow major disruptions to the labor market and the economy. The Institute for Emerging Issues at NC State predicted that 24 percent of current jobs in North Carolina would cease to exist by 2040, with county-level variation from 15 percent to 41 percent. He added that worldwide, different locations could see from 10 percent to 70 percent of current jobs cease to exist in the coming decades. In the short run, he described how the pandemic had rapidly reorganized the economy, with grocery store revenue increasing by 27 percent and restaurant revenue decreasing by 25 percent. The pandemic has also caused rapid change in service delivery, with all the K-12 and college students in North Carolina transitioning to online learning, and up to 100 million students across the country.

Mr. Boney said that even before the pandemic, businesses were frustrated at the hard and soft skills possessed by graduating students, with surveys of employers showing satisfaction rates ranging from 76 percent for computer science graduates to just 18 percent for graduates' writing abilities. He added that job tenure is decreasing and career changes

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are becoming more frequent, especially for younger workers, even as fewer people are moving for work than ever before. He identified two questions for the group to answer: what hard and soft skills will be necessary for the workforce of the future, and what kinds of collaboration between academia, industry, and government will be necessary to deliver those skills?

Skills for the Future

Dr. Carol Dahl of the Lemelson Foundation praised the Council's 2016 publication Work, particularly its listing of soft skills desired by employers on page 49. Mr. Boney discussed how his own field of engineering has seen a rapid change in needed skills, particularly an increase in digital skills requirements. Mr. Chad Evans identified digital skills as an example of changing competencies even in jobs that will continue to exist in the coming decades. Council Senior Advisor Ms. Carol Ann Meares argued for a generic skill base that will allow workers to transfer between roles and careers as the labor market changes ever more rapidly in the future, and Dr. Dahl also differentiated between job skills needed immediately in the economy, and the skills that will be needed for jobs in the future that don't yet exist. Ms. Meares also stressed the need to train teachers to quickly retool their curricula to prepare students for rapidly a changing job market, which would require consultations with employers and technology developers.

Other participants stressed the continued importance of non-technical skills. Ms. Ciannat Howett of Emory University emphasized that the broad skills developed by liberal arts schools, including adaptability, collaboration, and systematic thinking, will be increasingly important both for a rapidly evolving labor market and for addressing persistent threats like climate change. Dr. Maya Trotz of the University of South Florida discussed how many women were using sewing skills to create face masks during the pandemic, and consulting with healthcare workers to develop innovative masks with new materials. She urged the group to remember that basic skills will continue to be important for innovation and supplying basic needs, and should not be overlooked.

Participants debated how best to actually develop skills in students and workers. Dr. Dahl referenced research showing the importance of hands-on and integrative learning, especially at the K-12 level, in developing "soft" and transferable skills like problem solving, creativity, adaptability, planning, and communications skills. Mr. Boney spoke of the need for developing credentials to illustrate these kinds of skills to employers and show them how they are transferable, such as "Learning Records" or "competency credentialing." Dr. Mohammad Zaidi, formerly of Alcoa, praised the quality of computer science education at many universities, describing the solutions computer science students developed to problems as "astounding." He urged the continued promotion of these skills and called on employers and venture capital to better recognize them.

Sustainability

Sustainability, specifically sustainable design of products and services, emerged as a problem-oriented skill in the discussion. Dr. Dahl stressed the need to begin educating students in sustainability early on, and of giving them the skills to design sustainable business models and products. Dr. Tommy Gardner of HP Federal underlined the importance of diverse knowledge backgrounds and collaboration by people with different skill sets in finding sustainability solutions, especially in engineering. Dr. Dahl added that engineering schools should fully integrate sustainability into their curriculum, rather than having brief and perfunctory coverage in students' coursework. The Honorable Deborah L. Wince-Smith praised the U.S. Naval Academy for integrating sustainability education into its engineering curriculum, and Dr. Trotz discussed the National Academy of Engineering's Sustainable Development Goals program, which has been adopted by many universities, and the American Society of Civil Engineers' adoption of sustainability skills as a component of their accred-

itation process. Dr. Dahl urged even deeper curricular incorporation of sustainability, saying that not every engineering student is exposed to it during their studies. Dr. Trotz also shared with the group the ENVISION credentialing program from the American Society of Civil Engineers, which pushes for sustainable infrastructure design, and Dr. Dahl shared a report from the nonprofit Venturewell on skill sets needed for sustainability. Finally, Dr. Trotz discussed the emergence of problem-focused sustainability initiatives, including the American Society for Engineering Education's Wicked Problems in Sustainability Initiative, which encourages students to find solutions for particular problems, such as food waste.

Middle-Skill Workers, the Skills Gap, and Job Mismatch

Ms. Yasmin Hilpert highlighted the importance of pinpointing which industries and jobs are most at risk of disruption, as this will enable better tailoring of recommendations on which skills and workers to focus on for re-skilling. In particular, she cited middle-skill workers as particularly vulnerable to job loss. She emphasized the need to better align skill sets with labor market demands, and called for the identification and sharing of innovative models and best practices. She also discussed the work of the Global Federation of Competitiveness Councils on a forthcoming report on workforce skills for the future. Ms. Meares elaborated that routine work will be increasingly automated, and that workers of the future will need to develop customer service, communication, collaboration, and thinking skills for non-routine tasks.

Mr. Boney concurred and referred to a "barbell economy" in which there is rapid job growth in low-skill service professions, which middle-skill workers are overqualified for, and in high-skilled technical and service professions they are underqualified for. He characterized this as an employment "Valley of Death" by way of analogy with the entrepreneurial phenomenon, in which low-skill workers lack upward mobility because of a dearth of middle-skill jobs with attainable skill and experience requirements, and the inability to develop the high skills needed for higher paying jobs. Mr. Bill Bates noted that many workers were also unable to relocate to areas where jobs were available because of a lack of affordable housing or fears of leaving an existing job due to the lack of portability of health insurance. Dr. Dahl said such frictions explained why Seattle simultaneously struggles with unfilled software engineering jobs and a high homelessness rate, and she warned that the disconnect would worsen unless the country started preparing workers and students for future jobs, many of which don't yet exist. She added that this "future" was only a couple of years away in many cases.

Capabilities vs. Skills

Ms. Erica Volini of Deloitte predicted that workforce readiness and education would begin shifting from an emphasis on "skills" to an emphasis on "capabilities." She described Deloitte's upcoming annual Human Capital Trends Report, and how many organizations don't know what their short-term skills needs will be, let alone their long-term needs. She suggested that employers begin recasting job descriptions and roles to allow for greater movement over time, and to frame them in terms of broad capabilities rather than narrower skill sets. She further called for employers to begin defining and identifying these capabilities. Ms. Wince-Smith agreed and lamented the tendency of stale language to "stovepipe" thinking about problems. She described the continued use of rigid "skills" in evaluating government employees for promotion and tenure, and in job descriptions on job sites. Ms. Trimble shared the Council's descriptions from Work of needed capabilities in the future workplace, including complex communication, creativity, problem solving, adaptability, critical thinking, and planning and execution skills.

Talent Sharing

Ms. Volini described the rise of job transfer platforms as a solution to rapidly changing labor market needs. She described CVS's recent hiring of laid off hotel employees for customer service roles, and envisioned a new era of "talent sharing" where workers can quickly pivot to new roles that make use of their capabilities as the demand for labor changes. Mr. Evans praised Deloitte's work in helping laid-off service workers find new jobs created by the COVID-19 pandemic and its reorganization of the economy, and expressed hope that the economy would retain the capability to rapidly repurpose workers after the crisis has passed. Ms. Amy Lientz of Idaho National Laboratory described her lab's efforts to not only share talent as regional governments and contractors hire construction and energy employees in Idaho, but also to partner with schools and labor unions to help train workers for this shared environment. This partnership across sectors has allowed them to better communicate the needs of employers and design curriculum to match them, and it created a better understanding of the capabilities needed for new jobs. They have also partnered to recruit employees, apply for grants, and share training techniques and curricula.

Accelerating Transformation of Institutions

The theme of rapid transformation of institutions to adapt to changing needs and economic realities was another topic of discussion. Mr. Evans praised the rapid turnaround on NC State's Centennial Campus to begin manufacturing personal protective equipment, and Dr. Boney noted that the crisis forced the school to come to a much quicker agreement with manufacturers regarding the retooling and commercialization processes. Ms. Howett discussed a similar rapid transformation of healthcare capacity at Emory, with researchers working to rapidly develop antibody tests and vaccines for COVID-19. Mr. Evans wondered if the crisis would provide institutions with lessons on how to develop solutions to problems faster, and find better and quicker ways to adapt and transform. Dr. Jim Stock of the University of South Florida urged K-12 and higher education to develop this capability, arguing that schools and colleges are too slow to adopt new curriculum and credentials. He said that by the time schools introduce new coursework or modules, the labor market has already changed, and urged greater institutional flexibility.

Communication and Collaboration

Participants identified insufficient communication and collaboration as a significant contributor to skills mismatch, as universities and schools were unaware of employers' needs. Dr. Zaidi discussed his frustration as a venture capitalist with entrepreneurs who could not explain the value proposition of their business to investors, as well as the inability of firms to respond to clear criteria set forth by venture capital firms. He described how it took nearly 60 tries to find a firm that could develop clean energy and carbon capture technology at a specific price point, because firms didn't understand what his company was looking for despite clear guidelines. He stressed the necessity of entrepreneurs understanding investors needs and interests. While he acknowledged the importance of broad capabilities, he called for curriculum to convey to students where these capabilities intersect with specific industry needs and goals.

Other participants shared examples of efforts at better communication. Dr. Gardner noted the Accreditation Board of Engineering and Technology's attempts to align curriculum and programs to employer needs, and Mr. Boney urged faster and more accurate communication between academia and business. Ms. Lientz discussed Idaho National Laboratory's use of labor economists to "translate" between employers' descriptions of their needs and educators' understanding of terms and concepts. Dr. Boney identified

the rise of "co-living spaces" where businesses share facilities and partner with universities as a way for employers to both find talent more easily and better communicate their needs to academia. He described how universities were responding faster than usual as a result of these efforts. These include granting credits for prior knowledge and demonstrated capabilities to expedite degree completion, and moving away from the standard semester model to tailor course and module length to the specific capabilities or skills being learned. He also described the rise in rolling start times for courses to offer greater flexibility to students, and industry-designed "Professional Science" Master's degrees that are tailored to specific industry needs.

Conclusion and Further Discussions

Ms. Trimble, Ms. Wince-Smith, and Mr. Evans thanked the group for their thoughts, and Mr. Boney noted that the topic was worth far more extensive discussion than the session allowed for. Ms. Trimble reminded the group that next Monday's session would continue with the same theme.

Working Group 2 Calls April 20

Introduction

Mr. Chad Evans and Ms. Kathy Trimble welcomed the group to the discussion, and Ms. Trimble introduced the opening speaker, Mr. Leslie Boney of North Carolina State University. Ms. Trimble also shared a copy of the Council's 2016 publication Work with the group, as it contains substantial information on the issues discussed on the call.

Opening Remarks

Mr. Boney began by noting and praising the Council's extensive previous work on the future of skills and the nature of work, in particular Work. He summarized his experiences overseeing the Centennial Campus at NC State, where more than 75 private companies partner with the university to co-create curriculum and programs of study, and where partnering institutions employ over 1,500 students as interns or full employees, and connected this innovation to changes in the global labor landscape. Mr. Boney discussed how the rise of skilled labor forces around the world, especially in China and India, has combined with AI and widespread automation to disrupt both blue- and white-collar occupations. He characterized the current U.S. economy as a "barbell" economy, where opportunities abound for low- and high-skill jobs, but middle skill jobs are disappearing. He said this problem was exacerbated by a shortage of labor in the skilled trades, where there are unfilled middle-skill jobs, because of a lack of interest and marketing, leading to issues of an aging workforce.

Mr. Boney then pivoted to the question of workforce skills. He asked the group what hard and soft skills educational institutions should develop in students, offering as an example high satisfaction among employers with graduates' computer literacy but low satisfaction with their writing abilities. He also asked

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what the proper roles were for business and academia in developing these skills, and how they could more effectively partner. He noted that a survey of workers laid off during the COVID-19 pandemic showed many of them want to return to skill, especially if they can do so through their employers, and stressed the need for more lifelong learning opportunities as the economy and job market begin to evolve more rapidly.

Skills vs. Degrees

Dr. Ricardo Ernst of Georgetown University said that employers have traditionally relied on degrees as a proxy for skill sets, but that this was changing as firms begin to place more importance on what graduating students can do rather than what they studied. He said that universities are constrained by their need for revenue, and many view students as customers to satisfy, rather than products to develop, something he said was a mistake. He warned that treating students like customers leads universities to prioritizing what students find most enjoyable rather than what they will need to succeed in the workforce. Dr. Jim Stock of the University of South Florida said this mentality was beginning to change, and that leading universities were emphasizing the skills students develop during particular programs of study. However, he cautioned that this was primarily for required courses rather than electives. Mr. Boney said employers value work experience above all, and that they typically assume students have basic "hard" skills, but want to see they have experience applying them through prior work, apprenticeships, or internships. Conversely, Dr. Carlotta Arthur observed that many firms prefer to hire from a small set of "elite" institutions, and described the difficulties she faced upon graduation due to this bias. She noted minority-serving institutions were especially disadvantaged by this practice, and emphasized that the "degree" mentality is still widespread. Mr. Boney replied that many employers were afraid to break from their standard practices, but that he was hopeful this mindset would decline based on his experiences with organizations focusing more on competencies than degrees.

What Employers Look For

Mr. Evans asked the group what kinds of competencies employers were beginning to look for from new hires. Ms. Stacy Lippa of Target emphasized the importance of creativity, emotional intelligence and communication skills, and data literacy. She described the importance of effective communication when so much work is done remotely and so many conversations carried out over video or email, and of being able to not only understand data, but apply it to challenges facing a company. Dr. Stock said that at the University of South Florida, employers determine the skill sets that the school stresses in its coursework, particularly for the business and engineering schools. He stated that students needed to know how to use particular programs and technologies, not just about them. Mr. Evans added that the Council has also stressed the importance of learning by doing in its reports on skills and workforce readiness.

Incentives in Academia

Dr. Carol Dahl said that the discussion raised the issue of rethinking education delivery, and of aligning incentives for both K-12 and higher education. She spoke of the need to educate students for a world that is constantly changing, and that many university professors are concerned more with research than with teaching. This is due to both the primacy of research in determining tenure, as well as the lack of training professors receive on how to teach students and engage with them effectively. She detailed her experience of receiving no instruction on how to teach when she was in academia, and said developing professors' teaching ability was the key to developing successful lifelong learning programs. Dr. Ernst concurred on the problems of incentive alignment, and asked how universities could leverage incentives to encourage professors to focus more on teaching. He discussed younger professors' reluctance to engage in activities that don't help them secure tenure, and warned that greater collaboration with employers would not be effective if universities did not align incentives for professors to be responsive to employer needs.

Mr. Boney tied these issues to the "student as customer" mindset, and added that while in the long-run parents would be more satisfied if their child's school prepared them to get a good job, universities were mostly focused on the short-term. Dr. Dahl asked if there was a way to tie funding to post-graduate outcomes, or encourage industry to engage with academia through funding of programs rather than just transfer of intellectual property, as ways to encourage academia to focus on workforce readiness. However, Dr. Arthur warned that many universities, especially elite universities, viewed themselves as educating students for life rather than for careers, and might balk at a "short-term" focus in education. Dr. Stock said that schools could learn from existing best practices, such as the state of Florida's funding allocation mechanism that is based on universities' abilities to develop skill sets in their students that have been identified as crucial by employers. Dr. Ernst discussed the idea of an SAT-like exam that would provide a standardized certification of skills for students across educational institutions. If developed by employers, it would be an accurate benchmark of students' employability, and would not discriminate based on the reputation or perception of a student's alma mater. Finally, Dr. Dahl worried that many of the skill sets employers desire need to be developed before a student reaches higher education, and that too much focus on universities would be ineffective in developing students' skills.

The Role of Employers

Participants discussed how employers should become involved in designing curriculum, and how they should communicate their needs to academia. Dr. Stock described how firms regularly consult with USF's business school to help design the curriculum for the supply chain management major, and how this has resulted in nearly 100 percent of graduates getting employed in the field or going to graduate school, as well as the highest starting salaries of any major in the business school. He also mentioned the major's internship requirement as a key to building relevant experience for students. Dr. Stock added that firms want new hires to be contributors right away, and want schools to train them in specific software programs and practices. He said these skills were as important as general skills like writing and communication. He characterized firms' opinions of schools and their graduates, as reflected in their hiring decisions, as being the ultimate arbiter of a school or professor's quality, rather than its reputation within academic circles.

Mr. Jonathan King of Southern Company discussed the importance of adaptability for his company's employees. He said that with his firm comprising 80 different companies within its footprint, it was imperative for employees to be able to move to different roles and continue to be able to solve problems. He also discussed the importance of partnerships with academia and labor. One third of Southern Company's workforce is craft labor, and Southern Company has co-designed curriculum and accreditation programs with both community colleges and labor unions for the building and electrical trades. Ms. Tiffany Davis of Southern Company added that they have seen a significant improvement in the talent pool as a result of these partnerships. Mr. Boney described the change in employers' expectations of higher education over the years. Firms today expect schools to train students in specific workforce-relevant competencies, whereas in years past the role of schools was to teach basic skills while employers trained new hires for specific jobs. Dr. Stock echoed this observation, and added that schools now solicit input from firms on curriculum design rather than just financial donations. He added that USF was increasing its emphasis on working in disruptive environments in response to the COVID-19 pandemic. With a mindset of resilience in the face of uncertainty, workers will be able to respond to both familiar and novel emergencies, and curriculum can provide a structure for approaching disruption. Dr. Ernst noted

that companies that provide input on curriculum design can also scout potential hires up close, as they can see if the school is instilling the needed competencies in its students. Dr. Arthur expressed concerns that more accreditations and certifications might provide an additional obstacle for underserved students, and asked how these programs would be paid for, as well as whether employers were willing to invest in their employees. Dr. Stock said that at USF, the school negotiates discounts with the firms providing the certification services, and that it provides scholarships for students who cannot afford them.

Conclusion and Next Steps

Ms. Trimble encouraged the group to continue the conversation via the online portal. She also outlined the schedule for the rest of the week, including this Friday's upcoming call from 2 to 3 PM.

Working Group 2 Calls April 24

Introduction

The Honorable Deborah L. Wince-Smith and Ms. Kathy Trimble welcomed the group, and Ms. Trimble introduced the guiding questions for the discussion, focused on sustainability in production and consumption. She then introduced the two opening speakers, Dr. Tommy Gardner of HP Federal, and Ms. Ciannat Howett of Emory University.

Opening Remarks: The Business Case for Sustainability

Ms. Howett laid out the business case for sustainability, and the importance of sharing with industry the economic benefits of greater resource efficiency. She cited research showing that companies with Environmental and Sustainability Goals outperform other companies, and that large companies benefit in particular from commitment to sustainability. She said that work done by Bob Willard at IBM found that small companies committed to sustainability grew on average by an additional 51 percent in their first 3-5 years, and that large companies with a similar commitment grew by an extra 81 percent on average in their first 3-5 years. Ms. Howett also discussed the recent trend in corporations' sustainability reports being focused on the UN's Sustainable Development Goals framework, and have also been paying more attention to diverse, locally-sourced supply chains that incorporate small businesses.

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Opening Remarks: The Importance of Examples

Dr. Gardner discussed his experience working at one of the largest, and most sustainable, countries in the world, and the importance of leadership by large firms. He noted that because of their scale, large companies are in the best position to create a tangible impact from sustainable behavior, and to inspire other firms to imitate them. He also stressed the need to use case studies and examples to educate corporate leadership about the benefits of sustainability and offer them proof of concept. He gave the example of CAFE standards for automobiles in the United States, which were initially opposed by car manufacturers but ended up spurring increases in efficiency that improved their bottom lines due to increased consumer demand and new discoveries resulting from sustainability research. Mr. Chad Evans agreed on the importance of case studies, and discussed the Council's showcasing of PepsiCo's sustainability efforts in the primer to the National Commission's January Launch Conference in Arizona.

Economic Benefits of Sustainability

Dr. Ricardo Ernst of Georgetown University said he was glad to the group's emphasis on sustainability, as it had become an increasingly important topic for businesses even before the COVID-19 pandemic disrupted supply chains. He discussed a shift in mindset from individual components of supply chains trying to economize on costs for efficiency's sake to companies taking a holistic view of their supply chain and identifying ways to make the chain as a whole more effective. He gave an example of a company spending to build a healthcare facility near one of its plants. The extra up-front costs pay off in the long run because of improvements in employee health, morale, and productivity. He added that companies were beginning to share best practices across their industries because they believed widespread adoption of these norms benefits them in the long run, as competitors striving for sustainability generates new ideas, and a set of best practices that makes all players in the industry more efficient develops through synergy. Dr. Ernst suggested the group compile a report highlighting examples of sustainability benefiting companies to catalyze corporate interest. Mr. Evans noted that the Council had found that 85 percent of S&P 500 firms had a sustainability report in 2017, 52 percent said climate change and sustainability were important concerns, and 40 percent reported investor pressure for sustainable practices. Ms. Amy Lientz of Idaho National Laboratory said her lab was forming more partnerships with companies to improve sustainability as those firms began to realize the extent of consumer demand, but worried that this demand would diminish with the advent of record low prices for fossil fuels.

Disconnects and Implementation Challenges

Dr. Carol Dahl of the Lemelson Foundation described her organization's discussions with businesses about adopting sustainability, and the disconnect she found between the enthusiasm of senior leadership and certain departments, like public relations, and the inability to install best practices in sustainability throughout the organization. She asked what companies were looking for from their workforces in terms of mindset and skill sets, and how they could accelerate a mindset for sustainability in employees. Ms. Howett noted similar challenges, including widely varying quality in corporate sustainability initiatives, and pointed out that often foreign companies are the leaders in successful sustainability policy. She expressed hope that sharing case studies of sustainability improving productivity, employee retention, and brand loyalty would spur other firms to increase their focus on sustainability.

How to Incentivize Sustainability?

Mr. Bill Bates asked whether market incentives would be sufficient in spurring adoption of sustainability measures by companies, or whether the government would need to intervene. Dr. Gardner said that the government would be most effective by setting standards and encouraging norms, but

allowing companies to develop their own methods of achieving broad goals, as this would encourage more innovation and potentially result in larger sustainability gains that could come from government mandated practices. Dr. Mike Goodman of the University of Massachusetts-Dartmouth expressed disappointment in the track record of deregulation in incentivizing sustainability, while Dr. Ernst suggested developing certification criteria to encourage changes in corporate behavior. He said well-designed sustainability criteria could become a proxy for quality, and encourage companies to take pride in their environmental responsibility. Ms. Carol Ann Meares of Tech Vision 21 likened such a program to the Baldrige Awards for quality in business practices, which she noted were used as benchmarks by companies even when they did not compete for the award. Dr. Gardner used the example of corporate responses to COVID-19 to illustrate the power of norms and expectations in shaping companies' decisions. He noted that companies were offering assistance even when it hurt their bottom lines because they believed it was the right thing to do, and suggested widespread pressure to adopt sustainability standards could reach a "tipping point" where they became universal. Mr. Evans offered the Global Federation of Competitiveness Councils' Competitiveness Principles, which are mapped to the Sustainable Development Goals, as a potential framework for evaluating corporate sustainability.

Unique Challenges Facing Small Businesses

Dr. Jerry Haar of Florida International University expressed concerns that small and medium-sized firms, especially distributors and suppliers working with major firms, would fail to appreciate the importance and benefits of sustainability, citing his own conversations with small business owners. He said "elite" firms had done a poor job in conveying the importance of sustainability, with relatable examples, to smaller firms. Ms. Howett noted that Bob Willard's studies at IBM found significant growth benefits for small businesses from adopting sustainability practices, including from reductions in energy cost and wasted materials. Mr. Evans said that the Council previously used a public-private partnership to correct a similar disconnect between small and large firms regarding the importance of high performance computing and advanced modeling and simulation. Working with the White House and Department of Commerce, the Council created a program to connect small and large firms and bridge gaps of resources and understanding. As a result of the program, small firms gained knowledge of how high performance computing could enhance their own businesses, expand market opportunities, and improve relationships with suppliers. He said a partnership to convey similar information about sustainability would be interesting to explore.

Solutions for Small Businesses

Dr. Haar suggested developing a certification program for small businesses to encourage uptake of sustainability best practices, in which large firms provided technical assistance in transforming their operations. He added that certification could become a signal of quality to firms' potential customers. Dr. Dahl worried that firms in industries where there were not large buyers with the leverage to encourage best practices would lack the inclination and the resources to retool their businesses. She wondered whether some form of assistance might be necessary to help small firms make the necessary investments in sustainability. Dr. Haar said that the key to encouraging change was in leveraging intermediary organizations consisting of peers to make the case to small businesses for sustainability, and likened such efforts to political campaigns that win voter support through relatable messaging.

Best Practices and International Examples

Throughout the discussion, participants identified domestic and international examples of guidelines and best practices that could help companies improve their sustainability. Dr. Maya Trotz of the

University of South Florida shared several examples, including the UN Global Compact's report on Sustainable Supply Chains and the American Chemical Society's 12 Design Principles of Green Engineering. These documents provide best practices, case studies, and other resources. Dr. Trotz also expressed interest in learning how firms were instilling commitment to sustainability in their workforces, and in how they were connecting with and developing customer bases hungry for environmentally friendly products. Dr. Goodman highlighted the EU's environmental certification guidelines, and urged the group not to "reinvent the wheel." Finally, Dr. Dahl shared the nonprofit VentureWell's Environmentally Responsible Engineering Guidelines.

Local and Regional Governments and Sustainability

Ms. Trimble asked how to encourage commitments to sustainability by state and local governments and other non-corporate entities. Ms. Howett detailed Emory's efforts to encourage sustainability in the greater Atlanta region, including programs to purchase recycled water and to purchase land in the region to establish sustainable farms. In addition to providing local, environmentally responsible food sources, the latter initiative addresses problems of aging and lack of diversity in the agricultural workforce, and helps increase food security in a region of the United States that will be heavily impacted by climate change. Dr. Trotz also mentioned the city of Atlanta's water-recycling project as a useful case study.

Sustainability, Urbanization, and COVID-19

Dr. Gardner described how engineers were turning their attention to sustainable production of food in a world with an increasing population and growing demands on resources. He mentioned vertical farming as a practice that enhanced productivity and reduced resource usage, and noted that increased density in living patterns reduces transportation costs and pollution and improves the efficiency of mass transit. Mr. Evans discussed predictions from the first Working Group that the COVID-19 crisis might reverse urbanization trends as people became uncomfortable living in densely populated areas. Dr. Goodman said it was too early to tell what the long-term effects of the pandemic would be, and noted that jobs and healthcare were concentrated in urban settings. Dr. Gardner acknowledge the possibility of reversal, and added that the pandemic could permanently reduce demand for air travel, as people increasingly choose to meet virtually rather than spend time and resources traveling around the country or world. Ms. Howett also emphasized the importance of proximity to healthcare in people's housing decisions, and Dr. Trotz suggested the pandemic might lead to a rethinking of housing for the urban poor, who are at greater risk because they rely more on public transit and often live in older, poorly ventilated buildings. Ms. Meares directed the group to Council Chairman Emeritus Mr. Chad Holliday's article "Production, Place, People: The Sustainability Opportunity for Business" for an in-depth exploration of these topics.

The Role of Large Businesses in Pioneering Sustainability

Ms. Wince-Smith encouraged the group to consider the role large firms play in driving sustainability practices. She discussed the Council's work with Wal-Mart, profiled in Drive (2009), and how Wal-Mart's requirement for suppliers to meet sustainability metrics throughout their supply chain transformed business practices throughout their supplier network. She said other large companies, including Target and Unilever, had made similar impacts, and noted the importance of these firms to economic resiliency, including after events such as Hurricane Katrina and during the ongoing pandemic. She added that in many parts of the country, large firms like Wal-Mart are the only source of safe, reliable goods, and because of this their sustainability efforts have both societal and bottom-line benefits.

Identifying and Addressing Gaps in Sustainability Adoption

Ms. Howett expressed support for gathering "success stories" of corporate sustainability to encourage widespread adoption of sustainability practices. She said this would have the added benefit of identifying gaps and shortcomings in corporate sustainability efforts and their promotion. She also encouraged the group to think of ways to advance the manufacture of recyclable goods, like biomaterials that mimic plastic, as China has stopped accepting the United States' plastic waste and many products are incorrectly labeled as recyclable. Ms. Howett added that consumers will increasingly demand sustainability, as climate change and the COVID-19 crisis will be seen as harbingers of dramatic future changes.

Dr. Dahl said that many sustainability efforts will require innovations that will come from small firms. She said larger firms mentoring and funding these startups will not only provide needed capital to generate sustainability technology, but also provide larger firms with networks of sustainable suppliers. She noted a lack of venture capital interest in physical products and the low likelihood of short-term funding from the government for such initiatives. Dr. Dahl further stressed the importance of the workforce development pipeline for providing firms with a supply of workers who are skilled in developing and implementing sustainable practices and products. Dr. Haar urged the cross-pollination of engineering and business curriculum in higher education, in which each discipline incorporates basic principles of the other, to improve knowledge of the importance of sustainability and expertise in achieving it.

Concluding Thoughts

Ms. Wince-Smith emphasized the importance of building sustainability into innovation for the future of the economy and the planet, characterizing it as being as vital as improving resiliency in preparing for future challenges. Mr. Evans encouraged the group to examine the resources shared and discussed by the participants during the call, which will be posted to the online portal, and Ms. Trimble reminded the group about the second call on this subject next Monday.

Working Group 2 Calls April 27

Introduction

Ms. Kathy Trimble and Mr. Chad Evans welcomed the group, and Ms. Trimble said the discussion would continue from last Friday's session on sustainability of production. Ms. Trimble then introduced the two opening speakers, Ms. Ciannat Howett of Emory University and Dr. Tommy Gardner of HP Federal.

Opening Remarks: Business Case for Sustainability

Ms. Howett summarized the group's discussion on Friday, which focused on convincing businesses of the benefits of sustainability, and on ways that larger businesses could help drive sustainability in their suppliers. She mentioned The Honorable Deborah L. Wince-Smith's discussion of the success companies like Wal-Mart and Unilever had in spurring sustainability among their suppliers, and of the challenges identified by Dr. Jerry Haar of Florida International University and Dr. Carol Dahl of the Lemelson Foundation around small business buy-in and of large corporations' uneven appreciation of sustainability, respectively. She also discussed Mr. Bill Bates' question about the necessity of government action to inspire sustainability in businesses, and Dr. Maya Trotz of the University of South Florida's highlighting of the importance of equity in sustainability discussions.

Ms. Howett cited the economist Dr. Nicholas Stern in characterizing climate change as the "largest ever externality," arguing that government action would be needed in spurring companies to act more sustainably within the required time window. She also expressed her surprise at the lack of standardization across states in sustainability policy, especially when

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compared to countries and supernational organizations like the EU. She concluded with an example of successful, bipartisan action on sustainability at the state level. In Georgia, environmental groups like the Sierra Club and the conservative Tea Party Patriots group formed the "Green Tea Alliance" to create an allowance for private corporations to help nonprofits take advantage of power purchase agreements to install sustainable energy sources. The nonprofits were unable to take advantage of tax incentives because of their nonprofit status. Ms. Howett also described the difficulty of updating building codes for Emory's medical facilities to reduce their carbon footprint. She encouraged the Commission to identify other opportunities for bipartisan action on clean energy, recycling, and other sustainability measures at the federal level.

Opening Remarks: Convincing Corporate Leadership

Dr. Gardner discussed the importance of illustrating to corporate leadership why sustainability was in their best interest, and of using specific examples to underscore this argument. He noted that corporations are motivated by the drive to growth their businesses and make their companies self-sustaining, and to successfully commit them to resource sustainability, they must see how those goals are aligned. He also discussed the difference between regulation and standards-setting. He noted that "you get what you inspect," and that when companies are required to meet specific standards and report on their progress along the way, they are motivated to meet those standards rather than follow procedures without a defined target. He described how HP's use of standards and annual progress reports had enabled it to reach its goal of net-zero paper consumption three years early. He said this goal would not have been met on time, let alone ahead of schedule, without clear metrics.

A Previous Example of Partnership on Production and Manufacturing

Mr. Evans discussed at length the Council's previous work in creating public-private partnerships between Original Equipment Manufacturers (OEMs), their Small and Mid-Sized Enterprise (SME) suppliers, and government. He described how in-kind engagement, training, and support from OEMs makes SMEs more competitive, and how it provides a multiplier effect for OEMs in the form of greater productivity through improved supply chains. He described how the initiative included models of successful partnerships, and added that there was ample opportunity in this space for public engagement and support. In particular, he discussed the use of modeling and simulation in supply chains and the development of specific metrics to ensure progress. Mr. Evans described how the partnership led to 20 pilot programs, 160 new jobs, $20 million in annual revenue, and the development of three new products.

Mr. Evans also discussed the takeaways of this initiative. These include the need for state support whenever a new "industrial commons" or novel infrastructure is needed to support the efforts of an entire industry, as SMEs cannot build this infrastructure on their own, but can pay for access, consulting, and training in using it. Other best practices included deployment of software-as-a-service to help SMEs reduce their time-to-market for new products, buy-in from senior management, clear goals, expectations, and understanding of the efforts required, making the "business case" for the partnership, and providing hands-on support and training. He added that the initiative became the basis for the National Manufacturing Innovation Institute, a much larger effort, on digital design and manufacturing. He said a similar national effort could be adopted for sustainability.

Tailoring Sustainability Metrics

Dr. Jim Stock of the University of South Florida spoke about how companies were changing the sustainability metrics they used, as many of them were costly to measure and not very significant for

the firm's sustainability. He discussed how companies were designing hybrid metrics that incorporated the Global Reporting Initiative's guidelines with their own proprietary metrics, and reporting these in their annual reports, rather than issuing conventional Corporate Sustainability Reports. Dr. Gardner said that sustainability standards needed to be tailored to different sectors, and that encouraging companies to compete to best meet those standards would facilitate the adoption of best practices as firms incorporated successful practices from their competitors. He added that consumer demand for more sustainable products creates further incentive for companies to strive to meet sustainability benchmarks. Ms. Howett said that external metrics were better than company-designed metrics for sustainability, as they enabled easy comparison and were designed by disinterested third parties.

Efficient vs. Resilient Supply Chains

Dr. Ricardo Ernst of Georgetown University discussed the distinction emerging between "efficient" supply chains, that strive to economize on inputs and resources, and "effective" or "resilient" supply chains, that are most robust against stress tests and ensure best results for end users. He said firms should begin thinking of competition as their supply chain competing with other firms' supply chains, rather than firm vs. firm. He said the "black swan" event of the COVID-19 pandemic was leading companies to rethink the potential benefits of redundancy, and urged the use of case studies to help expedite the adoption of this thinking, suggesting this as an idea for the Commission. Dr. Gardner characterized resilient supply chains as geographically diverse supply chains, where a disaster in one part of the world would not shut down the business's entire operation. He discussed his work on identifying threats to the U.S. economy with the Department of Homeland Security, and how he identified diversity of suppliers as the key to coping with natural disasters. He noted that HP has over 10,000 suppliers around the world, and if one is affected by a crisis, the company has numerous alternatives.

Dr. Ernst also distinguished between having a single supply chain and having a portfolio of supply chains. He described how companies benefited from tailoring their supply chains to specific products. He gave the example of a company locating its supply chain for a good with steady and limited market demand abroad for cost efficiency, while locating its supply chain for items with more varying and quickly shifting demand domestically to enable quicker response to market fluctuations that won't be disrupted by crisis. This duplicative supply chain structure also enables the firm to shift production from one chain to another in the event of a "black swan" event like a pandemic. He again discussed the importance of providing concrete illustrations of the benefits of "leveraging variability" through multiple supply chains, and noting that a one-size-fits-all approach generates mediocrity as the most efficient producers and suppliers are balanced out by the least efficient. He argued that a tailored portfolio of supply chains would maximize the potential of each link in each chain.

Climate Change and Sustainability

Ms. Howett pivoted to Dr. Trotz's idea of "ramping up" production for the COVID-19 pandemic, and discussed the need for a similar "ramp up" to deal with climate change in the needed time window. She mentioned the Sweden-based Center for Resilience, and similar institutions in South Africa and Australia, that focused on proactive development of resiliency in the face of crises. Ms. Howett urged the creation of a similar center in the United States, noting that university-affiliated disaster preparedness studies centers tended to be reactive rather anticipatory. She envisioned such a center as including collaboration between universities, industry, all levels of government, philanthropy, and the scientific community. She compared this idea to the Jet Propulsion Laboratory developed during World War II at Cal Tech, which helped the United States develop effective rockets before the Third Reich, and which was later instrumental in the Space Race with the

Soviet Union. Ms. Howett said this quick, "think tank" approach was essential in combating climate change. Dr. Carol Dahl of the Lemelson Foundation asked to what extent companies considered their carbon footprint in developing their supply chains.

Trends Towards Consolidation in Agriculture

Dr. Kathleen Merrigan of Arizona State University expressed her concern that government stimulus programs to help the food production and agricultural industries would reinforce the existing, rigid supply chains in those sectors, as policy makers focused on shoring existing firms up. She warned that such a policy would drive greater consolidation among a handful of large firms, and that this would leave the system more vulnerable to the next stress test. She asked how to encourage policy makers to be forward-thinking in crisis response. Ms. Carol Ann Meares of TechVision 21 noted the tension between building long-term relationships with suppliers, which encourages the consolidation of a firm's supply chain, with the need for diversity and resiliency. She said it was important for firms and government officials to strike a balance between these two models.

Thinking Holistically About Value Chains

Ms. Stacy Lippa of Target said that companies were beginning to bridge gaps between different elements of their production, including merchandising, sourcing, and supply chains. In particular, she noticed these changes in the food industry, which is working to improve traceability and transparency in its supply chains. Ms. Lippa spoke of the importance of understanding the "circular value chain," incorporating raw materials, human resources, and common standards, and the learning networks necessary to ensure all stakeholders contribute to the firm's value stream. She said more holistic thinking allows stakeholders to see how changes in one part of the production process impact the rest of the value chain, and that this integration was crucial to ensuring sustainability throughout a firm's supply chain and production process. Dr. Gardner said that emphasis on sustainability across the value chain encourages firms to focus on product design. If they must spend more on supply chains to ensure they are both resilient and resource efficient, the only way to increase or maintain their profit margins is by redesigning their products to generate less waste (and cost) in production.

Revamping Universities to Address Sustainability

Ms. Lippa asked how the academic world was working to shape its curriculum to account for the importance of sustainability. Dr. Merrigan discussed the emphasis at Tufts University on co-creation of knowledge between academia and the wider community, and discussed Arizona State's efforts to develop tailored certificate programs for specific audiences. During the COVID-19 crisis, ASU is working to certify unemployed chefs on plant-forward cooking, and Dr. Merrigan spoke of the need to improve the availability, customization, and quality of online education. Dr. Ernst described Georgetown's efforts to use corporate leaders as a sounding board for curriculum design in its business school. He said that while the internet means answers are abundant, the challenge in education is asking the right questions, and that industry feedback helps academics design curriculum that focuses students minds on the questions that companies most want answered. He linked this mindset to the skills-not-degrees paradigm shift in higher education that develops students who can solve problems.

Developing Certifications for Sustainability

Dr. Ernst also advocated for the Commission to develop a set of standards for sustainability that could be used to certify businesses in a similar fashion to the Baldrige awards for product quality. He said widespread adoption of these standards would spur an economy-wide push toward sustainable business practices. Dr. Gardner agreed with the idea, but questioned how to balance the need for certi-

fications tailored to each industry with the costs of doing so. He warned that one-size-fits-all standards would be less relevant and set to the lowest common denominator. He suggested using engineering certifications, which include a basic general certification followed by more extensive certifications in particular fields like civil or mechanical engineering, as a potential model.

Dr. Ernst suggested the group devote more time to fleshing out the idea of standards and certification development if it was worth pursuing, and suggested using the Baldrige criteria as a blueprint for a baseline sustainability metric, with input from group members' companies in designing industry-specific criteria. Ms. Howett suggested the Sustainable Accounting Standards Board's model of certification as a blueprint for highly sector-specific standards, and urged the development of a national research agenda for corporations and universities around climate change. She said stakeholders needed to identify the most important things they did not know and use them to identify specific research questions to focus climate change mitigation efforts more effectively.

Dr. Stock discussed his belief that research on sustainability metrics and the development of certification programs would come from university-affiliated think tanks and research centers, rather than "traditional" academia. He described one such effort at USF on supply chain management, which includes senior executives from a variety of industries on conjunction with university faculty. He said that if lots of universities and companies participate in these initiatives, the collective benefits to society will be substantial. He also discussed the tradeoff between including suppliers at all levels of supply chains in discussions of sustainability and making the complexity and logistics of such discussion manageable.

Ensuring Certifications Do Not Produce Obstacles

Dr. Carlotta Arthur of the Luce Foundation warned that certifications costing money could disadvantage women and minorities, as well as women- and minority-owned businesses, as they were less likely to have the resources required to complete such programs. She discussed how she did not pursue an engineering certification after graduation due to the prohibitive costs, and she encouraged the group to think of ways to mitigate this and ensure that any certification programs were open to businesses and individuals regardless of background or resources.

Dr. Merrigan echoed this sentiment, and urged higher education to rethink its structure in order to improve its affordability. She discussed her desire to recruit more students from underrepresented backgrounds and the cost challenges providing full scholarships presents. Ms. Howett agreed and said that racism and poverty were "perversely resilient" systems that would require targeted measures to address and disrupt.

Concluding Thoughts

Dr. Gardner continued the theme of the importance of diversity, relating his experience with online games. He said that players from different backgrounds came up with different approaches and solutions to problems, which expedited discovery and innovation. Dr. Gardner described how the same principle applied to academic and corporate efforts to answer research questions and solve problems.

Ms. Howett described Emory Healthcare's position that the healthcare industry will not return to its old normal following the pandemic, and said it would be wonderful if the group could develop a positive vision for the United States moving forward that is not an attempt to return to normal. Instead, the focus should be on making the United States better, stronger, and more resilient in the face of future challenges.

Ms. Trimble said that in the weeks going forward, the group would engage in deeper explorations of the topics discussed today.

Working Group 2 Calls May 1

Introduction

The Honorable Deborah L. Wince-Smith welcomed the group and discussed the unconventional format of the day's call, which was focused on drawing on the Council's past work as a framework for promulgating recommendations and reinvigorating and updating the Council's message to reflect new challenges and the ongoing importance of sustainable production and consumption. She noted that the Council has been involved in thought leadership around clean energy, advanced manufacturing, and their intersection since 2008. She discussed past Council engagement with sustainability and low-carbon technology, and the Council's dialogue with the Obama administration on these issues. She described how the Council's work in this space underscored the importance of manufacturing in establishing clean energy supply chains, and prompted a series of sectoral explorations on the convergence of advanced manufacturing and energy. These efforts culminated in Accelerate (2018), which provided a portfolio of insights, thought leadership, and actionable recommendations.

Mr. Chad Evans discussed the Council's National Innovation Initiative, which culminated in Innovate America (2005), and its connection to the present work of the National Commission. This initiative provided an innovation agenda for the country, and foreshadowed tremendous transformations in both energy and manufacturing that would shape the Council agenda for the next decade. In particular, the renaissance in U.S. manufacturing made possible by a changed energy landscape inspired numerous Council initiatives that are predecessors for the National Commission. Mr. Evans cited these previous initiatives as examples of prior reforms and recommendations that the National Commission can build on, draw inspiration from, or even revive if they remain relevant.

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Past Council Initiatives

Mr. Bill Bates provided further background on previous Council initiatives on energy and manufacturing. He discussed the Energy Security Innovation and Sustainability Initiative, which ran from 2007 to 2009 and included a "First 100 Days" plan for both presidential campaigns in the 2008 election, called Prioritize that included goals for energy efficiency, infrastructure investments, technology breakthroughs, and workforce development. This publication was later expanded into Drive (2009), which laid the foundations for much of the Council's future work. Shortly afterward, the Council commenced the U.S. Manufacturing Competitiveness Initiative, which focused on generating a manufacturing renaissance in the United States and led to the publication of Make (2011). Make focused on five challenges: fueling the innovation and production economy, expanding manufacturing exports, leveraging smart manufacturing to unleash next generation productivity, fostering talent development, and upgrading and updating manufacturing supply chains and logistics. Many recommendations from Make were implemented, including the creation of regional manufacturing hubs to boost advanced manufacturing, and the Council pivoted to working on the intersection of clean energy and advanced manufacturing.

Public-Private Partnerships and the AEMC

Mr. Evans discussed the Council's work during the transition between President Obama's first and second terms on using high performance computing, modeling, and simulation to enhance productivity in advanced manufacturing, which inspired the Advanced Energy and Manufacturing Competitiveness Partnership (AEMC). The Council proposed the AEMC to the Department of Energy's Office of Energy Efficiency and Renewable Energy, and had the dual goals of improving competitiveness in the production of clean energy products and improving manufacturing competitiveness writ large through increased energy productivity. This project ran from 2013 to 2015 and included the development of public-private partnership initiatives to advance these goals.

Much of the groundwork underpinning the public-private partnership recommendations flowing from the AEMC was laid by the Council's work on public-private partnerships in December 2012 and January 2013. During this period, the Council researched over 190 such partnerships from around the world related to energy and/or manufacturing competitiveness, and developed a framework for establishing successful public-private partnerships from this research. In The Power of Partnerships (2013), the Council investigated obstacles to U.S. leadership in manufacturing clean energy and energy efficient products. It found that high capital requirements, a lack of national innovation infrastructure, low investment in advanced manufacturing, large structural costs, and cyber infrastructure challenges all contributed. The Council also identified essential ideas and strategies for co-creating successful clean energy and manufacturing public-private partnerships. These included strong leadership, a clear and compelling mission, early funding from the public sector, and flexible intellectual property practices to entice corporate participation. The Council's work on these partnerships catalyzed nine regional dialogues, four national summits, and three webinars, as well as the creation of a Clean Energy and Manufacturing Analysis Center. This center was established in Colorado in conjunction with the Department of Energy, and helped rebuild U.S. manufacturing infrastructure and launch over $1 billion worth of new public and private investment. Notable projects funded by these investments include a network linking national laboratories working on advanced materials.

Other Council output during this time frame included a new public-private partnership for high performance computing in energy, manufacturing, and materials that not only continues to the present, but has expanded to encompass transportation. The Council's work on partnerships led to two other public-private partnership ideas: a Clean Energy Mate-

rials Accelerator to de-risk investment in products and provide new standards for novel technology, and a Manufacturing and Energy Technology Accelerator to provide a platform linking labs, corporations, and other stakeholders for the development of new products and services. The Council established five criteria for evaluating partnership ideas. The proposed partnership must address a high-impact problem, the public sector must be capable of making a large impact relative to private efforts alone, the problem addressed must be broad enough to concern the public sector but open to new approaches and performers, government participation and investment must have an enduring economic benefit, and government participation and investment must not duplicate or crowd out the work of the private sector.

The Energy and Manufacturing Competitiveness Partnership

Mr. Bates discussed the Energy and Manufacturing Competitiveness Partnership (EMCP), a private-sector analog to the AEMC that resulted in six sector-specific studies that took deep dives into the intersection of manufacturing and energy for water, agriculture, energy, aerospace, advanced materials, and biosciences. Each sector study put forth specific recommendations, and the Council also published an overarching report, Accelerate, in October of 2018. During this process, the Council found cybersecurity to be such an important cross-cutting issue that it amalgamated the cyber-specific recommendations into Secure, published in December of 2018. Important recommendations stemming from these reports span regulations, infrastructure, the energy market, research, scaling technology, the Internet of Things, big data, workforce development, and cybersecurity.

Accelerate encourages states and local governments to experiment with new, more effective regulatory regimes that foster innovation, including Arizona's allowance of autonomous vehicle experimentation on its roads. The report also encouraged making permanent the executive order that two regulations be repealed for every new regulation issued in order to lighten the regulatory burden. The report repeated the Council's longstanding call for greater infrastructure investment, and Mr. Bates characterized the lack of action on this front during a period of low interest rates as a missed opportunity for the nation. Because much of America's infrastructure comes with high legacy costs, the Council called for setting aside a percentage of infrastructure spending for research on "leapfrogging" technologies that would allow the telescoping of infrastructure improvement, such as moving directly from landlines to 5G technology. The report also urged expanding investment in nuclear energy and modernizing the power grid. In particular, the Council called on states to allow utilities to recoup R&D investment in the form of rate increases, and to allow them to depreciate equipment more rapidly.

The Council issued many recommendations governing research in Accelerate. These include establishing a baseline of 1 percent of GDP for federal research funding and developing a national research agenda prioritizing disruptive technologies with major economic and societal impacts through the position of a national Science Advisor. Other recommendations included continued support for the Manufacturing USA institutes and investments in advanced technology, better technology transfer policies including streamlined and simplified intellectual property rules, and funding to help technologies scale successfully (crossing the "Valley of Death"). With the major impact the rise of sensory technology and the "Internet of Things" will have on resource use and efficiency, the Council called for incentivizing investments in these technologies, as well as developing uniform standards and security features in consultation with stakeholders. Finally, the Council advocated the creation of a federal verification system for crowdsourced data, to ensure that firms could productively use the information generated by the "data tsunami" to draw valuable insights.

Issues to Consider with Commission

Ms. Wince-Smith mentioned subjects that previous Council efforts have not addressed, including the security of America's healthcare, pharmaceutical, and medical device supply chains, as well as rare earth minerals. She noted that Chinese dumping on the U.S. market had devastated the domestic rare earth market, but that many initiatives were underway in the United States to develop sustainable synthetic rare earth minerals, including one at the Colorado School of Mines. Mr. Evans also discussed the potential for the group to discuss additive manufacturing, including the emerging fields of 4D and 5D manufacturing. He also stressed the importance of U.S. leadership in advanced microelectronics, noting that new microprocessors would have massive ramifications for energy efficiency and sustainability in advanced technologies across all sectors, and that the investments required for new technology were too large for any single stakeholder.

Dr. Maya Trotz of the University of South Florida discussed the Council's previous engagement with the Energy 2030 roadmap, and asked how much of it remained relevant. Mr. Evans noted that the current administration had prioritized other initiatives, but added that it was an interesting avenue for further exploration. He said it provided an interesting roadmap for many sectors of the economy to transform their productivity. Mr. Evans emphasized the importance of sustainable production and consumption for the group, as it was the only working group with sustainability as a key part of its mandate. Dr. Carol Dahl of the Lemelson Foundation observed that many of the Council's previous energy recommendations could be updated with a simple pivot to low-carbon, carbon-neutral, or carbon-negative technology and remain highly relevant. She spoke of the need to prioritize investment in carbon capture and reuse technologies because of lack of federal or investor interest in a potentially substantial market. Ms. Ciannat Howett of Emory University discussed how the COVID-19 pandemic had actually bolstered renewable energy markets because of the collapse of fossil fuel prices from reduced demand and the increased effectiveness of solar panels due to reduced air pollution. She urge the group to remain alert to the potential implications of the COVID-19 pandemic on sustainability.

Supply Chains

Ms. Trimble asked the group for thoughts on the role of supply chains in sustainability. Dr. Ricardo Ernst of Georgetown University predicted that the substantial disruption to supply chains caused by the COVID-19 pandemic would alter the future policy landscape, potentially altering the relevance of many recommendations concerning supply chain sustainability. He expected increased political considerations for supply chain management in the future, compared to the previous paradigm that prioritized efficiency. He also said he was intrigued by the implications of supply chain relocation on infrastructure. Other disruptions he identified include companies reducing R&D as they struggle to maintain operations with reduced cashflow, as well as changing public demands for sustainable products in the face of disruptive crises. He discussed how a friend's company in Mexico had seen an upsurge in demand for plastic bottles as people became less concerned with sustainability during the COVID-19 pandemic.

Presidential Administrations and Federal and State Policy

Mr. Bates discussed how the political landscape can affect the audience for policy recommendations. He said that with a divided political landscape, it is often easier to find receptive audiences at the state level, and that states are more willing to conduct bold experiments and test out reforms. He expected this to continue if there is no change in administration after 2020, but said that a new administration might be more interested in bold reforms because of the desire to "run with" something new and make a mark on the policy landscape. He encouraged the preparation of federal proposals similar to those in Prioritize for the first 100 days of a new administration in the event of a regime change next year.

Addressing Short-Term and Long-Term Challenges

Ms. Wince-Smith expressed concern at recent GDP and unemployment numbers, and advocated for a large-scale investment in infrastructure to ensure the entire country benefits from the new economy that will emerge from the current crisis. She described how American roads, airports, and wireless connectivity lag behind competitors, and asked how the group could encourage the funding released into the economy as stimulus to flow into developing state-of-the-art advanced infrastructure. She further encouraged making investment in carbon-neutrality a "given", and noted that it was much more difficult for manufacturers to become green than companies providing services. She also discussed feedback from the Council's University membership encouraging focus on the long-term future of the economy, not just short-term challenges provoked by the COVID-19 pandemic, even with the grave stresses universities are facing currently.

Engaging the Public

Dr. Trotz drew on Dr. Ernst's anecdote about plastic bottle production, asking how to ensure continued public engagement on sustainability. She said providing an outlet for the public to be heard was especially important because regulators were relaxing environmental rules for firms, and public concerns about more sustainable commuting and transportation in the Tampa area were falling on deaf ears. Dr. Ernst said that people are very responsive to numbers, and are more willing to engage with stories and narratives when they have quantifiable information. He suggested the group gather these kinds of numbers and begin monitoring their trends during weekly discussions. Eventually, the Commission could publish these numbers, organize them into general topics or clusters, and use these statistics as a "hook" to encourage greater public interest in the Commission's work on sustainability. Mr. Evans responded that this could be a topic of discussion for the Outreach and Engagement Committee, and said that the Competitiveness Decoder, developed by the Global Federation of Competitiveness Councils in conjunction with other organizations, could serve as a starting point for gathering data. The Decoder contains information for over 130 countries spanning over 30-40 years, with over 100 metrics, including many surrounding sustainability, manufacturing, and energy. The Decoder also enables comparisons across countries, within a country over time, and across clusters. He also encouraged members of the group to share other metrics, reports, and interesting materials via the online collaboration portal.

Concluding Thoughts

Ms. Wince-Smith thanked the group for their participation, Ms. Trimble announced that the discussion would continue on the same topic on Monday. In the next session, Dr. Mohammed Zaidi of Braemar Energy Ventures will share his experiences working at Alcoa and in the startup world on putting sustainable production and consumption into practice.

Working Group 2 Calls May 4

Introduction

The Honorable Deborah L. Wince-Smith welcomed the group and introduced the opening speaker, Dr. Mohammad Zaidi of Braemar Energy Ventures. She discussed his experiences both as Chief Technical Officer of Alcoa, where he was involved in implementing sustainability practices in the company's production, and his current involvement in the venture capital space with sustainable companies. Ms. Kathy Trimble expressed interest in hearing his perspective on broader sustainability and security risks facing the economy.

Mr. Chad Evans announced two structural changes for the Commission: the spinning off of a fourth working group focused on Unleashing Capabilities for Work and Entrepreneurship and the pivot for this group toward The Future of Sustainable Production and Consumption; and the introduction of group co-chairs who will lead discussions following the launch of the National Commission's second phase. These changes will begin the week following the June 16th virtual meeting of the Commissioners, and during this period calls will move from twice per week to once per week, and will focus on developing detailed policy recommendations. Each call will include a primer with background information and specific policy proposals for the group to discuss.

Sustainability Threats

Dr. Zaidi identified four major sustainability threats that posed danger to companies and to the United States and world economy as a whole: cybersecurity, pandemics, terrorism/armed conflict, and climate change. He said firms are increasingly focusing on these topics in their Enterprise Risk Management strategies, and warned that both the private and

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public sector were behind the curve in preparing for these threats, which are unpredictable, hard to manage, crippling, and long-lasting in their impacts.

Dr. Zaidi said that cyberattacks and other cybersecurity threats were responsible for $600 billion in economic losses in 2019, with that number set to approach $5 trillion per year by 2023. He characterized this risk as unsustainable for businesses, and by extension, for society. While healthcare, defense, finance, energy, advanced materials, and other major sectors are investing heavily in infrastructure to withstand cyberattacks, they are still behind the curve and face constant attacks designed to blackout cities and cripple computer systems. Dr. Zaidi said companies already have large teams of engineers working around the clock to prevent attacks on America's electrical grid, and that we are still far below the peak level of cyber threats the nation will face in the future.

Another major risk comes from pandemics. Even before the current COVID-19 crisis, many companies, especially those with global operations, were vulnerable to disruption from previous outbreaks, including SARS, MERS, and Ebola. Dr. Zaidi said that attempts to control pandemics are nearly always erratic, and noted that the World Economic Forum had raised the dangers of pandemics to global supply chains at Davos neatly a decade ago. He also warned that for all the devastation of COVID-19, it could become worse if the pandemic reappears or repeats itself in the future.

Wars and terrorism represent a third major threat to sustainability. While there are lots of policies and initiatives designed to counter these threats, the risks to our economic system from terrorism and conflict remain considerable, especially with the advent of cyber warfare. Dr. Zaidi noted with alarm that the Russia-Ukraine conflict represents a new era of large scale electronic warfare, and warned that China represents both a physical and cyber military threat.

Finally, Dr. Zaidi discussed the threat of climate change, extreme weather, and pollution. While this concern is at the forefront for every major business and government, both public and private sector actors are behind the curve in addressing the risks of climate change. Most data indicate that climate risks are continuing to rise, and that government and corporate actions alone will not be enough to address the issue. While investments in renewable energy, carbon capture and sequestration, efficient farming, and waste reduction are all crucial, Dr. Zaidi argued that society as a whole must be given the tools to self-organize for sustainability and better manage risks.

Frameworks and Examples for Addressing Sustainability Threats

Ms. Ciannat Howett of Emory University asked Dr. Zaidi to elaborate on the nature of distributed self-organizing tools. Dr. Zaidi cited the proliferation of information and communication technologies as an example of low-cost, easy to use innovation proliferating organically and dramatically altering society and the economic landscape. He also discussed examples of people creating and installing their own solar panels and other energy efficient technologies, and the growing use of telemedicine to more effectively address health needs in response to the COVID-19 pandemic. Dr. Zaidi said that the proliferation of tools and innovations like these throughout the population will enable people around the globe to begin implementing solutions for sustainability themselves. He also suggested leveraging public policy to encourage the proliferation of these tools and encourage the population to take the initiative on making their lifestyles more sustainable.

Dr. Carol Dahl of the Lemelson Foundation asked what role corporations should play, both individually and systemically, in mitigating the four risks Dr. Zaidi outlined, and whether those risks could be reframed as opportunities. Dr. Zaidi responded that most businesses will invest in mitigation when the business

case is strong, and that businesses initially focus on efficient production before incorporating other concerns as they move along the cost curve. He described Alcoa's long-term, large-scale investments in sustainability that are only beginning to come to fruition, but could reach market values that exceed the current value of the whole company. He added that companies are increasingly developing protocols to address specific risks and their responses to them. Dr. Tommy Gardner of HP Federal discussed his advisory work with a Department of Homeland Security task force on threats to supply chains, and said that the group had identified 282 different supply chain threats across nine broad categories. He added that the CARES Act directs the National Academies to examine the risks to America's supply chains from pandemics, particularly those relating to health care, and said that disruptions in one supply chain will cascade into other sectors as markets try to reestablish themselves in the wake of the COVID-19 pandemic.

Ms. Amy Lientz of Idaho National Laboratory noted that many national laboratories are doing extensive work on cybersecurity and critical infrastructure protection. She encouraged the group not to duplicate the efforts of other groups and tasks forces in this space, and she suggested approaching these groups to see if they would share findings and information with the working group. Ms. Wince-Smith supported this idea, and asked if participants would be willing to volunteer to approach task forces or groups in their networks. She stressed the desire to build upon, and not simply rehash, the work of other groups.

Dr. Zaidi discussed the real-world applications of risk mitigation in the case of extreme weather. Citing studies that estimate the costs of repairing damage from extreme weather to be seven times the costs of investing in prevention, he said there was already a strong business case for infrastructure resilience, and forecasted trillions in new spending on these efforts in the United States and around the world.

Examples of Sustainable Production

Dr. Zaidi continued his remarks with several examples of sustainable production in practice. Most of these involved renewable energy and energy efficiency, but some also involved cybersecurity investments. One example is the rapid adoption of renewable and low carbon energy as its price declines relative to fossil fuels. He cited the example of a utility in Florida that converted a planned natural gas plant into a solar plant because of the rapid cost reduction in solar panels. He also promoted the idea of a circular economy, in which waste from production is used in creating new products rather than thrown out. In Japan, a government mandate banning the dumping of fly ash from power production into landfills inspired engineers to develop a way to turn it into cement for construction. Dr. Zaidi said these types of policies are easy to implement and should be adopted globally.

Other examples of sustainability in practice come from Dr. Zaidi's former company, Alcoa. Thirty years ago, Alcoa pledged to plant 1.3 trees for every tree it cut down during its mining operations, and also developed a means of pumping carbon dioxide underground, reducing the pH of mining waste and allowing livestock to graze on the green space above aluminum mines. He said that besides gaining community support as consumers increasingly demand sustainable products, these measures drastically reduced Alcoa's costs by reducing the expensive hazards stemming from mining waste, and enabled Alcoa to secure much longer leases and extensions on its aluminum mines than other resource extraction firms can secure. Alcoa has also made use of locally abundant but difficult to transmit hydroelectric power at many of its locations in countries like Iceland, and now generates 70 percent of its power supply via hydroelectricity. Yet another sustainability-enhancing innovation is the development inert anodes that enable companies to generate oxygen, rather than carbon dioxide, during the aluminum mining process.

While Alcoa has invested hundreds of millions on developing this technology over the years, it only recently made it to market, with Apple purchasing zero-carbon aluminum for laptop casings.

Alcoa has also retrofitted its facilities to use recycled aluminum, resulting in a 90 percent reduction in energy use, and Dr. Zaidi described efforts by beverage companies to produce containers that do not make use of fossil fuels. He described a college-aged inventor's solution for a non-plastic bottle that he predicted would be purchased by major producers, as well as Coca-Cola's development of a plant-based bottle.

Another arena where sustainability has been put into practice is additive manufacturing, or 3D printing. Dr. Zaidi predicted that most companies working on producing the same product at lower prices will fail unless they incorporate new functionalities only available from additive manufacturing, which significantly reduces waste in production. He also discussed how one of Alcoa's subsidiary companies is using additive manufacturing to produce airplane parts. Companies are also investing AI and sensors to reduce wasted energy while lowering costs and emissions. "Early warning systems" using these technologies can identify accidents, inefficiencies, and even cyber attacks with record speed, enabling much faster response times and easier mitigation. Dr. Zaidi said that utilities were already implementing these systems, and went so far as to suggest they become mandatory for future plants and facilities as part of the permitting process. He closed his remarks by reiterating his call for all of society to take the initiative in using self-organizing tools to adopt and promote sustainable behavior, as he did not belief government and industry action alone would produce change on the necessary scale.

Cultivating Talent and Workforce for Sustainability

Dr. Dahl asked if there was a sufficient talent base for companies to begin incorporating and developing sustainable technologies and practices, and what could be done to improve the talent pool. Dr. Zaidi said there was a shortage of necessary talent, especially in fields like AI and autonomous systems. He said this was especially true for firms like Alcoa, who get outbid for top talent by big tech companies. However, he noticed during his time at Alcoa that the company's reputation for sustainability was a major draw for talented applicants, and suggested that companies invest in sustainability as a method of attracting talent.

Venture Capital, Startups and Test Beds

Mr. Evans asked Dr. Zaidi about his concerns in the startup field, given the importance of small and medium-sized firms to future innovation. Dr. Zaidi identified connectivity between universities and entrepreneurship programs and the needs of the market as a major issue. He said that venture capital invests $50 billion, and other entities like large firms a further $30 billion, in startups, but that much of that will be wasted if startups, including those spun off from university research, don't understand what will work in the marketplace. He said there were around 1,000 different startups working on energy storage, but they were not connecting with investors in a way that made economic sense. Dr. Zaidi expressed particular concern about the belief that startups primarily need money from larger firms, when access to test beds is a much larger obstacle for scaling innovations. He described Braemar's work brokering deals with established firms to get them to provide test bed capabilities for promising startups, and said it has been a powerful tool in helping companies scale. He gave an example of a firm that developed software to monitor electrical

signals to identify peak load usage and cyberattacks ahead of time, but had no place to test it out. When Braemar connected them with a utility company that could benefit from the technology, they were able to develop and scale their idea, and the company is now worth tens of millions of dollars. Mr. Evans connected this idea to Dr. Dahl's remarks about the importance of human capital, and he noted the role of investors and large firms could play in brokering connections between innovators and small and medium-sized businesses. He also expressed support for the idea of test beds and said that while some large companies were already engaged in this space, it was ripe for further exploration.

Incentives and the Business Case for Sustainability

Mr. Jonathan King of Southern Company discussed the importance of incentives in encouraging companies to partner with startups for test bed capabilities. He discussed Southern Company's significant investments in sustainability, to the tune of nearly $1 billion, as part of a goal to reduce greenhouse gas emissions by 50 percent relative to 2007 levels by 2030. He said the company was well on track to meet this target due to shifting its energy mix from 70 percent coal to 22 percent, with a significant increase in natural gas and renewables. He said the most difficult component of investing in startups and granting access to test bed facilities was flexibility, and he spoke of a need for policies that would enable companies like Southern Company to balance obligations to risk-averse shareholders with the need to stay on the cutting edge. He also discussed the challenges of cost-benefit analysis in determining when to incorporate a renewable energy technology, as many of them are still far costlier than fossil fuels. He also spoke of the importance of maintaining a reliable energy supply for Southern Company's customers. Mr. King said any policy that would reduce the downside risks to companies willing to provide test bed capacity to startups would be highly impactful.

Dr. Gardner said a major challenge in the adoption of sustainable technology is lack of knowledge by both companies and the general public about the progress that has been made in recent years in clean energy. He discussed the case of a fuel cell company in Connecticut that has developed a technology that not only reduces greenhouse gas emissions from fossil fuel power plants, but also enables them to produce 20 percent more energy from the same inputs. However, because of the high initial capital investment required to install it, the company is struggling to find buyers for its technology, even though it almost pays for itself. Dr. Dahl discussed Lemelson's work in cultivating a public-private partnership with the government of India, philanthropic

organizations, and industry to develop more energy efficient air conditioning systems, called the Global Cooling Prize. She also discussed the government's traditional role in providing test beds for technology through agencies like DARPA and the National Institutes of Health, adding that including private industry in these efforts would ensure that the innovations tested corresponded to market needs. She asked how to encourage more companies to become involved in brokerage and test bed activities.

Mr. Evans identified several potential policy levers, including accelerators, incubators, and demonstration platforms, that could de-risk investments in technologies, as well as tax incentives for investment in sustainable technology. Mr. King said that policies granting firms flexibility would be even more valuable, such as allowing them to exclude these investments from reported earnings, and allowing them to partner with regulatory bodies to approve investments in test bed projects. Ms. Lientz shared a recent Executive Order on securing America's bulk power system, noting that it identified the connection between cybersecurity and a reliable, sustainable energy grid.

Concluding Thoughts

Ms. Wince-Smith thanked the group for its discussion, and noted that many clear recommendations were emerging for the Commission to build upon. She emphasized the need to show the business and productivity benefits from sustainable production, and expressed great interest in exploring the test bed issue. She said that government has already been active in running carbon capture and carbon sequestration test beds through the national laboratory system, and she suggested cross-pollinating the test bed idea with Working Group Three. Ms. Wince-Smith suggested the idea would benefit from input from experts on finance and the tax system, and stressed the need for a bottom-line driven incentive to encourage companies to invest in test beds. She closed by reiterating her interest in having people share recommendations and policies from task forces focused on similar issues, and said that the Council could share its 2018 cybersecurity-focused report, Secure as a baseline to build upon for cybersecurity recommendations.

Working Group 2 Calls May 8

Introduction

The Honorable Deborah L. Wince-Smith welcomed the group and introduced the featured speaker, Mr. Noel Kinder, the Chief Sustainability Officer for Nike. She noted that Nike is a leader in the corporate world for sustainable business practices. Ms. Kathy Trimble said she was struck by Nike's sustainability goals, which incorporate measurement indices across all product lines in addition to greater use of recycled materials and sustainable clean-up practices. She also said that today's discussion would include the topic of product innovation, and how sustainability practices have altered the production process and the experience for the end user.

Mr. Chad Evans announced two important shifts in the Working Group discussions following the June 16th virtual meeting of the National Commissioners. First, the current Working Group 2 will split into two groups. Working Group 2 will focus on the future of sustainable production, manufacturing, and consumption, while the newly formed Working Group 4 will focus on unleashing capabilities for work and entrepreneurship. Additionally, beginning the week of June 22nd, working groups will convene once per week and discussions will be led by co-chairs nominated by the Council. The topics will be proceeded by a primer with background reading and policy recommendations to consider, and the discussions will be focused on distilling actionable recommendations from the working group deliberations ahead of the National Competitiveness Forum in December.

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Ms. Kathy Trimble

Mr. Gourang Wakade

Ms. Yasmin Hilpert

Mr. Josh Oswalt

Mr. Tim Planert

Featured Remarks

Mr. Kinder said that when he assumed the role of Chief Sustainability Officer at Nike, there was broad consensus within the company on the need to integrate sustainability experts throughout Nike's portfolio of products and various departments, rather than having a centralized sustainability team. He said this change has helped Nike develop more effective sustainability solutions for each aspect of its business.

Mr. Kinder noted that Nike is primarily a "consumer products company" and has a core customer base of Millennials and Generation Z, who expect large companies to both be sustainable and contribute to improving the world. He added that nearly all of Nike's 76,000 employees around the globe have a passion for sustainability, and that sustainability is of paramount importance for the incoming Chief Executive Officer. Because Nike makes physical products, sustainability in its production process is the key to becoming sustainable overall. As a result, Nike has invested in sustainable materials, becoming the largest industry consumer of recycled polyester and making use of recycled "fly leather," among other innovations. However, Mr. Kinder said that many of these practices had not been successfully scaled yet.

A major theme of Mr. Kinder's remarks was the need for industry-wide sustainability. He said that Nike is only one stakeholder in an industry that accounts for 5-8 percent of the global carbon footprint, and that Nike going carbon-neutral tomorrow would have no significant impact on the environment. Mr. Kinder said Nike's greatest asset for driving sustainability is its brand and ability to inspire and connect with consumers. Because of this, in order to alter consumer behavior and encourage the prioritization of sustainability, Nike needs to "put its own house in order" first and lead by example. One way in which Nike seeks to use its influence is through pre-competitive collaboration. Mr. Kinder said that Nike shares production facilities with companies in other industries, meaning securing cooperation on issues like labor practices and climate responsibility is essential to encourage their suppliers to adopt new practices. He gave an example of Nike's efforts to fight climate change through forming a coalition for sustainable apparel, and setting public targets to meet the UN's Framework Convention on Climate Change commitments.

Mr. Kinder closed with an example of Nike's collaborative work to encourage sustainability. In Vietnam, many of Nike's plants rely on coal supplied by China. To help them afford the switch to renewable energy, Nike and other tenants of these factories helped create a Power Purchasing Agreement that would subsidize the cost of renewable energy, with the cost shared among the United States Agency for International Development (USAID), the Vietnamese government, and other major companies like Apple.

Supply Chains and Re-Globalization

A major theme of the group's discussion was the shifting nature of globalization. Ms. Ellen Donaldson of the Davidson Community Foundation discussed her background working in pharmaceutical production and pharmaceutical services, and her alarm at the shift in the supply chain for critical drugs from North America and Western Europe to China and India. She expressed similar concerns about the supply chains for critical technology, and noted the geopolitical (China) and product quality (India) concerns stemming from this evolution. She warned that China has taken over products that were formerly strengths of the United States, and said that companies were learning the hard way that there were considerations other than short-term cost efficiency. Dr. Jerry Haar of Florida International agreed and added that there were challenges even in decoupling from China, as other competitors might fill the void created by U.S. withdrawal and out-compete U.S. companies on cost. As a hedge against this risk, he suggested relocating factories not to the United States, but to Western Hemisphere nations that were somewhat more expensive than China but also much closer, enabling a shorter product delivery time.

Dr. Ricardo Ernst of Georgetown University expanded upon this theme of regionalization of supply chains. He said that companies had previously focused primarily on efficiency and minimizing costs, but that he foresaw an increasing focus on delivering products quickly, which meant locating supply chains in nearby nations. He said that rather than de-globalization, the COVID-19 pandemic was leading to re-globalization, and that the economic downturn had illustrated the extraordinary degree of interconnection and interdependence between companies and countries. He also said it was crucial for the group to carry this message to the wider public, and praised the Global Federation of Competitiveness Councils' Competitiveness Decoder project for its comprehensive information on all aspects of competitiveness. He said that the volume of information could be overwhelming to the general public, but encouraged the Commission to provide examples of relevant data and frame it for the public in a way that sparks broader interest in the Commission's work.

Ms. Donaldson asked if re-globalization signaled a shift to reliance on Western Europe and North America for supply chains rather than China and India, and Dr. Ernst said that it did. He added that the reshoring movement he foresaw would be of particular benefit to Mexico, which is more expensive for manufacturers than China but has major geographic advantages, enabling them to respond more quickly to shifts in consumer demand. He stressed that re-globalization was not equivalent to economic nationalism or isolationism, and instead framed it as a shift in the decision making process of manufacturers from solely focusing on efficiency to also prioritizing effectiveness, or the ability to satisfy customers in a timely manner. He added that the United States should engage Mexico during this time, as the country is facing major challenges and the new version of NAFTA requires readjustment.

Dr. Michael Goodman of the University of Massachusetts-Dartmouth questioned whether the current supply shocks from the COVID-19 pandemic were the result of just-in-time inventory practices. He noted that if companies had stored critical supplies on location, they would have had weeks of lead time to establish alternative supply chains, but that such practices are ordinarily considered wasteful. Dr. Ernst strongly agreed, and said that just-in-time inventory was developed in Japan, where space constraints made it essential for production facilities not to have extra supplies occupying floor space, but that for all its efficiency gains in normal times, it is not resilient during "Black Swan" crises like a global pandemic.

E-Commerce and De-Materialization

Another trend that emerged as a topic of discussion was the rise of E-Commerce and what Dr. Ernst referred to as "de-materialization." He said that in the wake of the pandemic, consumers were becoming much more comfortable ordering products online and purchasing without physically examining or inspecting the product, and that this made "last mile" considerations essential for supply chains. He added that this shift toward delivery meant that many companies were rapidly increasing their production of waste from packaging and shipping materials. He observed that companies often used standard-sized boxes for efficiency and time-saving, even when the product is much smaller than its container. However, he noted that some retailers like Amazon are increasingly soliciting customer feedback on their packaging in an attempt to recalibrate. He also stressed the need to bring awareness to the sustainability costs of dematerialization, and highlighted the importance of finding business opportunities for companies to incorporated recyclable or reusable packaging material to reduce the environmental impact of E-Commerce.

Product Integrity and Consumer Protection

Many participants expressed concerns about certifying the authenticity and quality of products in an era of widespread online shopping. Ms. Wince-Smith said that concerns about substandard or counterfeit materials purchased online were eroding consumer trust in companies, and called for greater data transparency and standards for product verifica-

tion and quality control. Dr. Ernst said that retailers like Amazon, by agreeing to sell products for other companies, are increasingly assuming responsibility for the quality of the products they sell, and urged certification of vendors as being beneficial for both consumers and producers as a stamp of quality.

Dr. James Stock of the University of South Florida agreed on the need for certification, but warned that many companies do not re-certify vendors and suppliers to ensure they are continuing to follow proper quality and sustainability practices. Dr. Ernst said that the group could provide substantial value by working with major producers to identify similar constraints and obstacles, and help brainstorm ways around them. He said that in this "new normal" such actions were an opportunity to make a major impact. Mr. Evans highlighted examples of certification best practices in the Working Group 2 primer from companies like PepsiCo and Levi's and encouraged the identification of more general lessons to be drawn from companies' experiences. Dr. Haar said working with members of groups like the American Apparel Manufacturers Association, which have experience certifying suppliers and suppliers' suppliers, would be a great opportunity to identify wisdom and best practices in developing effective certification.

Ms. Wince-Smith called for building integrity of intellectual property ownership into supply chains, and criticized the current standard in which the burden of proof of an IP violation is on the injured party rather than the supplier of the good. She said such requirements, along with burden-of-proof laws regarding safety and quality already existed for food products and imports, but should be adopted more generally. She added that people are often willing to pay a premium for these guarantees of integrity, especially for healthcare products. In particular, she called for stronger source-of-origin requirements for product components, especially pharmaceuticals. Dr. Carlotta Arthur of the Luce Foundation noted there was some precedent in this regard, as many companies require their suppliers to meet ASTM standards for materials, as confirmed by outside laboratories. Dr. Haar said that some accountability was provided by customer evaluation platforms like Yelp!, TripAdvisor, and CNet. Dr. Arthur said that grassroots, consumer-driven demands for sustainability and quality were essential to ensuring companies implement these best practices.

Implementing Sustainable Innovation

Dr. Carol Dahl of the Lemelson Foundation said that some problems could be reframed as major opportunities to develop innovations. She cited the example of environmentally friendly compostable packaging developed by the company Ecovative. Dr. Maya Trotz of the University of South Florida asked if localizing supply chains offered opportunities to incorporate new, sustainable manufacturing techniques like 3D printing into the production process, and Mr. Evans said there would be many opportunities to leverage technology-based innovations to energize new supply chain relationships. He added that there was a link between this topic and one of the focuses of Working Group 4, which will be on the democratization of production and innovation. Dr. Ernst agreed that demand-driven innovation was essential to adopting more sustainable production practices.

Portfolios, Redundancy, and the End of One-Size-Fits-All

Dr. Haar characterized non-redundant supply chains focused only on efficiency as being like high-wires with no net underneath, and said that the customer needed to count in production decisions, not just cost savings. Dr. Ernst encouraged the conception of efficiency as just one of a portfolio of concerns facing companies, and said that one-size-fits-all is a poor model for supply chains, especially for companies that make different kinds of products. He suggested companies develop more geographically compact and resilient supply chains for products marketed on quality, essential products, and products where demand changes more quickly and requires faster responses to consumer behaviors. Ms. Wince-Smith suggested including reliability and performance alongside efficiency as criteria in supply chain location.

The Brand Impact of Sustainability

Citing Dr. Kinder's remarks about the effects of Nike going carbon-neutral, he asked if doing so would impact Nike's brand and reputation. Dr. Kinder, while questioning the wisdom of committing to targets so far in the future that the executives making them would not oversee their completion, said that committing to science-based benchmarks and targets, such as the Paris Agreement, does have a positive brand impact. He added that Nike found that to meet the sustainability goals outlined in the Paris Agreement, it would need to reduce the carbon footprint of its extended supply chain by 30 percent by 2030, and of its owned and operated supply chain by 65 percent during that time. He also said that during its investigation of how to reach these goals, Nike realized the crucial importance of materials sustainability, including making totally circular (reusable) and even carbon-negative products. He discussed the importance of Nike's sustainability team in serving as an "innovation engine" that generates ideas based on these external targets. Mr. Evans underscored the importance of science-based recommendations, and noted that many policy makers are craving these kinds of metrics.

Concluding Thoughts

Ms. Trimble and Mr. Evans thanked the group for their discussion, and reminded the group about next week's calls on Monday and Friday. Mr. Evans also said that further discussions of Nike's innovation process and connections with stakeholders in Nike's supply chain would provide valuable perspective and lessons for the group.

Working Group 2 Calls May 11

Introduction

The Honorable Deborah L. Wince-Smith welcomed the group and introduced the featured speaker, Mr. Bill Johansen of Lawrence Berkeley National Laboratory. She said that the discussion would focus on developments in the bioeconomy and their connection with sustainability, and discussed the Council's previous work with Lawrence Berkeley on biomanufacturing in Leverage: Advancing U.S. Bioscience (2017), which she said would be available via the online portal.

Featured Remarks

Mr. Johansen opened by discussing the importance of sustainability to Lawrence Berkeley National Laboratory, and connected sustainability to the discussion by the Working Group at the January Launch Conference, in which it discussed the importance of changing consumer behavior, the role of employee expectations of leadership in creating a culture of sustainability, and the constraints facing leaders who want to be more sustainable. Notable obstacles facing organizations trying to increase their sustainability include the availability of sustainable and recycled materials for use in products, potentially prohibitive costs for engaging in sustainable behavior, and limited supplies more generally, especially during the COVID-19 pandemic.

Mr. Johansen said that Leverage contained several recommendations that remain relevant and should be up for discussion by the group. These include developing a nationwide strategic roadmap for investment in sustainability, coordinating investments across

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government agencies, finding ways to leverage bioscience to address knowledge- and cost-prohibitive technologies for industry, and creating successful public-private partnerships. He warned that if laboratories do not create materials and products that the private sector can use, their efforts and funds will have been better spent elsewhere.

Next, Mr. Johansen discussed why the Department of Energy, including the National Laboratory system, is concerned with sustainability. Not only does the U.S. economy need to minimize the environmental impacts of its supply chains while simultaneously enhancing the competitiveness of its industrial sector, there is an urgent need to generate less waste for landfills producing more efficiently and reusing resources. He also emphasized the need to use energy more efficiently, and said energy and materials were both critical components of reducing greenhouse gases and conserving resources.

Mr. Johansen also detailed several initiatives by the national labs to galvanize innovation in sustainable products and processes. The Innovation XLAB program, which consists of a series of Department of Energy initiatives in different areas, includes a Biomanufacturing project. Lawrence Berkeley hosted a dialogue as part of this endeavor that brought together stakeholders from industry, labs, and other research institutions. The dialogue focused on bridging gaps between stakeholders and ensuring better alignment of research projects with industry needs, and he shared a link to a summary on the Lawrence Berkeley website. He also said he would look for a white paper or other formal publication from the event to share with the group.

Another major initiative Mr. Johansen discussed was the Department of Energy's Plastics Innovation Challenge, first released in November of 2019. This challenge consisted of five goals to accomplish by 2030. First, to develop novel technology to prevent plastic from entering the ocean. Second, to develop processes to deconstruct plastic waste effectively into new chemical compounds that are environmentally friendly and can be reused. Third, to increase the rate of upcycling, or reusing products in new, higher-value products. Fourth, designing new products with recyclability in mind, including new kinds of recyclable plastics. Fifth, bolstering the domestic supply chain for upcycling plastics to enable American companies to scale and deploy new technologies in the domestic and international marketplace.

Related to the third challenge, Mr. Johansen discussed the BOTTLE Initiative, announced in March. This upcycling consortium is a joint effort of the Department of Energy's Advanced Manufacturing Office (AMO) and Bioenergy Technologies Office (BETO). It provides $25 million in funding for the development of new plastics capable of recyclability and for new strategies that can break existing plastics into chemical building blocks that can be used to make higher value products. Additionally, the project will seek to develop consortium collaborations to tackle challenges in plastic waste.

Mr. Johansen concluded his remarks by establishing that the Department of Energy has had a longstanding interest in sustainability research, and has stepped up these initiatives in recent years. However, as the Council recommends in Leverage, better coordination within the government and between government and external stakeholders like industry is essential for further progress. He discussed efforts to make solar energy cheaper to make it easier to commercialize, and said other renewables and sustainable materials need similar price reductions in order to be widely adopted in the marketplace.

Private Sector Leadership in Biomanufacturing

Ms. Ellen Donaldson of the Davidson Community Foundation asked which firms were taking the lead in innovative biomanufacturing efforts, and how nations around the globe were investing in biomanufacturing. Mr. Johansen said that the United States had a strong advantage and head start in its biomanufacturing research, although he noted that the United States relies on much research stem-

ming from international partnerships. He said that numerous companies across a variety of sectors were displaying leadership in this space, and that industry is very interested in the subject beyond questions of optics. He noted that many companies are already facing constraints of dwindling supplies and have strong incentives to engage in sustainability research. Dr. Nathan Hillson of Lawrence Berkeley National Laboratory shared links to the Global BioFoundries Alliance and Synbiobeta, both of which provide case studies of exemplary firms in biomanufacturing and sustainable materials research.

Ms. Ciannat Howett of Emory University discussed the importance of highlighting companies making strides in sustainability, both to spread best practices across industry and to educate the general public about the importance of such endeavors. In addition to HP, she discussed the Georgia-based Interface Flooring Company, which makes carpets out of recycled plastics and has inspired competitors to try and outdo its own sustainability efforts. She asked if the Commission could play a role in highlighting these kinds of efforts to encourage other firms to follow suit. Mr. Evans agreed on the importance of case studies, and he encouraged the group to pass along other examples of best practices they are aware of.

Metrics, Targets and Parameters

Dr. Ricardo Ernst of Georgetown University asked if there were existing or potential metrics that could be used to gauge progress on plastic waste reduction and other sustainability efforts. Mr. Johansen said that Lawrence Berkeley's Applied Research and Materials and Biotechnology teams were both working on new metrics, and that he would share some of this work with the group.

Ms. Howett discussed Emory's challenges in establishing a circular economy, including the difficulty of buying back products made from the material it has recycled and the challenges in finding a certification process for recyclability that is accurate and consistent. She expressed hope that a market would develop among individual and corporate buyers of recycled products, but also asked who should be in charge of the certification process. Dr. Hillson said that the Department of Energy's Office of Energy Efficiency and Renewable Energy is funding research on increasing the varieties of plastic that can be recycled, which could alleviate concerns about the advertised recyclability of plastics by merchants.

Dr. Carol Dahl of the Lemelson Foundation asked how stakeholders should set targets and parameters for the characteristics of sustainable new materials, and how to publicize and share those specifications outside of labs. She also asked how researchers were evaluating downstream investment opportunities for companies that might commercialize technology developed during these efforts, and how to support technology spinoffs that are likely to successfully scale. Mr. Johansen said that while the Department of Energy has a detailed roadmap for plastics by 2030, there is no national roadmap for any aspect of new materials, including parameters and standards. He said this was one reason dialogue between the private and public sectors on this issue was so important. Concerning scalability, he described AMO's efforts to evaluate the potential of new technologies, and said that Lawrence Berkeley, like other national labs, has an accelerator program. He said accelerators were especially important for biotechnology, because there are not investors willing to make large, high-risk investments the way there are industries like pharmaceuticals. Partnering with startups and to de-risk their products for investors is crucial to attracting enough capital to scale them up and bring them to market.

Dr. James Stock of the University of South Florida expressed concerns about FDA regulations governing the use of recycled materials in packaging of food products. He said products with recyclable packaging have to use multiple layers because of rules forbidding direct contact between recycled materials and food or beverages. Mr. Johansen said he would ask the team at Lawrence Berkeley about that issue, and added that it was important to make packaging that keeps products safe from contamination but that is also environmentally friendly and easy for the consumer to open.

Gaps in Public Knowledge and Merchant Claims About Recycling

Ms. Howett discussed the growing problem of merchants touting the recyclability of their products when only some components are recyclable, and the inability or unwillingness of consumers to separate these components out for proper disposal. She also reiterated the challenges in finding a reliable certification system that accurately tracks whether products can be recycled or composted. She said Federal Trade Commission efforts to prosecute "greenwashing" only punish violators after the damage has been done. Mr. Johansen said this issue reminded him of the challenges that Lawrence Berkeley has had in changing behavior by employees. Even for scientific professionals, the rules and procedures for properly disposing of waste have proved confusing. Dr. Stock concurred with this, and added that his own research has also indicated many consumers do not know how to properly recycle materials and said that many of the group's recommendations will require public education for successful implementation.

Ms. Stacy Lippa of Target said efforts at public education need to be balanced with the reality that our society is currently exhausting natural resources faster than innovation can keep up. Mr. Johansen said that it is difficult to get people and companies to make sustainable choices when they are difficult or expensive, and that products made with recycled materials suffer from perceptions that they are poor quality. He said the rapid changes unleashed by the COVID-19 pandemic offered a window of opportunity to implement changes in mindset as the public conception of "normal" is rapidly evolving. Dr. Tommy Gardner of HP Federal added that his own company was reevaluating its practices, and had cancelled all travel until October not just for safety reasons, but because employees are productive working from home, and the company is saving money and being more sustainable by not commuting or traveling.

Mr. Evans asked the group what technological developments and research projects were on the horizon. He noted that researchers possess the ability to probe, manipulate, and analyze biological molecules, and wondered about the innovation possibilities inherent in this capacity. Mr. Johansen identified new materials and micro-engineering of biological molecules as promising lines of research, but urged a collaboration across disciplines and subject areas to maximize innovation. He called for a "Manhattan Project" mindset focused on solving grand challenges. Dr. Gardner offered the Manufacturing USA institutes as a model for a grand challenge initiative in sustainability, because it is easy for policy makers to understand due to its familiarity. In this model, the government and industry partners provide matching funds for five years, at which point the initiative is expected to stand on its own without public funding. Industry participants all have access to intellectual property developed during the research. He suggested starting with four consortia located in different regions of the country focused on developing

products and processes that reduce waste, develop new materials, and facilitate recycling and upcycling. Dr. Michael Goodman of the University of Massachusetts-Dartmouth observed that the historical record suggested shortages of resources provide strong incentives for innovation and the development of substitute materials.

Private and Public Sector Drivers of Sustainability

A major topic of discussion for the group was what roles the private sector and the government should play in driving sustainable products and processes. Ms. Kathy Trimble noted that Leverage had shown that some changes only take when they occur organically through market processes. Mr. Johansen said both private sector and public sector initiatives are needed, because the optimal actions are often not the easiest ones, and the government has a role in ensuring that private actors either want to make sustainable choices or at least don't stand in the way of others making sustainable choices. He gave the example of potentially incorporating AI into recycling facilities to sort products through software that scans micro-bar codes and tells people how to sort their recycling rather than requiring them to do the logistical work themselves.

Dr. Gardner said that government regulation often distorts markets, and creates unpredictable second- and third-order consequences. He said policy makers need to provide incentives for companies to be sustainable for economic reasons. Dr. Gardner said that HP is a leader in sustainability primarily because its leadership has seen clear business benefits in both resource use and in attracting consumers, who are increasingly demanding more sustainable products. As an example, he discussed how HP's sustainably-made printers were popular with health-conscious consumers because they did not pollute indoor spaces with off-gassing of toxic chemicals. Dr. Stock called for the creation of a centralized platform where individuals and companies could find easy information on questions about sustainability. He said existing resources were too far-flung and only consulted by people with vested interests in specific topics. He also touted the benefits of cross-fertilization if people came to the platform with a specific question and then saw information on related topics in sustainability housed in the same place.

Ms. Amy Lientz of Idaho National Laboratory said there were many opportunities for the government to improve sustainability in its own operations. She discussed how both the Department of Defense and national labs have incorporated sustainable production criteria into their procurement bid evaluation process, but that these measures could be expanded to other agencies and implemented more consistently. She also described efforts at Idaho National Laboratory to do the same for locally-sourced materials.

Dr. Gardner cautioned against implementing standards that backfire. He said that without a binding global agreement similar to the Paris Climate Accords, new sustainability requirements for U.S.

companies will lead to offshoring of jobs as companies relocate to cheaper countries without those standards. He also gave the example of American car manufacturers. While they did face government mandates in the form of CAFE standards, they also faced strong economic incentives to produce more fuel efficient cars, and this pressure resulted in a burst of creativity and innovation, with cheaper, higher quality, and more environmentally friendly vehicles hitting the roads. However, he stressed the importance of more sustainable production, referring to research suggesting we would need 2.3 earths worth of resources to provide a decent standard of living for the projected 2050 population at our current standard of resource efficiency. In particular, he discussed the challenges the computer industry faces with the growing shortage of rare earth materials, and the need to recycle them to stay in business.

Dr. Dahl discussed her experience with the Advanced Technology Program, developed by the federal government in the 1990s to encourage private investment in long-term, high-risk research. She asked if there was a role for government in subsidizing the kinds of high-risk, high-reward investments corporations will not make on their own. Dr. Gardner said the existing tax credits for research and development are valuable because they allow companies to spend their research money on whatever projects they deem most important. He also advocated greater use of public-private partnerships, and discussed HP's many investments in initiatives ranging from modular nuclear reactors to micro-biomanufacturing. He said that without government and national laboratory partnerships, HP would not be able to make these potentially groundbreaking investments, including those that could help combat COVID-19, because of the risk to shareholders.

Concluding Thoughts

Ms. Wince-Smith thanked the group for their discussion, and said she noticed many areas of overlap with the discussions of the other Working Groups. She discussed her own involvement in the Advanced Technologies Partnership and the controversy at the time over funding going to large companies rather than to smaller firms more in need of assistance. She observed similar concerns about relief funding from the recent CARES Act stimulus passed by Congress in March. She encouraged the group to think about accelerating America's value creation and sustainability and driving it to a new place rather than merely returning to normal, and to frame recommendations for policy makers in a way that highlights the role they will play. She concluded by noting that many valuable recommendations had emerged from the day's discussion.

Working Group 2 Calls May 15

Introduction

Mr. Chad Evans welcomed the group, and Ms. Kathy Trimble introduced the featured speaker, Mr. Jonathan King of Southern Company. She said that Southern Company's connections with every facet of the group's mandate allowed for a unique perspective on issues of sustainable production and consumption, as well as the future of the workforce.

Featured Remarks

Mr. King opened by providing a background on Southern Company. The utility is one of the three largest in the United States, serving over 9 million customers. Although primarily based in the southeast, the company's renewable and natural gas branches operate throughout the country. He then discussed Southern Company's efforts and challenges in sustainability and in developing the workforce of the future.

In 2007, Southern Company set a goal of reducing greenhouse gas emissions by 50 percent by 2030, and to be net carbon-neutral by 2050. This required a significant shift in energy sources, as the company relied on coal for 69 percent of its power generation in 2007. As of 2020, the company has cut its coal usage by 50 percent and increased renewable generation twelve-fold, and is constructing a large nuclear plant outside Augusta, Georgia. Mr. King said that investor pressure for sustainability is making Environmental, Social, and Governance (ESG) scores as important to corporations as credit ratings for attracting investors. He said that Southern Company has become focused on making its energy generation not only sustainable, but also resilient and reliable for consumers.

A significant challenge in pursuing further sustainability improvements, including adding more renewable energy to the grid, is recouping the costs of investments. While Southern Company has found some investment support through its participation

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in the Energy Impact Partners confederation with over 20 other companies, utility regulations make it extremely difficult to secure approvals to raise rates on customers to recoup the costs of investments. This remains true even when those rate increases will fund the incorporation of renewable energy that will make the grid more sustainable and lower costs in the long run.

Mr. King also talked about Southern Company's workforce development efforts. He said that the company employed 27,000 people, 1/3 of whom were unionized skilled labor, and the other 2/3 of whom were white collar professionals. He said that 42 percent of the workforce were women or minorities, and that the workforce spanned five generations. He discussed the challenges the company faces as the older generations, who make up the bulk of the workforce, reach retirement age, and how the long tenure of the average worker is a benefit for worker experience but has led to a shortage of training and worker development resources.

To address these issues, Southern Company has created partnerships with the International Brotherhood of Electrical Workers, the North American Building Trades Union, and local community colleges for an Apprenticeship Readiness Program. This collaboration establishes curriculum and training for skilled laborers and includes a 2-year community college degree and workforce training that enables graduates to go straight to the workforce upon completion. Through three graduating classes, 70 percent of workers have been hired immediately after finishing the program. Nevertheless, the company has seen high turnover in its skilled blue-collar positions, as well as slow uptake of training opportunities, and Mr. King said that it remains important for the stakeholders involved to showcase the importance and high wages of these jobs. He reported that workers who maintain utility poles earn between $65,000 and $100,000 per year, and characterized the apprentice program as a collaboration between industry, labor, and higher education to bolster a sustainable middle class.

Mr. King concluded his presentation by calling for feedback from participants on similar challenges in workforce or sustainability they have encountered with their organizations, and whether or not it was possible to scale up collaborations between different stakeholders in workforce development like the Energy Industry Partners. He also stressed the importance of finding a way to reduce downside risk to making investments in education and sustainability for companies. Mr. Evans expressed interest in learning more about the Energy Industry Partners initiative, and said that perhaps the Commission could help amplify any recommendations or best practices emanating from its work.

Models for Workforce Development

Dr. Mohammad Zaidi of Braemar Energy Ventures discussed the effectiveness of the German technical education system, comparing his experiences opening plants producing cars in Germany and in Toledo in the United States. He found the German workers to be more productive and that they required far less supervision, even to the point of not requiring floor engineers. He attributed this difference to both the level of resources Germany commits to skilled technical education and to the heavy emphasis on theory in addition to practice in their technical curriculum. He asked if the United States should consider incorporating elements of this system, especially as new energy technologies and the growing importance of cybersecurity increase the skill demands on the technical workforce. Mr. King agreed that this was an important consideration, and said he felt the right stakeholders were already invested in improving workforce development in the United States in the form of labor, industry, and higher education.

Dr. Thomas Gardner of HP Federal described the findings of several studies of the German technical education system in comparison with the United States, and that they all came to the conclusion that there were both challenges and opportunities in incorporating elements of the German system in the United States. Of particular importance in this regard was the need for taxpayers to support an expanded

technical education system and a relative shift in the allocation of educational resources. He also called for building up the community college system in the United States, and for changing the culture around credentials away from the belief that a bachelor's degree is essential for entry into the middle class. A two-year degree and an apprenticeship can provide an equivalent standard of living.

Human Resources and the Skills Gap

Dr. Kathleen Merrigan of Arizona State University asked how diverse Southern Company's Board of Directors and C-Suite were, and what kinds of skills were the hardest to find among skilled workers. Mr. King provided a link to information on the company's Board of Directors and identified electricians, welders, pipe fitters, and field engineers as particular areas of need. Ms. Amy Lientz of Idaho National Laboratory concurred, and said that in the Pacific Northwest, there were needs for welders, masons, and electricians. She added that many of the professionals in those fields are nearing retirement age, but that companies are having trouble finding and retaining apprentices to replace them. She discussed Idaho National Laboratory's efforts to encourage greater collaboration between community colleges, unions, and businesses, and noted the challenges of navigating tensions between the different stakeholders. Mr. King said that Southern Company was fortunate to have few tensions, as all of their unionized workers were from the same organization, and the contract workers they engage with are part of unions that are all within the larger North American Building Trades Union umbrella.

Regulatory Policy to Spur Investment in Clean Technology

The Honorable Deborah L. Wince-Smith asked what regulatory changes would allow Southern Company to make more investments in advanced technologies like batteries, as well as better deployment and optimization of resources. Mr. King said that the biggest challenge was convincing regulators to allow utilities spend money on projects, and to pass those along to consumers. He described an ongoing project in renewable natural gas, and how securing approval for exploratory research would enable the company to incorporate lower cost and more sustainable energy generation into the grid, resulting in long-term cost reductions for consumers. He also described a microgrid the company maintains for backup generation during surges in power usage or power outages, and how being able to raise funds to invest in battery technology would enable the company to power that grid with stored renewable energy. Mr. King said that the Energy Industry Partners coalition offset some of the risk from investing, but that allowing the company to recoup its research costs more fully would enable them to engage in even more innovation on their own. Ms. Ciannat Howett of Emory University discussed the importance of working with subsidiaries to garner support for investment projects. She described Emory's attempts to secure a backup microgrid for its hospitals, and the initial rejection of the plan because of opposition from Georgia Power. Ms. Lientz said that the Department of Energy has recognized the labor-intensive nature of the energy industry, and discussed Idaho National Laboratory's four major nuclear projects.

Dr. Thomas Gardner of HP Federal said that he had seen success from pre-competitive collaborations on military technology, in which stakeholders shared intellectual property up until the prototyping stage. He mentioned a recent National Renewable Energy Laboratory initiative providing matching funds to manufacturers investing in advanced manufacturing technology. He said that private industry needs large returns in order to take significant risks in attempts to improve its capabilities, and that reducing the risk to industry will encourage more investment in new technologies.

Cybersecurity and Resiliency

Ms. Wince-Smith asked how Southern Company was addressing challenges related to cybersecurity, and Mr. Evans asked whether customers looked to Southern Company for cyber solutions in their own

enterprise. Mr. King said that cybersecurity was an increasingly important issue, and that Southern Company responded to cyberattacks every day. He said that consumers don't generally look to Southern Company for guidance on cybersecurity issues, but that they do rely on the company to keep their electricity supply flowing. He stressed the importance of gathering information about the location and nature of cyberattacks, and noted that the current Presidential Administration issued a recent Executive Order clarifying that the electrical grid is a critical part of the national infrastructure. He also discussed the need to develop more cybersecurity professionals. Dr. Gardner warned that an attack on America's oil refineries could cripple the national grid and transportation system, and would require six to twelve months to recover from. He strongly agreed that the cybersecurity of critical infrastructure should be a major national priority.

The Circular Economy and Sustainability

Mr. Noel Kinder of Nike discussed Nike's work on reusing its own products to create new ones, including a shoe that Nike is developing made out of recycled consumer and industrial waste. He suggested that with the proper infrastructure in place, people would be able to recycle their consumer products to be used in new goods, similar to the bottle deposit programs in place in many states. Consumers would pay a deposit when purchasing a good, and if they turned it in to a recycling facility, would receive their deposit back. Dr. Michael Goodman of the University of Massachusetts-Dartmouth discussed the value of power purchasing agreements. In Massachusetts, the state government mandated the use of these agreements to procure power from renewable energy sources, and the developers bidding on contracts offered bids that priced electricity from renewables below the cost of fossil fuels without any incentives or public subsidies.

Encouraging the Development of Test Beds

Dr. Zaidi praised Southern Company for its investment in what he saw as four critical technologies for the future: cyber security, renewable energy, carbon capture, and low-cost storage of renewable power in batteries. He noted that all of these items require innovation, workforce training, and other significant investments, and observed that industry was reluctant to offer test beds for these projects. He asked what it would take to encourage industry to provide these test beds, and what the Department of Energy or other government agencies could do to help. Mr. King said that the regulatory environment was the biggest obstacle, and that making it easier to invest in projects without significant downside risk would remove a major barrier.

Ms. Wince-Smith asked how the regulatory framework should be altered to catalyze test beds, and Ms. Howett suggested building relationships with all the stakeholders involved in such an effort. She described Emory's efforts to secure battery storage

capacity for research and operational purposes on campus, and how the school needed to separately liaise with the utility and the state public service commission. She suggested framing the issue as one where the parties want the same outcome, and need to find a unified way to approach regulators with a proposal. Mr. King agreed and said there were two dynamics at play in the case of Southern Company. The public service commissions the company deals with prefer proven solutions, and are reluctant to approve projects where they have not already seen previous examples succeed. He added that both solar energy and batteries have yet to reach the tipping point where they are always more economical than fossil fuels for both commercial and residential energy. Ms. Lientz agreed with these assessments, and added that the Department of Energy has developed various resources to encourage greater uptake of renewables. Dr. Zaidi discussed Alcoa's frequent outsourcing of research and leveraging of external technology to solve challenges, and noted that the automotive industry was excellent at developing new capabilities in its suppliers. He suggested there was potential for cross-industry learning, and noted that cybersecurity, battery storage, renewable energy, and carbon capture combined to offer a compelling national security and competitiveness case for investment in upgraded capabilities. Ms. Wince-Smith said the Chief Technology Officer of the United States, the Honorable Michael Kratsios, was interested in reforming regulatory bottlenecks that delay the deployment of advanced technology systems.

Concluding Thoughts

Mr. King summarized three key takeaways from the group's discussion. First, more discussion was needed on how to best partner at the regulatory level to engage in allowing companies to invest in improvements more effectively. Second, stakeholders should explore ways to partner with the Department of Energy to fund test beds and incubators for sustainability innovations. Finally, there is a huge opportunity to strengthen the middle class through improving the size and training of the craft labor workforce, as well as a great need to continue to attract talent to those fields and to newer positions that are emerging in sustainable energy. Ms. Wince-Smith thanked him for the outstanding presentation, and said that this summary provided a roadmap of where the group should proceed on these issues.

Working Group 2 Calls May 18

Introduction

The Honorable Deborah L. Wince-Smith and Ms. Kathy Trimble welcomed the group and introduced the featured speaker, Dr. James Davis of the University of California, Los Angeles. Ms. Wince-Smith discussed Dr. Davis's previous work with the Council on the Clean Energy Smart Manufacturing Innovation Institute (CESMII), housed at UCLA, which formed the basis of a conference in June 2019 and a report and Congressional briefing this past February. She added that Dr. Davis has an extensive background in smart manufacturing. Mr. Chad Evans discussed upcoming changes to the weekly Working Group calls as the National Commission proceeds toward Phase II over the summer and fall. This includes a hiatus beginning next week while the Council synthesizes the contents of the various Working Group discussions and prepares for the second phase of their work, during which discussions will be led by co-chairs.

Featured Remarks: Framework and Overview

Dr. Davis opened his presentation by discussing the Council's workshop with CESMII in June 2019, and the Council and CESMII's Capitol Hill briefing on smart manufacturing in late February 2020. He said it was prescient that the discussion at the latter event focused on pharmaceutical manufacturing given the subsequent COVID-19 crisis. He added

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that the themes of the June 2019 workshop, Democratization and Innovation, remain relevant today. Dr. Davis also went into the background of CESMII, which is housed at UCLA and sponsored by the Department of Energy as part of the Manufacturing USA Institutes program. It has $35 million in project funding in its third year, and by the end of next year will have $50 million in project funding.

Dr. Davis described the digital transformation of manufacturing as a "frontier" that would fundamentally reshape manufacturing operations going forward, and said that in spite of the immense economic incentives for American manufacturing to adopt smart manufacturing techniques, the United States does not have the same interest and drive in coordinating a national transformation of the manufacturing sector that many European countries have. He attributed this to a combination of industry voice and the sheer scope of the transformations required in the United States. He added that much of the considerable American investment in advanced manufacturing practices is siloed and focused on one-off innovations without broader application. This leads to missed opportunities as those funds could have been directed into programs with much broader applicability that could help expedite the universal adoption of smart manufacturing in the United States.

The Democratization of Innovation

Dr. Davis categorized the necessary transformations of manufacturing as building the talent for the workforce of the future, "data and infrastructure thinking" to address challenges and implement best practices, "market thinking" for strategic investment in smart manufacturing, and "data opportunity and security thinking" to ensure smart and secure manufacturing. He said that the first pillar, developing the workforce, was essential to the success of the other three objectives, and he spoke of the need to get rid of the notion that manufacturing was "dirty, dumb, and dangerous" and to replace it with an inspirational vision of what manufacturing is and can be. Dr. Davis expanded upon this theme by distinguishing between a "manufacturing" mindset and a "making" mindset, the latter of which he characterized as thoughtful and innovative.

Another important distinction Dr. Davis drew was that between "digitization", or putting operations into digital format, and "digitalization", or restructuring operations as a result of data. He said the latter term was more precise and better captured the transformations necessary for smart manufacturing. Dr. Davis then went on to describe the primary objectives (competitiveness, consumption, data opportunity and security, and resilience) and means (productivity, precision, performance, and innovation) of digitalization.

Dr. Davis defined the objective of competitiveness in terms of market share, global economic value, and the safety and environmental impact of manufacturing operations, which he emphasized are increasingly important components of global competitiveness. Regarding consumption, Dr. Davis stressed the imperative of using less energy and fewer materials more effectively as a key objective of smart manufacturing. He described data security as a major sustainability issue, and emphasized that it was an opportunity as well as a challenge because of its potential to enhance productivity. Finally, he noted that the importance of resilience was finally becoming clear to manufacturers in the wake of the COVID-19 pandemic, after thought leaders in manufacturing had stressed it for years with little success. He included supply chains, re-shoring, workforce safety, and the ability to retool production and operations in response to crises as components of resiliency. He also discussed the importance of data security to resiliency, noting that advanced manufacturing can be hampered by cyberattacks and by the failure to identify opportunities revealed in data. Dr. Davis added that manufacturers were already discussing resiliency as it pertains to both physical equipment and intellectual property in the wake of the pandemic.

For means, Dr. Davis discussed the importance of improved productivity across the production process. He also emphasized the need for precision as demand for purpose-built products continues to grow and products come with more and more specifications. Related to precision is performance, which Dr. Davis defined as being efficient on a local level and doing things right the first time. Finally, he framed innovation in the context of smart manufacturing as the product of data in context, with the right kind of data in the hands of anyone who can drive value across the entire manufacturing ecosystem, supply chain, or value chain.

Case Studies in Smart Manufacturing

After this framing, Dr. Davis gave several case studies of the benefits of smart manufacturing. First, he discussed the use of sensor technology in furnaces that convert methane into hydrogen. Because running furnaces at a higher, more even temperature yields increases in productivity and efficiency, a manufacturer began placing infrared cameras around the outside of its furnaces, and converting the scans from those cameras into temperature data across all 96 furnaces. This real-time data enabled the factory to maintain constant, high temperatures across all its furnaces, enabling much higher productivity and efficiency. The keys to this data collection were image processing, feature extraction, modeling, and machine learning, all of which helped convert the scans from the cameras into temperature data.

Another application of smart manufacturing is in steel making. The components of steel are heated, mixed, and poured through a funnel that turns into a slab, that is then rolled and sent off to secondary manufacturers, like car companies. With conventional techniques, imperfections that render the steel unusable are not detectable until the rolling stage, but using cameras during the casting and pouring processes, as well as putting sensors on rollers, allow steel makers to identify and even predict imperfections, and consequently intervene to prevent them, at an earlier stage of the process.

Glass making also benefits from smart manufacturing. The glass maker Corning Incorporated procures its supplies from specialty small suppliers, and widely distributed data collection tools among its supplier base allows it to know the particle size distribution of all its component ingredients. This gives the company much greater precision, and thus efficiency, in its manufacturing process, and is an example of the benefits from interoperability between companies in a supply chain.

The food processing industry also benefits from smart manufacturing. General Mills has over 4,000 suppliers that contribute materials to its gluten-free Cheerios, and a single grain elevator that is contaminated with gluten would normally require the company to throw out entire batches of raw material. However, sensors that detect gluten and model how it is mixed, matched, and removed in the supply chain enable suppliers to identify and prevent cross-contamination at a much earlier stage, drastically reducing wastage.

Finally, Dr. Davis discussed the case of a small specialty cardboard packaging manufacturer. Just one sensor on their equipment enables them to manage their volume and assets at such an improved level that they can save 20 percent in production costs. Dr. Davis continued by noting that smart manufacturing can add 15-25 percent to a company's economic value. He said that if just 10 percent of manufacturers across the country adopted the sensory and modeling technology he discussed, the economy would see $200 billion in new production, 1.5 million additional jobs, and two quads (quadrillion British Thermal Units) of energy.

The Socio-Technical Dimension of Resilience

Dr. Maya Trotz of the University of South Florida asked if more smart technology in socio-technical systems could reduce food waste. She discussed public reactions to farmers dumping milk supplies in the midst of an economic crisis, and asked if better data would

allow oats contaminated by gluten to be used for other purposes rather than thrown out. Dr. Davis said that in addition to companies with more digitalization capabilities faring better during the COVID-19 crisis, General Mills could use information about those batches and their location and condition to find another use for them. He said that this idea was an example of the importance of data to resiliency.

The Evolution of Smart Manufacturing Technologies in the United States

Next, Dr. Davis discussed the evolution and incorporation of technology into U.S. manufacturing, including why the United States is much more siloed in its adoption of advanced manufacturing technology. He characterized the four waves of industrialization as (steam) mechanization, electrification, digitization, and smart manufacturing/machine learning. He said that the data revolution was missing from this paradigm. He described early examples of digital transformation in manufacturing, including the movement from manual to voltage-driven machine controls, and the advent of modular coding, including initiatives like the Aspen Project, in the 1970s. Dr. Davis said these early data-using technologies were asset-oriented and functional, engineered to the specifications of a particular industry regardless of the processes or supply chain. By the 1990s, the rise of the internet made a new kind of data possible, but Dr. Davis said the real distinction was not "big" versus "little" data, but contextualized versus non-contextualized data. Contextualized and interpreted data is the key to smart manufacturing, and Dr. Davis said that industry, having moved from passive to reactive data, now needs to move to predictive data with AI and machine learning. He summed up contextualized data as the right information at the right time and place in the right form, fed into the right technology for the right people to make smart decisions.

One particular feature of the internet is its use of "layered" or "network" thinking. Underlying code, whether HTML, XML, or any other code, is horizontal and can be used across technologies. It can also be layered on top of other codes to produce more complex machines. Dr. Davis said that AI and machine learning also operate in the same object-oriented fashion: the code sets up "classes of objects" and code is reusable in a horizontal way between objects in a given class. He said that while AI did not gain traction in manufacturing in the 1980s, the internet and information technology provide examples of the benefits of horizontal coding with reusable classes and data. By contrast, manufacturing coding is vertically-oriented, leading to extensive compartmentalization in manufacturing technology despite strong economic pressures for interoperable technology. Because technology, data, and coding designed for one kind of manufacturing equipment are not interoperable, up to 90 percent of the cost of advanced manufacturing projects comes from data, presenting major constraints as technology is managed to the level of greatest complexity. Dr. Davis described trying to create interoperability in functional or asset-developed coding was essential for the effective widespread implementation of smart manufacturing technology.

Dr. Davis concluded this section of his presentation with a warning that while AI and machine learning provide many tempting opportunities for one-off investments, they can badly malfunction in the absence of contextualized data. He said that CESMII was focused on thinking carefully about the horizontal infrastructure and layering necessary to make AI-based smart manufacturing technologies viable.

"Market Thinking" and the Value Proposition of Smart Manufacturing

Finally, Dr. Davis spoke of the need to alter the value proposition for manufacturing. He said that currently it still makes economic sense for companies to invest in siloed technology, even with the proliferation of cloud products that should make interoperability easier. He said that this combination of "island" technologies and cloud capability is increasing, rather than

decreasing, the complexity of smart manufacturing. He said that because only large companies can afford smart manufacturing technologies, the widespread adoption of smart manufacturing practices is impossible. Moreover, small and medium-sized companies account for 99 percent of manufacturing supply chains, yet many small firms have trouble installing even one sensor into their factories. Dr. Davis said he was hopeful that sufficient economic incentives were accumulating to shift the value proposition toward horizontal integration, but it is still an open question how to move out of the existing environment. He said that a stronger voice from manufacturers on the importance of adopting smart manufacturing technology and making the case for the value proposition in infrastructure will be essential to securing the necessary investment to bring this transformation to fruition.

Challenges and Opportunities for Public-Private Partnerships

Mr. Evans asked what opportunities and challenges CESMII was seeing with public-private partnerships, noting that it is putting into practice many of the ideas discussed regarding new forms of public-private partnerships. For opportunities, Dr. Davis identified the ability of public-private partnerships to bring "critical mass" to initiatives in order to demonstrate the value of the changes the institute advocates, as well as the ability of these partnerships to act as neutral bodies promoting best practices and innovations without concerns of ulterior motives that would arise if any individual stakeholder was spearheading the effort. For challenges, Dr. Davis cited conceptualizing how the partnership will play out in practice as the most difficult obstacle, noting that most of the Manufacturing USA institutes operate on a five-year timeline, and that they need to align their mindsets to properly tackle challenges. He distinguished between institutes focused on a particular technology, which can build coalitions for the expansion of said technology, with those like CESMII that have a more abstract focus. He noted that CESMII, with its focus on digitalization, has the ability to move quickly compared to many institutes, but that it also faces organizational, market, and risk barriers around the leveraging of data in the manufacturing process.

The Geography of Smart Manufacturing

Dr. Helene Dillard of the University of California, Davis asked where smart manufacturing operations would be located, and if they were located in rural areas, what barriers internet service would create. Dr. Davis said that CESMII has developed a concept of innovation centers located throughout the country, and emphasized a mentality of taking the institute to industry, rather than bringing industry to the institute. He added that small and medium-sized manufacturers in rural areas were a critical part of the manufacturing sector, and finding a way to incorporate smart manufacturing into their operations was crucial. He added that the internet was not yet a barrier because so many small and medium-sized manufacturers have "low hanging fruit" with regard to basic data and sensor incorporation, and that existing initiatives are not yet at the level of data intensity where internet capacity has become an issue. However, he did foresee these challenges being an issue in the future.

Workforce Upskilling and Training

Ms. Amy Lientz of Idaho National Laboratory asked about the importance of upskilling the workforce and aligning workers' capabilities with future industry needs, including skills in digitalization, AI, and high performance computing. Dr. Carlotta Arthur of the Luce Foundation said that as a quality control engineer, smart manufacturing is a dream come true because it is more efficient, less wasteful, and higher quality than conventional manufacturing. However, she echoed the importance of changing manufacturers' mindsets and upskilling the workforce. Dr. Davis said he was seeing interesting trends in workforce development, including reverse mentorships, apprenticeships, and other initiatives. He characterized the

major challenge as trying to scale and repurpose these programs across the manufacturing sector, and institutionalizing many of these educational programs in four-year and vocational institutions. Dr. Davis said that layering and horizontal thinking skills were as important for workers as they are for manufacturers, and should be considered as part of their training along with training in particular technologies. He noted that the most pressing challenge facing manufacturing was encouraging adoption of smart manufacturing practices without scaring away industry with the return on investment.

Challenges and Opportunities for U.S. Manufacturing

Ms. Wince-Smith asked Dr. Davis what gaps he saw in the Manufacturing USA institutes, and where he would invest in, ramp up, or combine efforts of different institutes if he had a mandate to better coordinate them. Dr. Davis identified developing a stronger and more consistent voice for the U.S. manufacturing industry as a key component of such efforts, as the U.S. manufacturing industry has a relatively sporadic and weak voice compared to the industries of other countries. He said U.S. manufacturers need to develop a more concerted and coherent value proposition regarding digitalization, and that the compartmentalized efforts of individual institutes do not have same impact as all of them, or the industry as a whole, speaking as one. He also called attention to the need to emphasize the risk to industry from outdate equipment and information technology, as well as the current intellectual property regime, and the need to establish a value proposition for mitigating or managing those challenges. He particularly identified shared infrastructure as a critical component in doing so, because of the role it plays in facilitating layered or horizontal thinking.

Ms. Wince-Smith also asked what the state of the U.S. manufacturing supply chain was, and whether it had the capability to quickly scale production of vaccines or other treatments for COVID-19. Dr. Davis said that he could only speak anecdotally, but that the consensus among CESMII's membership base was that the United States possesses the production capabilities needed to produce large quantities of vaccines, but that further, more coordinated efforts at digitalization will be needed. He expressed optimism but again stressed the need for industry to speak as one voice on the importance of encouraging this digitalization and then to work together to implement it. Ms. Wince-Smith asked if there was a role for the federal government in coordinating this response, and Dr. Davis said that orchestration by a coordinating body was needed to ensure the response of industry is coherent and does not result in unnecessary duplication of effort. He added that a similar coherence was needed for nationwide cybersecurity efforts, as the United States becomes increasingly vulnerable to cyberattacks.

Concluding Thoughts

Ms. Wince-Smith thanked Dr. Davis for his presentation and the group for its discussion, and said that the Council would welcome any disruptive recommendations participants have that emerge from these discussions. She observed that the United States possesses lots of pieces that could be synthesized into a dynamic innovation ecosystem for smart manufacturing, but that more integration is needed rather than the current approach of splintered individual efforts.

Working Group 2 Calls May 22

Introduction

The Honorable Deborah L. Wince-Smith and Ms. Kathy Trimble welcomed the group, and introduced the featured speaker, Dr. Ricardo Ernst of Georgetown University. Ms. Trimble announced that this call would be the end of the first phase of the Working Group discussions, and that the Working Groups would reconvene for Phase II the week of June 22nd. She added that more information would be coming soon.

Featured Remarks: Overview and Framing

Dr. Ernst opened his remarks by discussing his work with colleagues on the impact of the COVID-19 pandemic on global supply chains, and the increasing importance of supply chain resiliency. He discussed how the crisis had revealed the dependence of supply chains for chemicals, textiles, pharmaceuticals, and other goods on multiple countries all over the world, driven by more demanding consumers and a drive for cost efficiency. He noted that there was concern about global supply chains even prior to the pandemic because of the escalating tariff war between the United States and China, and that interrupting global supply chains inevitably creates major disruptions because of the interconnectedness of the world economy. Dr. Ernst also noted increasing media interest in supply chains during the pandemic.

De-Globalization or Re-Globalization?

Dr. Ernst discussed a book he recently co-authored called *Globalization, Competitiveness, and Governability*, and its central theses that globalization was here to stay, and closely linked to and influenced by competitiveness and governability. He said although globalization is going to change in the wake of the pandemic, it is very unlikely to disappear, as each successive disruption reveals the increasing interconnectedness of the world. Dr. Ernst described the globalized economy as one in which companies compete "with everyone, from everywhere, in everything," and observed that a single cup of Starbucks coffee involves 19 different countries in its supply chain. As supply chains expand across the globe, companies

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follow a mantra of "produce nowhere to sell everywhere," and the heated competition between firms in the global marketplace has shown that customers care about brands, not where products come from. Dr. Ernst said that companies respond to this incentive by building their supply chains based around leveraging brand. While the idea that the era of globalization is over has become popular recently, and has even been entertained by magazines like The Economist, Dr. Ernst argued that the pandemic would lead not to de-globalization, but to re-globalization, or a reorganization of the relationships between and among companies and countries.

Supply Chains and Inventory

Dr. Ernst argued that competition between firms should not be seen as "my company vs. your company," but as "my supply chain vs. your supply chain." He predicted that with the disruptions to supply caused by the pandemic, firms would begin to rethink their opposition to inventory, which becomes very valuable when disruptions prevent new supplies from arriving and cripple the "just in time" model that prevails among cost-conscious firms. While acknowledging that this would increase the expense of supply chains, and consequently of products, Dr. Ernst stressed the benefits of adding a "safety net" back into the production process, and avoiding the economic contraction that began when quarantines shut down the supply chains of all firms with suppliers or distributors in China, Italy, and South Korea. He added that while supply chains initially went to China because of the low labor costs, the renewed push for resiliency is revealing that there are costly risks to only focusing on efficiency.

Classifying Disruptions and Describing Resilience

Drawing on the work of management consulting firm McKinsey and Company, Dr. Ernst characterized resilience as being composed of resistance to disruptions, including avoidance and containment, on the one hand and recovery from disruptions, including both stabilization and reopening, on the other. He also drew on a conceptual framework developed by McKinsey for characterizing business risks. Highly predictable disruptions with a small business impact are considered "Business Challenges", and include labor disputes, regulatory changes, and changing customer requirements. They can be managed within a framework of other business development decisions. Unpredictable but minor disruptions are "Manageable Surprises" and include supplier bankruptcies and localized conflicts in countries with few company operations. These disruptions can easily be avoided or accepted as a part of doing business. Highly impactful but predictable disruptions are "Brewing Storms" and include events like Brexit and the tariff escalation between the United States and China. These risks are significant enough that they require contingency planning. Finally, highly damaging and unpredictable disruptions are "Black Swans" and include wars, natural disasters, terrorist attacks, cyberattacks, and pandemics like the current COVID-19 outbreak. These disruptions require a robust crisis management plan that is in place before a disaster.

Dr. Ernst also discussed typical versus atypical risks, and discussed how COVID-19 is the epitome of an atypical risk. It is affecting the entire planet rather than a locality or region, it is affecting all industries instead of just some, it is affecting both supply and demand instead of just supply, and there is no recent prior experience to guide policy response. Further, it has been highly correlated with the performance of the financial system, is of an uncertain and extended duration, and will have a large, unpredictable impact on people's long-term behavior.

Recalibrate, Reevaluate and Redefine

In response to the unprecedented disruption of COVID-19, Dr. Ernst argued that economies and companies need to recalibrate their expectations, reevaluate scenarios, and redefine their businesses and business models. He said that thinking in terms of re-globalization will enable firms and countries to successfully transition their supply chains. Critical to the redefinition of supply chains is distinguishing

between "efficiency" and "effectiveness." Dr. Ernst defined efficiency as reducing costs in facets of production that are internal to the organization and within its control, including labor, equipment, raw materials, money, and operations. He defined effectiveness as a company's ability to satisfy its customers and respond to their needs. He described four types of companies based on their ability to anticipate market changes and their need to be proactive or reactive, and gave examples of industries and firms fitting each archetype.

Firms that are reactive and able to anticipate market shifts are "Agility" firms, and include fashion companies like ZARA. Their business models are built on being able to respond quickly to changing customer tastes, like new fashions for clothing. Firms that are reactive but have low anticipatory ability are "Efficiency" firms, and include makers of commodities and consumer goods, like Proctor & Gamble. These firms focus on cost minimization in their supply chains above all else. Firms that are proactive and have high anticipatory ability are "Effectiveness" firms, and include makers of luxury or higher goods like Apple, as well as makers of essential supplies like vaccines. These firms need to prioritize quality, safety, and customer service to thrive. Finally, firms like Amazon and makers of durable goods are "Flexibility" firms, with low anticipation and a proactive business model. These firms try to find a balance between efficiency and effectiveness. Dr. Ernst noted that Amazon is not always the cheapest provider of a given product, but it sells over 560 million different products, allowing it compete on efficiency, effectiveness, or both depending on the circumstances.

Dr. Ernst concluded his remarks by emphasizing that one size does not fit all for supply chains, and that different firms will need to prioritize different elements depending on their industry and circumstances. He said firms also need to view themselves as having a network of multiple supply chains and organizing them to maximize resiliency. He added that supply chain experts have begun asking businesses questions about their supply chains, including how they define resilience, what resiliency measures they are taking, how involved suppliers are in their decisions, how they categorize and define their products, whether they are proactive or reactive, how they measure the resilience capability of their supply chain(s), whether their supply chains vary for different products, if they link risk management to supply chain management, and if they prioritize cost or response time in their product lines.

Amazon and "Inoculating" Supply Chains

Mr. Chad Evans asked if Amazon's $400 million effort to "inoculate" it supply chain from disruptions and increase its resiliency will be successful, and if being able to brand themselves as having the most secure and reliable supply chain will provide them with a competitive advantage. Dr. Ernst said that it would not be easy to do and will necessitate increasing costs, but that it is possible as Amazon's competitors, especially brick and mortar stores, will be facing higher supply chain costs as well. E-commerce firms like Amazon also have a significant advantage in convenience, and by competing on quality, safety, timeliness, and convenience, Amazon can maintain or even expand its market share.

Special Considerations for National Security

Mr. Bill Bates asked if there should be different rules or regulations for supply chains that are purely commercial and those that have national security or public health implications. Dr. Ernst said they there should definitely be different rules, and discussed his experience working in humanitarian logistics, where organizations placed a premium on safety and responsiveness as opposed to low costs. Ms. Wince-Smith said it was important to rebuild trust in supply chains, and predicted that companies would increasingly compete on safety, security, integrity, convenience, and timeliness. She discussed problems with tainted food supplies from China and said that Japan

does not allow Chinese products in its food supply chains. Ms. Wince-Smith also advocated restarting pharmaceutical production in Puerto Rico, and forging closer economic ties with Mexico and other Latin American countries, building on the reworked North American Free Trade Agreement. She added that U.S. firms should incorporate labor standards into their supply chain decisions, and she discussed the importance of the rule of law and good governance, as corruption and fiscal mismanagement led pharmaceutical companies to leave Puerto Rico in the first place. As another national security concern, Ms. Wince-Smith discussed the need to end China's dominance of the global rare earth mineral market. She noted that the United States, Australia, and Kazakhstan all had rare earth mineral supplies, but that they could not compete with China on cost, leading to a major national security challenge.

De-Sinization of Supply Chains

Mr. Evans asked if relocating supply chains from China was feasible or even possible, especially in a short time frame. Dr. Ernst said that the shock to companies of the tariff wars between the United States and China had already caused firms to rethink their supply chain decisions, and that quality and stability of governance is an important factor in competitiveness. He noted that China was offshoring some of its own manufacturing as well. Ms. Wince-Smith added that firms also chose to set up in China in order to be close to the potentially enormous Chinese market. She asked if there was an opportunity to realign supply chains at a regional level, with the United States moving toward more supply chains based in the Americas. Dr. Ernst said there was, and that while Latin American countries cannot compete with China on cost, they have much higher quality manufacturing, including state-of-the-art Audi and Whirlpool factories in Mexico, and are much closer, giving them a time-to-consumer advantage that China cannot compete with. Ms. Wince-Smith said that supply chain decisions needed to have a strategic component, and Dr. Ernst agreed, while adding that the importance of strategy would vary depending on the product in question.

Regional Supply Chains and the Latin American Opportunity

Dr. Ernst warned that there was a short window of opportunity for U.S. firms to relocate production to Latin America and take advantage of its security and proximity, and he urged firms to take action as soon as possible. He said that China would no longer be the world's preferred supplier for everything, and paraphrased Darwin in arguing that responsiveness to change, not size, strength, or intelligence, is the key to survival, both in nature and in business. He said it was important to come up with normative recommendations for companies to follow to become more resilient. Ms. Wince-Smith noted that China cannot compete on time and convenience in its supply chains, and Dr. Ernst agreed. He discussed Ikea's investment in delivery services, and their increased competitiveness from being able to deliver high-quality products and eliminate the need for consumers to travel. He said this was indicative of long-term trends as people become more willing to pay for convenience and added free time, and that this would impact what companies prioritize in their business models.

Concluding Thoughts

Ms. Wince-Smith thanked Dr. Ernst for his presentation, and said she hoped he would be able to speak to the Global Federation of Competitiveness Councils on the topic of supply chains. She said the Council was looking forward to Phase II of the Working Group discussions, and noted that the Council had previously formed a close connection with a similar organization in Mexico.

Working Group 2 Calls June 22

Introduction and Summary of Changes

Mr. Chad Evans and The Honorable Deborah Wince-Smith welcomed the group. Mr. Evans reminded the group that it will not meet on July 6 or September 7 due to the Independence Day and Labor Day holidays, and mapped out an agenda for the session, including summaries of Phase I of the Working Group Calls, remarks from the group Co-Chairs, and a summary of the virtual meeting of the National Commissioners and Advisors on June 16. He discussed the formation of a fourth Working Group on Unleashing Capabilities for Work and Entrepreneurship, and reminded group members they were welcome to join that group as well. Ms. Wince-Smith said that the new Working Group would focus on the future of work, workforce skills and training, the democratization of innovation, diversity and inclusion, and regional innovation ecosystems. This group will continue to focus on the sustainability of production and consumption, as well as questions of energy and the circular economy. She also thanked Senior Advisor to the Council Ms. Carol Ann Meares for her contributions to the National Commission's efforts through research, writing, and data analysis.

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Ms. Yasmin Hilpert

Mr. Tim Planert

Ms. Carol Ann Meares
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Overview of June Commissioners and Advisors Meeting

Mr. Evans summarized the June 16 meeting of the National Commissioners and Advisors. He observed that over 90 people attended the call, including over 50 Commissioners, and that they applauded the work of the Working Groups and expressed gratitude for their contributions. They urged the Commission to leverage its activities sooner rather than later, and to begin a push for external engagement with its work. The Commissioners also requested added emphasis on two topics: increasing inclusion and social progress to advanced opportunity for underrepresented groups, and increasing resiliency in supply chains, materials, and other aspects of the economy. The Commissioners felt that the country's shortcomings in these areas inhibit growth, competitiveness, and inclusive prosperity. Mr. Evans also discussed the charge from Arizona State University President Dr. Michael Crow, a Co-Chair of the Commission and the University Vice Chair for the Council. He stated that the rules of engagement have radically changed, and that policies that worked in the 20th Century no longer work. He urged the Commission to explicitly look at the evolving landscape and propose dramatic policy changes. Finally, Mr. Evans noted the attendance at the meeting of Sen. Todd Young (R-IN) and the recording of a video address to the Commissioners by Sen. Charles Schumer (D-NY), who co-authored the Endless Frontiers Act, a bicameral, bipartisan bill that increases funding for R&D and seeks to galvanize innovation in the United States.

Phase I Recap and Explanation of Synthesis Documents

Mr. Evans discussed the synthesis report that the Council put together from the first phase of Working Group calls, as well as the compendium document containing summaries of every Working Group session. He said that the Council identified nine "pillars" of common themes that emerged across the different Working Groups' discussions and were "pivotal, strategic, and urgent." The Council's press release summarizing the Commissioners' Meeting and announcing the Nine Pillars has already received significant media coverage. Mr. Evans explained that the concepts were color-coded in the compendium to identify discussions that were relevant to each pillar across the Working Group calls, and how the pillars helped the Council prioritize what it presented to the Commissioners. As one example of a key pillar, Mr. Evans discussed the COVID-19 pandemic and the need to improve the nation's resiliency in the face of crises, as it emerged as a consistent discussion point across all three groups. He added that the Commissioners agreed with the Nine Pillars during their meeting, and that they expressed the belief that the country is entering a historic time and that the Commission has a distinct role to play.

Strategic Communications and Opportunities for Engagement

Mr. Evans and Ms. Wince-Smith discussed the growing awareness in Washington, DC of the importance of innovation, as reflected in numerous pieces of legislation. In addition to the aforementioned Endless Frontier Act, Mr. Evans discussed the CHIPS Act, a bipartisan piece of legislation that aims to increase production of semiconductors and advanced microelectronics in the United States. The Council has also approached and been approached about other opportunities for innovation policy on topics relevant to the mission of the Commission. Ms. Wince-Smith discussed the video series the Council has begun in collaboration with the Commissioners highlighting important issues in competitiveness and aimed at the general public. She also discussed the Council's progress in filling out the membership of the Innovation Council and upcoming Technology Leadership and Strategy Initiative Competitiveness Watch session, in which the Chief Technology Officer of the United States will address the Council's conference of Chief Technical Officers. Ms. Wince-Smith further discussed the Council's engagement with the President's Science Advisor.

Mr. Evans elaborated on the role of the Innovation Council, a group comprised of senior standing government officials that will partner with the Council to help tailor recommendations to maximize their impact and success. The group includes the directors of the Defense Advanced Research Project Agency (DARPA), the U.S. Patent and Trademark Office, the Export-Import Bank of the United States, and the Undersecretary of Commerce. The Innovation Council will help the Council pull together Year One recommendations in the fall ahead of their release in December at the National Competitiveness Forum. Mr. Evans also discussed the Outreach and Engagement Committee, a group of strategic communications leaders who are part of the National Commission and will act as in-house experts on publicizing and fostering engagement with the recommendations and ideas that come out of the Working Group sessions. He said the Council would begin to deploy the Outreach and Engagement Committee shortly with the release of the Nine Pillars.

Remarks from Co-Chairs

The Co-Chairs of the Working Group shared their backgrounds, interests, and goals for the second phase of Working Group discussions. Ms. Stacy Lippa of Target described her background in supply chain management and manufacturing spanning 25 years, and her current role as director of the food supply chain at Target. She expressed great interest in the discussions the group has had around building consistency and sustainability into supply chains, and characterized the problems facing corporate supply chains as complex and requiring creativity, innovation, and strategy to address. Ms. Lippa added that the pandemic had accelerated the rate of change, and expressed hope that the group's discussions would identify key takeaways from the COVID-19 pandemic and use them to discuss supply chain designs and sustainability in a new way. She spoke of the importance of preparing the next generation to be stewards of sustainable businesses and of developing a "people first" strategy of supply chain management to leverage varied and diverse perspectives and drive more business value. Ms. Lippa also expressed appreciation for the group's inclusion of leaders from both academia and the corporate world, creating a group with diversity of thought and expertise.

Dr. Al Pisano of the University of California, San Diego discussed his career in academia and his experiences at DARPA and in startups. He emphasized that the production and consumption processes of the future do not all exist yet, and stressed the need for change and innovation. He said there was insufficient union between corporate and academic efforts on innovation, and he particularly highlighted the need to "open the funnel" of innovation to informal, amateur, or "new" entrepreneurs. He characterized the US economy as being at the point where generating new jobs and innovative methods of production and consumption could be a powerful force for driving the economy forward.

Dr. Branko Terzic of Berkeley Research Group discussed his background in regulated utilities, specifically electricity and natural gas distribution. He highlighted the need for the group to discuss not just de-carbonization, but control of other greenhouse gases and the production of toxic materials in supply chains, especially for energy sources like batteries. He emphasized the need for innovation and new technology to address the economic, environmental, and public health implications of these problems. He also warned that regulated utilities are slow to innovate because of heavy government intervention and oversight, and spoke of the need to ensure that government does not favor the wrong technologies or innovations, and accepts the right ones under appropriate standards.

Dr. Mohammad Zaidi of Braemar Energy Ventures described his 27 years at Alcoa, working on metals, mining, and aerospace, automotive, and commercial transportation products. He characterized his career as being evenly split between manufacturing and running businesses, and noted that his work at Alcoa had taken him to Alcoa facilities all around the world, including China, Russia, and India. Dr. Zaidi said he now is involved with venture capital, running a firm in New York that has investments in 45 different energy, transportation, and materials companies. He

is also a Fellow at the Council and formerly served as the Co-Chair of the World Business Council for Sustainable Development. Dr. Zaidi encouraged the group to identify new policies innovations, and applications that are implementable at scale in the new technological, geopolitical, and socioeconomic landscape, rather than focusing on issues of the past. He further cautioned that many other organizations focus on promoting and disseminating best practices, and encouraged the group to focus on being innovative and challenging fashionable thinking to maximize its impact. As an example, he noted the focus on how much the U.S. spends on R&D relative to China, but observed during his work at Alcoa how productive China's R&D was even when it spent a fraction of what the U.S. did. He encouraged the group to think about decoupling ideas and concepts that seem to naturally co-occur. He also urged nuance on the question of re-shoring supply chains, and expressed a desire to identify solutions that promote broader involvement from society in addressing sustainability challenges.

Subgroups and Deep Dives

Dr. James Stock of the University of South Florida observed that several members of the group had deep expertise in supply chains, and wondered if it would be productive to split into subgroups that would conduct deep dives on specific topics where members had expertise. Mr. Evans said that the idea was interesting, and that he would welcome members who wanted to take a deep look on a particular topic to share their findings with the group. Dr. Pisano suggested not discussing subgroups until the group had already established cohesion, as cross-fertilization would provide more value than breakout sessions at the early stages of discussion. Ms. Ciannat Howett of Emory University agreed, adding that discussion among a diverse group of subject matter experts was the optimal way to generate the disruptive new thinking urged by Dr. Zaidi. Dr. Zaidi echoed support for beginning with one group discussion and forming subgroups offline to discuss specific innovative ideas that emerge on particular topics.

Platform Technologies and Market "Inversions"

Dr. Pisano discussed how many industries are being "inverted" by innovations, particularly of software and supply chains. He observed that the rise of autonomous systems in cars was turning competition in the automotive industry into one of software, with the hardware of cars increasingly becoming an undifferentiated commodity. He observed that some companies, like Tesla, were ahead of others, like Ford and General Motors, in recognizing this trend. He further illustrated this phenomenon with the example of the cell phone industry, and how Apple turned the industry from a hardware industry to a software industry with the iPhone, which disrupted the market by turning phones into computers that had telecommunication functionality. Dr. Pisano expressed his belief that a similar inversion would happen in the cellular market with the advent of 6G technology. Hardware like fiber networks will become increasingly commoditized, and will serve as a platform on which different kinds of software can operate.

Dr. Pisano noted that big technology companies have seized on the inversion model, and encouraged the group to explore other areas and sectors where it could apply. He noted that in addition to the role large companies play in this process, inversion turns technologies into platforms that enable small and medium sized firms and entrepreneurs to innovate on a massive scale. He suggested that identifying other opportunities to create platform technologies could spark a huge surge in innovation if smaller firms and entrepreneurs had access to these new technologies. Ms. Wince-Smith said there was great value to this idea, and highlighted its synergies with the ideas discussed in other Working Groups. She noted that tech companies like Apple have created tremendous wealth with their platforms, but that this wealth has become decoupled from improvements in the average American's standard of living and the growth of the middle class. She also discussed the necessity of ensuring Americans participate in an inclusive way in research and entrepreneurship through the creation of new jobs. Dr. Pisano said that platform technol-

ogy is often intimidating, with special knowledge or software serving as a barrier to entry. He argued that if the country did a better job opening access to platform technologies to small and medium-sized enterprises and individuals, the economy would not redistribute existing wealth from tech giants, but instead create new wealth.

Supply Chain Security

Ms. Wince-Smith urged the group to examine the actions taken by other nations to shore up their supply chain security, including Japan and Australia's attempts to decouple supply chains in strategic industries from China. She noted the wealth of expertise on the subject in the group, and encouraged anyone who wanted to present on the topic to do so. Ms. Lippa agreed and said she would also like to focus on the issue. She added that other countries' actions will provide many case studies in supply chain management for future learning.

Opportunity, Diversity, and Inclusion

Dr. Carol Dahl of the Lemelson Foundation said she was glad the Commissioners were supportive of the creation of a fourth Working Group, and stressed the importance of both supply chain resiliency and sustainability and changing the trajectory of opportunity for America's youth, who will form the workforce of the future. She characterized their response as a reinforcement of the Council's decisions. Dr. Nathan Hillson of Lawrence Berkeley National Laboratory expressed a desire to incorporate the National Laboratory system going forward, noting the influence in the Commission of current and former National Lab personnel. Dr. Kathleen Merrigan of Arizona State University supported the discussion of diversity because of its salience to current events, and added that she would like to see the group talk about the treatment of low wage workers in difficult occupations, such as meatpacking. In addition to a focus on equity, Dr. Merrigan expressed interest in the re-localization of food systems and other aspects of the economy, as well as carbon markets and carbon taxation. Dr. Carlotta Arthur of the Luce Foundation also expressed support for the discussion of diversity, and characterized diversity, equity, and inclusion as core to all of the Commission's goals. Mr. Evans also highlighted her sharing on the platform of a series of policy development tools to ensure that policy recommendations reflect racial equity, and Dr. Arthur added that she would be happy to further discuss them with members of the group.

Dr. Maya Trotz of the University of South Florida discussed her initiative to increase the black community's engagement with the innovation economy, and expressed interest in exploring how universities in cities with large African-American populations could better include the black community in their cities in innovation and competitiveness initiatives. She discussed challenges in finding engineering faculty to help put together the initiative, and wanted to know how the private sector engages with these questions. She also discussed the role of platform technologies in the future of innovation, and asked whether the technology that wins out and shapes what Americans produce and consume will be the one to recognize the benefits of inclusion.

Concluding Thoughts

Mr. Evans expressed support for Dr. Trotz's idea, and said it was the kind of big, innovative concept necessary to make the changes the country needs. He added that we would like to further explore the concept in depth, and he reminded the group to send the Co-Chairs and the Council Team a list of priority topics via email or the online portal. He said that while the group will winnow down these topic areas to 2-4 topics to prioritize developing recommendations for in year one, the Commission is a multi-year effort and those topics left off the initial list may be revisited at a later date. Mr. Evans further noted that the primer for this week's call includes criteria for creating recommendations that are actionable, including specifications for how to fund and oversee initiatives and specifying leadership and governance responsibilities. Finally, Mr. Evans reminded the group that meetings will occur every Monday at 1 PM, with the exception of July 6 and September 7 due to Federal holidays.

Working Group 2 Calls June 29

Introduction

The Honorable Deborah Wince-Smith welcomed the group and thanked participants who submitted a list of priority topics for the group to consider in the coming months. She reported that in addition to last week's successful discussion, the other three Working Groups had productive initial meetings as well. Mr. Bill Bates described the purpose of the session as building upon the assignment given to participants to outline priority issues, and focusing down on a set of topics that will be used to guide the next several discussions. He added that Ms. Carol Ann Meares, Senior Advisor to the Council, would lead in the drafting of issue papers to prepare members in advance of each call.

Co-Chair Opening Remarks

Dr. Mohammad Zaidi of Braemar Energy Ventures summarized the proceedings of the Working Group Co-Chair call last Thursday, including his identification of the options for the group's focus over the coming months. He said that while the group could focus on best practices and efficiencies in areas like waste reduction and resource efficiency, it would

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be more productive and worthwhile for the group to explore ways to get ahead of the curve and match or exceed America's competitors. He said it was crucial to provide new policies for lawmakers and recommendations for academia and industry that address the technologies of the future, and harnessing and deploying them in a sustainable way. Dr. Zaidi encouraged the group to envision a future where AI, synthetic biology, renewable energy, and other innovations dominate the landscape and consumption preferences have dramatically changed. The group should seek to identify policies that promote sustainable, resilient, and competitive positions in such a world. Dr. Zaidi also reported that he had received priority areas of interest from participants including the circular economy, repositioning supply chains, and enhancing sustainability education.

Ms. Stacy Lippa of Target agreed with Dr. Zaidi's characterization of the Co-Chair meeting, and said she believed the group should prioritize identifying leading strategies for sustainable production and resiliency. She said that the pandemic had exposed challenges in the country's supply chains, and that the group needed to focus its conversations, utilize its unique and diverse skill set, and challenge the status quo by approaching problems through a unique lens. Ms. Lippa suggested developing a roadmap for a sustainable and resilient supply chain and national infrastructure, as well as building AI and other robotic technology into the future of the workforce. She said that workforce preparation for a rapidly changing economy was another key issue area, as talent is both the biggest expense and the biggest competitive advantage for U.S. firms. However, she stressed the importance of building diversity and inclusivity into the talent pipeline.

Dr. Albert Pisano of the University of California, San Diego strongly urged the development of a national network of innovation centers that would combine the best minds and experts from across sectors to develop breakthrough platform technologies. He discussed successful examples of partnerships from the past, including the MOSIS project, an electronics initiative that led to the development and proliferation of Consolidated Metal Oxide Semiconductor (CMOS) technology. Dr. Pisano said such an initiative would be co-located at a major research university and involve government funding and industry participation. He added that a benefit of the MOSIS Project was the ability for anybody who wanted to design a circuit to contribute, and suggested a similar open model to funnel in talent and ideas from people outside of traditional innovation channels in addition to formal research efforts. Ms. Wince-Smith added that other technologies, including Extreme Ultraviolet Lithography and LIDAR, were developed through public-private partnerships, and stressed the importance of including the nation's laboratories as well as universities in these efforts. This includes not just the National Laboratory system, but other facilities owned by NASA, the Department of Defense, and other government bodies. She said that public-private partnerships could be used to help knit together the components of America's innovation system.

Dr. Branko Terzic of Berkeley Research Group remarked that six months ago, supply chain security and resiliency were not on the radar of policy makers or industry, but that the COVID-19 pandemic had revealed the dangers of relying on one foreign producer for critical technology and materials. In addition to advocating greater diversification and competition in supply chains, Dr. Terzic emphasized the need to make the economic case for sustainability, and to think about incentives and policy changes, like tax incentives, needed to overcome the barriers to companies adopting more sustainable business models.

The Business Case for Sustainability

Dr. Thomas Gardner of HP Federal agreed with Dr. Terzic's emphasis on the business case for sustainability, and in particular stressed the importance of developing and emphasizing metrics that illustrate the internal rate of return to sustainable business decisions for investors, as companies expect to see gains within two to five years of their initial investment in order to commit to an investment opportunity. He suggested using metrics developed in other industries as a baseline, but warned they would

have to be tweaked to the particular conditions of sustainable technologies and business practices, especially since many of these sustainable technologies have never been attempted before. Dr. Gardner also echoed the importance of including the National Laboratory system in sustainability initiatives because of their experience in developing new-to-the-world technologies.

Dr. Carol Dahl of the Lemelson Foundation noted that a major challenge for entrepreneurs in seeking the investment needed to scale their ideas is uncertainty about the size and nature of the market for cutting edge technology- it is hard to measure demand for products that don't yet exist. She said this problem was especially difficult for physical products in engineering, biology, and chemistry, and that innovations like carbon neutral and carbon negative technology do not yet have developed markets. Dr. Dahl said that with the current dearth of federal investment in groundbreaking technology, many innovators are turning to private foundations and other investors for investment in early-stage research, as well as to large corporations who can provide market information and feedback to innovators. To that end, she discussed several initiatives aimed at developing sustainable technology. The Global Cooling Prize funds the de-risking of investment in more efficient air conditioning technology, in collaboration with industry, foundations, and the government of India. Finding more efficient cooling technology will be essential to both cope with and avoid worsening global warming as the need for air conditioning will grow dramatically with population increases. The Rocky Mountain Institute co-sponsors the Third Derivative partnership to fund sustainable technology that is downstream of market demand and knowledge, and the VentureWell Foundation funds the Engineering for One Planet effort, which includes various initiatives in sustainable engineering. Dr. Dahl concluded by warning that the group could not lose sight of climate change in light of the pandemic, and that in order to address both climate change and supply chain resiliency it was essential to incorporate education in sustainability and entrepreneurship into the curriculum for STEM subjects.

A Network Approach to Partnership

Mr. Noel Kinder of Nike suggested using a network approach that leverages all of the country's assets to develop sustainable technologies and consumption habits. He noted that it took 20 years from the debut of Nike's performance wear made from recycled polyester for it to become mainstream, with the company now using one billion plastic bottles' worth of recycled material every year. However, he noted that partnerships can accelerate the development timeline for such innovations dramatically. He also discussed Nike's findings from focus groups that indicate younger generations not only expect large companies to be sustainable while producing high quality products, they also expect to not have to pay a premium for that sustainability.

Elevating Case Studies as Examples

Dr. Ricardo Ernst of Georgetown University suggested that the group leverage its academic and industry members to identify vignettes and case studies that illustrate the business case for sustainability. He argued that providing real cases from companies that saw an economic benefit from becoming more sustainable would make the Commission's message resonate more with industry, and noted that industry members of the group would have knowledge of such cases while academic members would be able to build a narrative framework around them. Dr. Gardner responded that there were several examples of cases studies that would validate the business case for sustainability in HP's annual sustainability report, and Mr. Kinder said there were also suitable vignettes in Nike's annual impact report. Dr. John Warner of the Warner Babcock Institute for Green Chemistry cited the annual Green Chemistry awards given by the EPA and the White House. These awards require a discussion of the economic benefits stemming from sustainable chemistry innovations in order for a discovery or innovation to be eligible, and the EPA website contains hundreds of case studies of previous winners, although these are all in the realm of chemistry. Dr. Warner also discussed H.R. 2051, a bill with seven-

teen co-sponsors from both sides of the aisle and that passed unanimously known as the Sustainable Chemistry Research and Development Act, which funds and prioritizes the development of technology that is both sustainable and has superior performance and cost to the status quo. Dr. Warner also suggested that incentivizing longer-term investment would help address the "Valley of Death" in new technologies, as the increase in early stage investment is the rate limiting step that slows down the rest of the technology development enterprise.

Keeping the Next Generation of Innovation at Home

Dr. Ravi Prasher of Lawrence Berkeley National Laboratory emphasized the problem of keeping innovations developed in the United States at home. He discussed the examples of lithium ion batteries and solar panels, two technologies where the United States conducted the early stage, costly research before allowing manufacturing capabilities for the technology to go overseas, resulting in countries like China and South Korea reaping the economic benefits from innovations developed by American researchers. Dr. Prasher further warned that unlike in microelectronics, many technologies of the future have low profit margins, making it more difficult to stand up initiatives like SEMATECH in these fields. He said entrepreneurs cannot be blamed for locating wherever they can get investment funding, and that it was important to develop public-private partnership concepts for low-margin businesses in order to compete with the Chinese government. He discussed the observation by a Vice President of Dow Chemical that because of China's industrial policy American firms are no longer competing in a free market. Finally, Dr. Prasher emphasized the need to make the case for partnerships in a way that highlights their economic benefits and preserves American values like competition and merit-based market success in order to convince policy makers and the public.

Dr. Zaidi cautioned against focusing too heavily on repatriating supply chains, drawing on his experiences at Alcoa, where the company found more success in leapfrogging the existing curve rather than chasing their competitors, as trying to copy the current state of the art led to improvements in efficiency that could not keep up with wage and raw material inflation. He noted that China can compete on quality in the supply chains for many products, and that the U.S. should strive to obviate this advantage by developing capabilities in the next generation of technologies, and doing so in a way that is "inherently sustainable," instead of "sustainable after the fact." Dr. Zaidi urged the development of a skilled workforce and an orientation around systems of sustainable production, as the highest paying jobs in the innovation space were at "systems" companies like social media companies and consumer electronics firms. Dr. Pisano strongly endorsed a systems orientation, noting that systems companies dominated their markets and led the way in value creation and new jobs. He said that focusing on innovation systems could give the U.S. a strong, powerful advantage.

Dr. Prasher said that the most important focus should be keeping the next big technological breakthroughs in the United States. He highlighted the importance of providing engineering student with economics training to enable them to think about the market implications of breakthrough discoveries, so that they do not spend years chasing investment in products the market is not interested in. He also warned that with just 20 to 25 years to act on climate change to limit future warming to 2 degrees Celsius it was crucial to begin deploying sustainable technology within the decade, which in turn made the business case for sustainability even more pressing

Expanding the Engineering Pipeline

Ms. Wince-Smith discussed a previous Council initiative with Lockheed Martin, the National Engineering Forum, that sought to emphasize engineering as a co-equal branch of the STEM disciplines. She lamented the lack of engineering requirements across STEM degree programs, and said that every major problem requires some form of "engineering" to address it, including this group's work to engineer new methods and ideas for sustainable production and consumption. She also stressed the need to increase the number of women, African Americans, and other minorities in engineering by 50 percent, noting that U.S. graduate institutions were excellent at educating the rest of the world's engineers but not at developing our own talent pipeline. Dr. Pisano agreed and suggested increasing engineering education in high school as a means of increasing outreach to underrepresented groups. Dr. Maya Trotz of the University of South Florida said that engineering programs could benefit from students taking courses in other disciplines to broaden their horizons, including anthropology and public policy. She also said that racial and social justice were linked with environmental and climate justice, and that it was important to consider issues of diversity as interconnected with questions of sustainability. She urged the group to consider how to include underrepresented groups when determining the sites for co-location of initiatives, and warned that the country trying to turn inward and make everything domestically was not synonymous with sustainability, and could in fact be counterproductive if it meant closing off the nation's borders. Finally, Dr. Trotz discussed the disconnected between academia and K-12 education in engineering, which she said contributed to the lack of diversity in engineering programs. She also pointed to lagging math and science scores among American students more generally on international standardized tests.

Concluding Thoughts

Ms. Wince-Smith concluded by re-emphasizing the imperative of providing high-skill, high-paying jobs for all Americans, and Dr. Pisano suggested including pre-engineering courses to high school curricula to increase early exposure to and passion for engineering. Ms. Lippa said she appreciate the distinction between focusing on cost and efficiency versus performance reliability and resiliency, and said that the Commission needed to make sure it was advocating for policies and incentives that would build diversity in the innovation workforce. Mr. Bates reminded the group that the next meeting would in two weeks due to the July 4th holiday, and said that the July 13 discussion would be focused on specific recommendations, with a primer being sent ahead of the call to prepare participants.

Working Group 2 Calls July 13

Introduction

The Honorable Deborah Wince-Smith and Mr. Chad Evans welcomed the group. Mr. Evans said that the Working Group Co-Chairs had a productive discussion the previous week and that Dr. Mohammad Zaidi of Braemar Energy Ventures had a proposition to focus the group's efforts going forward. Mr. Evans also reminded the group of the need to develop priorities for the first year of the Commission that would take advantage of the unique opportunity posed by the 2020 presidential election and subsequent transition of administrations, which would likely not come again during the Commission's timeframe. He said that the group should focus on issues that would have immediate impact for 2021, but that other issues could be explored later and were no less important to the nation's long-term competitiveness. He then turned to Dr. Zaidi for opening remarks.

Developing "Sets"

Dr. Zaidi described his vision for the rest of the group's discussions as focusing around "Sets", or broader issues that had applicability in many different areas. As an example, he discussed how the concept of the circular economy was both critical to sustainable production and consumption and lent itself to division into specific areas where the circular economy could be enhanced or developed, including apparel, food and beverage packaging, and consumer electronics. For each of these sectors, the group could identify the current state of

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the industry, the desired future state, and the set of policies and innovations needed to create opportunities and remove barriers to achieving that future state. He suggested using examples like food and beverage packaging because of their wide-ranging implications. Food and beverage consumption impacts energy, water, materials, waste, and public health, among other areas. Dr. Zaidi also suggested developing ideas for promoting public awareness of sustainable practices through tools like social media. By focusing on different sectors, like food and beverages, apparel, or consumer electronics, the group could identify commonalities to enhancing the circular economy as a whole. This template could then be used for other broad topics, like resilient infrastructure. Dr. Zaidi added that this approach would necessitate smaller subgroups to go into detail for each component of the broader topic, but that this workplan could be used as a road map for the rest of Phase II and generate lots of recommendations.

Sustainability Ratings

Dr. Branko Terzic of Berkeley Research Group proposed developing a sustainability metric or set of metrics that could be applied to packaging to alert consumers of the overall environmental responsibility of the product. He used the examples of Bordeaux wine scores and Energy Star ratings on appliances like dishwashers as successful models for informing consumers. Such a system would highlight the savings from sustainability and encourage consumers to look beyond the immediate price tag when considering the costs of products. Dr. Maya Trotz of the University of South Florida said that younger generations already sought this information, but that the older generation might not care enough to make it worthwhile to provide that information. Dr. Albert Pisano of the University of California, San Diego said that the rating would need to be succinct and highly salient, because consumers are unlikely to do in-depth background research and pore over corporate sustainability reports when shopping. Dr. Trotz also asked if there was a way to incorporate social justice and climate justice in ratings, as these are also issues important to younger generations.

Inherently Sustainable Systems

Dr. Zaidi spoke about the need to develop not just products, but systems that are inherently sustainable. He discussed how aluminum can be recycled and reused very easily, but how the dearth of recycling incentive programs like can and bottle returns in the United States contributes to a recycling rate of only 55 percent, compared to greater than 90 percent in most of Europe. He also discussed the scale of food waste, and the need for household converters of food waste into compost or energy to reduce its environmental impact. Dr. Trotz said that environmental engineers were developing systems for bio-digestion of food waste, as well decentralized systems for food waste, water provision, food production, and energy generation. As another example of inherent sustainability, Dr. Zaidi discussed Alcoa's efforts to safely store mining waste. He noted that it took over 20 years for Alcoa to move from just storing waste in a way that does not pollute the larger environment to actually reusing that waste material while still avoiding environmental degradation. Dr. Zaidi said that over 26,000 streams in Pennsylvania, Ohio, and West Virginia had no fish because of contamination from coal mines, and stressed the urgency of finding ways to do more than just store waste products, as a failure of the storage system could produce disasters like recent incidents at an iron mine in Brazil and a jade mine in Indonesia. On the other hand, following a ban on landfilling coal ash by the Japanese government, coal mines were able to repurpose their waste as asphalt for roads in an example of inherently sustainable reuse.

Encouraging Investment in Sustainability and New Materials

Dr. Carol Dahl of the Lemelson Foundation warned that the new materials and technologies needed for sustainable production and consumption were not receiving the necessary levels of investment from the private sector, and that this investment needed to be de-risked and accelerated through both direct governmental funding and pre-competitive consortia involving both the public and private sectors. In

particular, she noted a large funding gap in the carbon-neutral and carbon-negative technology space, where the lack of a mature market made projects too risky and long-term for most investors. Ms. Wince-Smith echoed this concern, noting that deep science manufacturing was not receiving sufficient investment, and that many venture capitalists have sworn off materials projects because of the long timeframe and high degree of risk. Since sustainability in manufacturing is all about materials, this underinvestment seriously jeopardizes U.S. competitiveness. Dr. Thomas Gardner of HP Federal said that the group should work to identify the root causes of underinvestment in different key sectors and develop solutions to address them, rather than merely flagging the problem. He said that venture capitalists were right to be cautious about these industries because they had been burned in the past, and that the group needed to "attack" the market failures in these sectors to make them attractive targets for investment. Dr. John Warner of the Warner Babcock Institute for Green Chemistry proposed creating incentives for investors to hold onto materials science investments for longer, as well as creating safe-harbor provisions for companies that invest in these crucial technologies to shield them from lawsuits that would dramatically increase their risk aversion.

Dr. Zaidi noted the massive potential benefits from U.S. leadership in sustainable systems investment. He said that cheap water treatment systems, in-home food waste digestors, and solutions to rare earth mineral bottlenecks and environmental toxicity challenges could all produce economic benefit equivalent to a new Apple for the U.S. economy. Dr. Dahl advocated developing a list of technologies where the U.S. cannot afford to let another nation lead because of their vitality to the future of production and consumption, and where there are not sufficient market incentives for any individual actor to take the necessary risks to invest in them. As examples, she gave carbon-negative technology and sustainable and reusable packaging. Ms. Wince-Smith emphasized that sustainability provides a boost to innovation and productivity in addition to being environmentally responsible. Dr. Trotz asked if the U.S. signing the Paris Climate Agreement would provide firms with a competitive advantage in securing government funding for sustainable technology, or provide an incentive for them to invest in carbon-neutral or carbon-negative products by committing the U.S. to emissions reduction.

Sustainability Education

Dr. Dahl noted that while youth were savvy consumers of sustainable products, they were not being prepared by the educational system to design new sustainable products or ecosystems. In particular, she advocated for the expansion of sustainability curriculum in engineering and much greater attention to sustainability in business education curriculum. Dr. Zaidi noted that modern technology provides new opportunities for sustainability education, and that even games or apps could promote awareness in young people about which products were sustainable. Ms. Ciannat Howett of Emory University endorsed the idea of using games and other novel approaches to expand sustainability knowledge, and suggested these might have a bigger impact than yet another sustainability metric for products. To encourage greater emphasis on sustainability in engineering curriculum, Dr. Dahl suggested involving universities, national laboratories, and industry in designing and advocating for sustainable engineering curriculum, and for similar initiatives at business schools. Dr. Pisano agreed with this, and called for the American Society for Engineering Education and the Accreditation Board for Engineering and Technology to endorse mandatory sustainability education in engineering curricula. Ms. Stacy Lippa of Target suggested focusing on future technological advantages and on recovering value from legacy technology and infrastructure, and focusing education on cultivating the mindset necessary in students to achieve those goals.

Issue Sets and Innovation Centers

Mr. Evans asked how Dr. Zaidi's Sets framework interacted with the idea of innovation centers for particular platform technologies needed for sustainability, proposed last week by Dr. Pisano. Dr. Pisano said there were synergistic connections between the ideas, and that Dr. Zaidi's suggestions were focused on high-level strategy, while his innovation centers idea was a practical tool for achieving a given strategy. For the circular economy, for example, Dr. Pisano noted that vulcanized rubber cannot be reused as rubber, but needs to be re-refined and re-processed into something else. He suggested an innovation center that would focus on finding ways of processing or otherwise reusing materials that are not currently recyclable or only recyclable with significant costs and effort, like plastics.

Sustainable and Resilient Infrastructure

Mr. Christopher Geiger of Lockheed Martin discussed the importance of sustainable and resilient infrastructure. He said that while infrastructure innovations are generally viewed as less interesting than other technologies like quantum computing, infrastructure is critically important, as it is essential to every other kind of innovation and to the economy as a whole. He also emphasized that it will always be relevant, and in particular will be relevant regardless of the outcome of the upcoming presidential election and the nature of the new administration. Mr. Geiger further underscored that because infrastructure impacts every American every day, once investments are made in improving its efficiency and resiliency, they will be quickly noticed and appreciated by the public.

Rare Earth Materials

A particular challenge for sustainability that emerged during the group's discussions was rare earth minerals. Ms. Wince-Smith expressed concern with both the costs of accessing them and the sustainability implications of mining them because of their toxicity. She emphasized the need to both develop synthetic minerals or alternatives to their use, and to address the national security concerns of relying on countries like Russia and China for crucial components of advanced technologies. Dr. Pisano agreed, noting that the United States did not mine its supply of rare earths because of ecological risks, allowing countries like China and Russia to corner the market for many key metals because of their willingness to ignore the safety hazards. He cited the example of Russia's cornering of the vanadium market and the impetus it provided to finding substitutes that reduced reliance on vanadium, and said alternative strategies for gathering rare earth minerals could simultaneously help the economy, improve America's geopolitical position, and help the planet. Dr. Gardner noted that rare earths were essential for computers, and that addressing the threat from a cornered rare earth market was a key priority for the industry. Dr. Pisano suggested a national strategic materials initiative, which would address the goals of enhancing the circular economy and providing strategic benefits to the United States as the world consolidates into distinct trading blocs. Ms. Wince-Smith enthusiastically agreed with this concept, and also advocated greater U.S. collaboration with nations like Australia and Canada in the production of rare earth minerals. She also noted that Kazakhstan has expressed resentment at being made to collaborate with China in rare earth production and would like greater economic partnership with the United States.

Using Case Studies

Dr. Ricardo Ernst of Georgetown University expressed concern about issuing general recommendations or best practices for industry in sustainability, as different companies and different industries varied dramatically in their commitment to sustainable production and consumption. He advocated finding case studies of companies that have been outstanding as leaders in sustainability in different fields, and promoting their examples as lessons for other firms. Dr. Gardner echoed this idea, saying it was critical to

show firms a path towards sustainability, and highlighted HP's extensive report on its progress towards the sustainability metrics it established for 2025. He noted there were many examples of best practices that could be applied to other companies. Dr. James Stock of the University of South Florida suggested identifying leaders in as many different industry sectors as possible, especially those the group plans to focus on for the study of the circular economy. These include Nike in apparel and chemical companies that use waste products from firms in other industries in their own production. Dr. Helene Dillard of the University of California, Riverside noted Olam as a company in the food and beverage industry that is a leader in sustainability. Dr. Terzic suggested looking at these companies' sustainability guidelines and identifying general principles that could be adapted by a wide range of industries, as well as potential barriers to even greater sustainability that these firms note in their annual reports.

Concluding Thoughts

Dr. Zaidi said that by the end of the next call, the group should have formed subgroups to dive deeper into specific topics and then report back to the larger group. Mr. Evans said that the Co-Chairs and Council team could begin planning and filling out these groups during Thursday's planning session, and solicit feedback from group members via polling. He also stressed the need to finalize the materials to discuss for next week's session, including confirming that it will be on the circular economy. Ms. Wince-Smith encouraged the Mr. Bill Bates to share with the group previous work the Council has done on manufacturing and materials as part of the Energy and Manufacturing Competitiveness Partnership, and Mr. Evans reminded the group that these studies were available on the online portal as well. The next meeting of the group will be on Monday, July 20th, at 1:00 PM EDT.

Working Group 2 Calls July 20

Introduction

The Honorable Deborah Wince-Smith and Mr. Chad Evans welcomed the group, and Mr. Evans said the goal of the discussion was to narrow down topics for deeper exploration. He said that while the group had reached a consensus on the circular economy as the first topic, the Council team would send a poll to the group to determine the other topics for deeper discussion, as well as identify a subgroup to lead discussions and preparations for the circular economy topic. Ms. Wince-Smith thanked the Co-Chairs for their work over the past week, and Mr. Evans thanked the members of the group who sent feedback on the primer the Council team prepared on the circular economy.

Template for the Circular Economy

Co-Chair and Distinguished Fellow at the Council on Competitiveness Dr. Mohammad Zaidi of Braemar Energy Ventures summarized the plan for the group's discussion on the circular economy. The Co-Chairs recommended dividing the topic into three discussions: best practices, efficiencies, and innovations. The best practices subgroup would use existing

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examples of sustainability from around the world and customize them into recommendations that meet the Commission's objectives around sustainable production and consumption. The efficiencies subgroup would discuss developing certification systems for sustainability similar to the Energy Star ratings for appliances, identify production and resource efficiencies, early warning systems for resource depletion, and policies that could decouple growth from resource use. The innovations subgroup would focus on technical enablers, challenges like alternative materials, additive manufacturing, and ideas like innovation centers dedicated to multi-sector collaboration on sustainability challenges. The idea would be for the subgroups to finish their recommendation generation by the end of August, at which point the group could move onto another topic following the same template. Mr. Evans said that the Council team would send a poll for members to identify their preferred subgroups, and that the expectation was for members of a particular subgroup to engage in extra preparation and help lead the discussion when their chosen topic was discussed.

Creating the Workforce of the Future

Dr. Albert Pisano of the University of California, San Diego emphasized that "innovation" in the context of the circular economy is far more expansive than new technologies, and said that the next generation of workers need to be "innovation workers." He warned that if the U.S. tries to recreate the jobs of the past, we won't win, and that if we invent the technology of the future but do not cultivate the workforce needed to deploy it, we will be paying for others to win. Workers of the future will need different skills, and where that workforce will come from is as important as new materials and industries. Dr. Carol Dahl of the Lemelson Foundation said that it would be valuable to establish exactly what skills and competencies workers of the future will need for the circular economy, and she called for more efforts to develop curriculum for disciplines, especially business, that focus on these skills. As a best practice, she cited the Engineering for One Planet Initiative led by the VentureWell foundation. Dr. Dahl also highlighted the opportunity the group had to provide incentives for industry to collaborate in the pre-competitive space on materials, innovations, and establishing the skills they need from workers.

Connections and Partnerships

Dr. James Davis of the University of California, Los Angeles asked Dr. Pisano how his proposed innovation centers would intersect with the Manufacturing USA institutes. He noted that several of these institutes, including his own Smart Manufacturing institute, overlapped in their mandates with the Commission's goals, and suggested that combining the Commission's efforts with theirs could amplify calls for new public-private partnerships and investment in sustainability. Dr. Davis also discussed how the Smart Manufacturing Institute is using data to make products that fit consumer specifications the first time, reducing waste. Dr. Pisano said that connecting any innovation centers established on the recommendation of the Commission with existing efforts was essential, and agreed on the importance of data and other non-material components to innovation in manufacturing. He said that disruptive innovation comes from inverting the business model, and turning materials and hardware into a platform that enables other innovation, rather than being the key feature of the product. As an example, Dr. Pisano pointed out that car manufacturers no longer compete on their engines or transmissions, but on other factors like smart technology and the driving experience. He added that stitching together the prowess of existing innovation centers and the disruption of new business models would unleash transformation of major industries. Dr. Davis said that the Smart Manufacturing Institute identified business inversion as the manufacturing of services.

Dr. Pisano discussed the MOSIS program for developing innovations in Consolidated Metal Oxide Semiconductor (CMOS) circuits as a model for partnership. He said providing a goal to develop new materials or products would be a powerful motivator for academics, and that the standards established

by the MOSIS program meant that any participating company could build models that worked. Dr. Pisano said using this approach for innovation centers and connecting them with the existing Manufacturing USA institutes could create a network of innovation hubs, provided the right companies in the right industries collaborated. He cautioned that any such initiative would need to be run by a neutral party. Dr. Merrigan said developing markets for innovations was the key to successful scaling of sustainable practices. As an example, she discussed the emerging soil carbon market, and her work with the Minnesota Department of Agriculture on how to measure soil carbon, its significance, and whether existing measurement efforts are benefitting farmers. Dr. Maya Trotz of the University of South Florida encouraged combining sustainability efforts with a focus on climate and environmental justice.

Definitions and Metrics

Dr. Ravi Prasher of Lawrence Berkeley National Laboratory urged the group to define the circular economy and establish metrics and benchmarks in order to develop actionable recommendations. As an example, he cited life cycle cost assessment for products, measuring their overall environmental impact and cost in resources, as one gauge of sustainability. He also encouraged the group to focus on a handful of the most important industries for sustainability, lest the group become stuck in a loop of endlessly establishing criteria due to the different meanings "circular economy" can take on in different sectors. Dr. Kathleen Merrigan of Arizona State University said that she was working with graduate students on a survey of organic agriculture stakeholders to define innovation in the context of organic farming and which innovations should be prioritized. Mr. Evans shared the Council team's characterization of the circular economy with the group, and said the primer would be available for viewing on the online collaboration portal.

Materials Innovation

Dr. John Warner of the Warner Babcock Institute for Green Chemistry described a growing tension between proponents of developing ways to recycle plastic and those favoring a replacement of plastic with biodegradable materials. He warned that this conflict was not beneficial for U.S. competitiveness, and that something needed to be done to "reel in" the conflict. Mr. Noel Kinder of Nike said that his firm had not yet felt a need to pick a side in this debate, but that he would look out for the conflict going forward. Mr. Kinder also cited materials innovation and material collection as areas where sustainability efforts were lagging behind. He said that many materials do not lend themselves to reuse without extensive chemical transformation that allows them to become new products, but that there were no at-scale processes for doing this efficiently. Additionally, the patchwork of local, state, and federal policies concerning recycling of materials made it difficult to collect and sort material for reuse in the circular economy. Mr. Kinder suggested incentivizing academia to work on new materials, with companies coming together in a public-private partnership to invest in their scaling once developed, and advocated investment in nationwide materials collection infrastructure. Dr. Pisano said that the key for materials reuse was to develop a way to make plastic and rubber as recyclable as metal or glass, and Mr. Evans encouraged the group to think about next-generation public-private partnerships on the "materials genome."

Looking for Generalizable Best Practices

Dr. Zaidi said that while he saw the benefit in picking industries to focus on for recommendations, he felt the group would have the most impact if it did not limit its search for best practices, since many best practices can be adapted or extrapolated to other industries. He also suggested that the search for best practices be guided by "inherently sustainable systems." Dr. Zaidi described how Alcoa developed CO_2 capture technology in 1995 when it was looking

for a way to not just minimize waste, but to reuse waste product and generate something else. Alcoa's investments led to their discovering ways to use mining waste to help turn surrounding areas into agricultural land. As a result, the community gained from both the mining industry and enhanced environmental quality and agricultural productivity, increasing public support for Alcoa's mining operations and tightening the bond between industry and community. Dr. Merrigan said that the food and agricultural sector should be a priority for best practices, noting that every United Nations Sustainable Development Goal will require transformative innovations in agriculture. Dr. Ricardo Ernst of Georgetown University suggested creating "clusters" of related industries with similar best practice needs, and then extrapolating from these clusters to industry in general. He also advocated the use of vignettes to illustrate the benefits of these best practices. Key to these vignettes would be the development of effective metrics specific to each cluster that quantify how best practices improve sustainability. Ms. Wince-Smith suggested focusing on the industries facing the greatest challenges in achieving sustainability, as most reports on "green" companies give the highest scores to firms that do not physically manufacture anything. For true progress on sustainability, the group should focus on making even the most intensive industries more resource efficient.

Concluding Remarks and the Road Ahead

Mr. Evans said that the Council team would come back with a poll, complete with detailed descriptions, to identify subgroups, and that the best practices, efficiencies, and innovations model was a good template for addressing topics. Dr. Pisano suggested further identifying goals and challenges in the realm of efficiencies, and Dr. Dahl shared a link to the Global Cooling Initiative as a model for encouraging efficiency innovation. This initiative works to develop more resource-efficient air conditioning systems as worldwide demand for cooling systems increases dramatically in the developing world. Dr. Zaidi said it was important to put context around the group's priorities, and noted that it should focus on the circular economy in the context of competitiveness, per the group's mandate. Ms. Wince-Smith agreed, noting that it was important for the group to focus on how sustainability challenges relate to U.S. productivity growth and the ability of American firms to stay competitive in the global marketplace. Ms. Stacy Lippa of Target said there would not be any perfect solutions for sustainability, but stressed the need to identify policies and objectives that can be put to practical application in the future, as well as the need to consider changing consumer wants and needs. Mr. Evans said he would be back shortly with a poll for the group, and would use the voting to develop ideas for next week's discussion, which will take place on Monday, July 27th.

Working Group 2 Calls July 27

Introduction

The Honorable Deborah Wince-Smith and Mr. Chad Evans welcomed the group. Mr. Evans opened by discussing the progress and agendas for the other Working Groups this week. Working Group 1, which meets on Tuesdays, will be focusing on one of its four "swim lanes" this week—innovation systems and structures. This topic includes six components: the concentration of innovation assets, research and technology initiatives at the national level, state and regional innovation efforts, technology transfer, the Valley of Death in startup financing, and venture capital. In particular, the featured remarks will focus on technology transfer and helping startups bridge the "Valley of Death." Working Group 3, which also meets on Tuesdays, is in the process of finalizing its schedule, but will focus on four different swim lanes: global competitiveness and existential threats, the national regulatory environment, systems infrastructure, and capital and financing innovation. Finally, Working Group 4, which meets on Fridays, opened its discussion on regional innovation and geographic inclusion last week. This Friday, the group will open its discussion of displaced workers and Main Street entrepreneurship, and next week it will begin discussing cultivating the innovation talent pipeline. Throughout the group's discussions, and especially beginning this week, Working Group 4 will be intentional about weaving in questions of diversity and inclusion, and Mr. Evans expressed hope that the other Working Groups would also make these topics a focus of their conversations.

Next, Mr. Evans introduced the theme of today's discussion, focused on innovation for sustainability, and in particular the idea, proposed by Co-Chair Dr. Albert Pisano of the University of California, San

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Diego, for a national network of innovation centers focused on platform technologies and using an open-access model.

Innovation Centers

Dr. Pisano framed his idea by drawing on a previous successful initiative in open-source, collaborative innovation: the Metal Oxide Semiconductor Implementation Service (MOSIS) program. Decades ago, Consolidated Metal Oxide Semiconductor (CMOS) technology was not the obvious standard for integrated circuits and computing, and faced many challenges and obstacles in spite of its promise of smaller components. In particular, the manufacturing process was complex and require more layers than other competitors. However, a group in the U.S. came up with an idea of a collaborative venture in which a group of companies would produce CMOS chips, which would be accredited and distributed by a neutral third party, and make their chips available to anyone who wanted to submit a design for software that would enable effective computing on CMOS circuits.

Dr. Pisano described the many advantages of MOSIS. By creating a platform of hardware on which researchers could create software programs, with an easy-to-use interface for writing the software, anybody could get access to a chip and design software for it and submit that design. The ease of submitting designs meant that bugs and flaws in the hardware were easy to fix or work around, and the open-source nature of the project drew in professors, graduate students, undergraduates, and corporations. The companies that put together the hardware for the project were also able to learn and gain insights from the ideas submitted, broadening their thinking and effectively crowdsourcing the most innovative ideas for their own products. The outcome of the MOSIS project was the development of an entire generation of workers and scientists who were skilled in using CMOS technology, ensuring companies pursuing CMOS chip designs had a large pool of talent to hire from, and the ideas the project generated ensured the U.S. skyrocketed ahead of competitors in design of chips, circuits, software, and algorithms for years. Key to this success was the ability of the project to draw in innovators from different disciplines and outside formal institutions and structures, significantly expanding the pool of talent and creativity. The collaboration between industry, academia, and government also meant that successful ideas were ready for large-scale production very quickly.

Dr. Pisano suggested replicating the MOSIS model on a large scale for a new set of technologies. He recommended developing a network of 15-25 innovation centers, each focused on a particular industry or technology, that pooled the resources of industry, government, academia, and the National Laboratory system. By replicating MOSIS's open-source model and linking together the different components of America's innovation ecosystem, such an endeavor could accelerate innovation and the deployment of advanced technology in the U.S.

Motivation and Funding for the MOSIS Program

Dr. Carol Dahl of the Lemelson Foundation asked how the MOSIS program was funded, and Ms. Stacy Lippa of Target asked what the impetus was for the program's genesis. Dr. Pisano said that MOSIS was funded by contributions from industry as well as initial funding by the Department of Defense, which paid for the assembly of the fabrication facilities, the development of a neutral third party organization, and the assembly of the software interface. Initially, the price of the chips was heavily subsidized by the government as well, but the subsidies decreased as the initiative gained more momentum. He explained that the motivation for the program came from academia needing an imperfect and under-developed technology to conduct novel research on, and industry attempting to leapfrog better-established competitors in other forms of circuit technology. Dr. Pisano added that given the population advantage China possesses over the U.S., leveraging open-source models and the creativity of the populace was necessary in order to generate per-capita participation levels in the innovation system that outpaced China

by the same ratio as China outnumbered the U.S. in population. He stressed that the current model of innovation was not delivering results fast enough. Mr. Evans noted that Working Group 1 developed a concept of corporations opening up their operations and serving as test beds and demonstrations for new technologies developed by startups in Phase I of the Working Group discussions. He noted such an effort would foster collaboration and facilitate the sharing of information while providing crucial resources for startups to scale their operations and move technologies to market.

The Importance of Inclusion

Participants stressed the importance of ensuring that collaborative, open-source efforts to develop new technology are inclusive and provide opportunity and access to members of underrepresented minorities. Dr. Maya Trotz of the University of South Florida noted pushback from the scientific community over the National Science Foundation's research agenda focused on AI, quantum information sciences, and computationally intensive technologies on the grounds that it was too prescriptive and narrowly focused. She emphasized the need to make systems and convergence the focus of future research. Ms. Ciannat Howett of Emory University said it was important to guarantee inclusive access to new technologies developed as a result of innovation initiatives, as well as to participation in the initiatives themselves. She discussed existing technologies, like aerobic digesters for household waste, and noted the negative impacts they can have on surrounding communites. She urged the group to consider in designing any initiatives the risk of disparate negative impacts or consequences on the most vulnerable. Dr. Pisano said that for many platform technologies, it would be possible to design interfaces for innovators with varying levels of experience, from beginners to experts, in order to maximize the range of potential participants in design contests. He suggested that many could even feature interfaces that allowed K-12 students to participate and contribute.

Connecting Back to Sustainability

Dr. Tensie Whelan of New York University asked for clarification on how the innovation centers would relate to the group's core mandate of developing more sustainable methods of production and consumption. She cautioned the group against developing a "solution in search of a problem", and said that the innovation centers would need to focus on platform technologies or processes essential to sustainable production and consumption to remain on-task for the group's mandate. She discussed examples of industry collaboration on topics like reducing plastic waste, but noted that these efforts had been patchwork so far. Dr. Pisano encouraged other participants to suggest alternative models, and said that while he could not predict what the industries of the future would be for the United States, he could make educated guesses about the technologies that would underpin them. He mentioned 6G telecommunications technology, quantum computing and communication, and the Rocky Mountain Institute's Global Cooling project aimed at finding sustainable air conditioning technology as examples of initiatives and platforms that would be valuable for future industries.

Dr. Whelan suggested using the UN's Sustainable Development Goals (SDGs) as a framework for focusing the innovation center model on sustainability, as these goals include diversity and inclusion and focus on specific topics like urban farming, waste treatment, green chemistry, and climate resilience. She said using the SDGs as roadways also made it easier to identify business opportunities, and that the $12 trillion in potential new markets and 380 million potential new jobs that could arise from efforts to meet the SDGs would provide a powerful incentive for industry participation. Dr. Mohammad Zaidi of Braemar Energy Ventures, a Distinguished Fellow with the Council on Competitiveness, suggested framing the development of new materials as the equivalent to CMOS technology due to its applicability to alternative energy, packaging, food, consumer products, and energy efficiency. Dr. Pisano said the SDGs provided a great list of sustainability goals

and challenges, and offered his model as a way to accelerate innovation in the service of meeting those goals. Dr. Carol Dahl of the Lemelson Foundation said that the 50 Breakthrough Technologies report, available online, identifies gaps where more innovation is needed to meet particular SDG metrics. She characterized these gaps as stemming from either lack of market incentives due to underdeveloped markets for new technologies, or from insufficient government prioritization of areas where the market has not stepped in. Dr. Dahl urged the group to define the top areas where there was insufficient public and private sector action, and analyze them to determine if the innovation centers model was a good fit for the problem. Ms. Wince-Smith suggested an innovation center based around the hydrogen economy.

Defining Metrics

Ms. Howett stressed that defining clear goals and metrics for new technologies to meet were essential if the innovation centers concept was to genuinely make production and consumption more sustainable. She reiterated the need to build inclusion into these metrics, and Mr. Jonathan King of Southern Company echoed this sentiment. Ms. Wince-Smith reiterated the overall goals and purpose of the group, including the overarching goal for the Commission to reinvigorate productivity growth and generate inclusive prosperity in the 21st century for the United States. For this Working Group, the goals include developing production methods for the future that re-establish the United States a leader in manufacturing; developing the future of energy and understanding its connection with zero carbon, new materials, manufacturing, and the energy intensity of production; and sustainability of production and consumption, including equity and access issues. Dr. Dahl recommended using the SDG benchmarks as metrics for the innovation centers, emphasizing inclusion and prioritizing topics lacking market incentives for early innovation, but where there is significant downstream market potential with sufficient public funding to help establish the industry. In this vein, Mr. Evans noted that the Council has previously called for centers for the development of advanced materials.

The Honorable Branko Terzic of Berkeley Research Group, a Distinguished Fellow with the Council on Competitiveness, asked for clarity on the specific recommendation Dr. Pisano had in mind. Dr. Pisano said that the Commission should recommend a network of innovation centers dedicated to advancing platform technologies that will enable sustainable production and consumption. He predicted that the next presidential administration would be interested in new science and technology spending initiatives, and that this model could offer a way for the administration to improve the productivity of its investments and accelerate the development of new technologies. Dr. Thomas Gardner of HP Federal was skeptical that the next administration would launch major spending initiatives with a long-term payoff during an economic downturn with pressing short-term needs. However, he agreed that the nature of production was changing, and that investment in new technologies was crucial. He noted that HP is currently working on net-zero production, including factories with no electrical input and self-sustaining microgrids, as well as the use of methane and other alternative energy sources besides solar and wind power. He also noted the potential for transformation of industries via optimization of existing resources, including telemedicine for health care.

Intel and a Case Study for Model Innovation

Ms. Wince-Smith discussed the recent news that Intel has been forced to delay production of its planned 7-nanometer computer chip. Dr. Pisano said that Intel's struggles highlighted the importance of the approach he was proposing with the innovation centers concept. Unlike its rivals, Intel has adopted an insular approach where it only produces its own chip designs and does not aim for transferability with other fabs. Conversely, TSMC is an "open shop"

that accepts outside chip designs and specializes in manufacturing them more efficiently, enabling it to collaborate effectively and absorb new ideas through contact with outside innovators who do not get tunnel vision on one particular model. Dr. Zaidi agreed that there were lessons to learn from the companies' contrasting approaches, as TSMC is already working on a 5-nanometer chip while Intel is struggling to get to the 7-nanometer level, and added that TSMC focuses on experimentation rather than analytics in its design process. He characterized the experimentation-based system as superior to the analytical system of design going forward, and said that the innovation centers model was an experimentation-based model. Dr. Zaidi added that one of the advantages of MOSIS that would need to be replicated for other technologies was the commitment by corporate partners to manufacture products that meet certain specifications and benchmarks, which promoted more rapid experimentation as designers were eager to see their products scaled. Dr. Pisano said that in the case of computer chips, the process is so highly automated that labor costs do not determine where fabrication is located. As a result, if the U.S. loses its domestic manufacturing capabilities there it will be because of a failure of its model.

Concluding Thoughts and the Road Ahead

Ms. Wince-Smith expressed enthusiasm for Dr. Pisano's concept of innovation centers, and encouraged the group to begin developing the idea in more detail, with a focus on sustainability of production and consumption and the deployment of low-carbon and no-carbon energy sources, as the basis of a recommendation. She also noted the applicability of Dr. Pisano's model to Working Group 1 and its mandate to develop and deploy at scale disruptive technologies, and the importance of cross-pollination among the Working Groups. Dr. Pisano thanked Dr. Whelan and Dr. Trotz for providing greater focus and refinement of his initial idea, and Dr. Whelan suggested using the UN Sustainable Development Goals as a benchmark for sustainability technologies due to their widespread adoption by governments and corporate investors. Ms. Howett urged that the centers be focused on interdisciplinary topics, and that they make a conscious effort to pull in experts from outside of science and engineering, as many of the obstacles to sustainability are not technology related. Dr. Whelan echoed the importance of a cross-cutting focus, and pointed out that the apparel industry in particular is concerned with materials sustainability. Ms. Shannon Lee of HP Federal expressed interest in working on issues of net-zero digital manufacturing, and Dr. Trotz and Dr. Dahl expressed interest in working with Dr. Pisano and Ms. Wince-Smith on a more detailed model for the innovation centers network. Mr. Evans said that the plan next week was to open discussion on best practices and efficiencies in innovation, but that he would get back to the group shortly on final plans for next week's session, which will be on Monday, August 3rd.

Working Group 2 Calls August 3

Introduction

The Honorable Deborah Wince-Smith and Mr. Chad Evans welcomed the group. Mr. Evans thanked the day's featured speakers, Co-Chairs Ms. Stacy Lippa of Target and The Honorable Branko Terzic of Berkeley Research Group, a Distinguished Fellow with the Council on Competitiveness, for developing nascent recommendations around best practices and efficiencies in the circular economy to serve as the basis for further discussion. He then provided an overview of the other Working Groups' agendas for this week. Working Group 1 will continue its discussion of the structure and components of the U.S. innovation system with a presentation by Dr. Paul Hommert, former director of Sandia National Laboratory and a Distinguished Fellow with the Council on Competitiveness, on the role the national laboratory system can play in optimizing the U.S.'s development and deployment of disruptive technologies. The group will also hear a guest presentation from Dr. Albert Pisano of the University of California, San Diego, who will share his concept of a national network of innovation centers that he discussed with the group last week. Working Group 3, led by Dr. Peter Dorhout of Kansas State University, will discuss global competition, including international rules of the road, standards, and regulation, as well as the competitive threat posed by China. Working Group 4 will discuss cultivating the innovation talent pipeline, led by Dr. Lee Cheatham of Pacific Northwest National Laboratory and Dr. Carol Dahl of the Lemel-

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son Foundation. Ms. Wince-Smith reiterated thanks to the Co-Chairs for leading today's discussion, and said it was great for the group to being moving forward into concrete recommendations.

Featured Presentation

Ms. Lippa began the featured presentation by defining key terms and concepts. She classified best practices as the efficient production of goods, and efficiencies as the efficient consumption of goods. She further defined "corporate social responsibility" as the understanding that corporations have goals other than profit maximization, and that stakeholders hold them accountable for meeting those goals. Stakeholders are those who can affect or are affected by an organization's objectives and their achievement of those objectives. Sustainability, as defined by the U.N.'s Sustainable Development Goals, is the satisfying of the needs of the present generation without jeopardizing the ability of future generations to do the same through stewardship of resources. Ms. Lippa discussed how innovation is the engine of productivity growth and inclusive prosperity, and how the pandemic has reawakened the American manufacturing sector and underscored its importance to the economy. She defined sustainable manufacturing as manufacturing that can adapt to fluctuations in demand, does not take the availability of raw materials for granted, and addresses sustainability issues around energy and material use in a coordinated manner. Sustainable consumption not only involves using materials, energy, and services in a way that ensures their preservation for future generations, but also reduces waste. Further, sustainable consumption must be combined with access to basic services, green and decent jobs, and a better quality of life for all.

Ms. Lippa went on to define sustainable business practices, including partnering with employees, developing resilient supply chains, engaging in recycling, and water and energy conservation. Material efficiency is defined as the degree to which raw materials are consumed, incorporated, or wasted compared to previous measures, and energy efficiency as the reduction of energy needed to produce a good or service. Drawing on the Council's definitions in the National Commission concept paper, Ms. Lippa listed examples of key technologies for U.S. competitiveness, including alternative energy, biotechnology, defense technology, environmental protection, high-end manufacturing, and information and communication technology.

Dr. Terzic next discussed the current state of energy consumption in the U.S. According to the Energy Information Agency (EIA), in 2014, 37 percent of U.S. energy production came from petroleum, 29 percent from natural gas, 14 percent from coal, 11 percent from renewables, and 9 percent from nuclear energy. Of note, electricity is a consumer of energy as a means of storage and distribution, not a producer of energy. Electricity generation relies on all five sources of energy outlined in EIA numbers. Dr. Terzic emphasized the potential of hydrogen as an energy source for a zero-carbon economy. He noted

that hydrogen produces only water as a byproduct, and that hydrocarbons, nuclear energy, and renewables can all be used to produce hydrogen. Hydrogen can also be used in a variety of settings, including pipelines, fuel cells, and as a residential energy source. Dr. Terzic noted that Europe leads the world in preparing for the hydrogen economy, and is developing a centralized plan to phase out other energy sources and replace them with hydrogen, using natural gas a transitional fuel. However, the United States may not be able to follow suit if states like California continue with plans to eliminate the pipeline infrastructure necessary to transition over to hydrogen in their effort to eliminate natural gas.

Finally, Dr. Terzic discussed the issue of waste and outline four goals for the group to consider. He noted that in 2008, the top U.S. export to China was scrap, and that between 27 percent and 40 percent of all food in the United States is wasted. Given America's tremendous inefficiency in waste production, he called for several interconnected goals for waste. First, to stimulate the development of consistent, cost-effective policies with respect to adoption of products and services based on whole life cycle analysis. Second, to encourage government to develop product and service sustainability indicators or rating systems for the most environmentally-relevant products and services purchased by consumers. He noted the national laboratory system could play a significant role in developing these ratings given their expertise in both science and economic life cycle analysis. Third, he proposed a national program to make the U.S. more competitive in the hydrogen economy, warning of the consequences for competitiveness if the U.S. falls behind Europe. Finally, Dr. Terzic called for the evaluation of the efficacy of national standards or requirements for recycling, waste disposal, and reuse, and the creation of national markets to address inefficiencies. He concluded by underscoring sustainability's role as a driver of innovation and competitiveness.

Other Dimensions of Sustainability

Ms. Ciannat Howett of Emory University asked where agricultural production was covered in the EIA documents Dr. Teric shared on energy consumption, and Dr. Terzic said it was included in industrial or commercial consumption, depending on the scale of the agricultural enterprise. Dr. Dahl asked if the group had completely unpacked the dimensions of sustainability, noting in particular the question of greenhouse gas emissions and toxic materials, especially those that cannot be easily used or recycled. She asked if there were charts from EIA showing emissions of carbon dioxide and methane. Dr. Terzic agreed on the importance of addressing toxic materials, and noted that the real problem was materials that could not be safely contained and disposed of. While some toxic byproducts, like nuclear waste, can be safely stored, others cannot and we are only just learning the extent to which our environment is being polluted by them. Dr. Maya Trotz of the University of South Florida shared a document called "Roadmap 2050" outlining steps needed to develop a sustainable economy, but noted that it did not cover land use and forest preservation.

Sustainability Infrastructure

Dr. Thomas Kurfess of Oak Ridge National Laboratory discussed the importance of infrastructure that enables sustainable choices. He discussed the advances and technologies necessary to make hydrogen safe as a fuel source, and the need to provide charging stations for electric cars to increase their range. He also discussed the growing need to develop ways to safely recycle lithium ion batteries, and the challenges posed by the inability to dispose of different kinds of batteries in the same fashion, which spurred much of Oak Ridge's research. Dr. Terzic noted that there were major safety concerns around hydrogen due to its flammability, but he noted that we are able to use volatile substances like gasoline, kerosene, and methane without issue, and that it is important to keep in mind that much of the fear around new technologies is rooted in a lack of infor-

mation. Dr. Zaidi recommended trialing new hydrogen fuels in cargo transportation first, as the lack of passengers would reduce the consequences in the unlikely event of an explosion, while also serving as a demonstration to the public and policy makers of the safety of hydrogen. Dr. Kurfess noted that home fueling stations already exist that can convert pumped-in natural gas into hydrogen.

Benchmarks, Goals, and Certifications

Ms. Howett shared several Sustainable Development Goals that she felt were important for the group to consider, including making modular components for products, retaining ownership of material from production through waste disposal, and decreasing the use of virgin material while increasing the use of recycled content in products. Dr. Zaidi suggested a recommendation that sensing and control systems that reduce energy and water use, early warning systems, and other efficiency mechanisms and benchmarks be made requirements for new production facilities as part of the permitting process. By building these requirements into existing environmental regulations, manufacturers would be incentivized to build sustainable plants from the beginning rather than trying to retrofit them later. Ms. Lippa agreed, and added that there are many existing best practices and examples for efficient and sustainable manufacturing that could be disseminated. Dr. Trotz advocated for a goal of decarbonization of lifestyles, including individuals making more sustainable choices about where and how to work and live. As an example, she noted the energy and resources savings from people working remotely or commuting short distances to work, and replacing traditional energy sources that are a major component of pollution. Dr. Terzic agreed, noting that working from home saves him three hours of commuting time and considerable energy resources every day, and noted the lifestyle improvements that would come along with comprehensive decarbonization.

The Competitiveness Angle

Dr. Zaidi noted advances in sustainability, including solar energy, wind energy, hydrogen, and water use in the EU, Japan, China, Israel, and elsewhere, and urged the group to think of best practices and efficiencies where the U.S. could either leapfrog competitors or become leaders in a new, less-developed dimension of sustainability. Ms. Wince-Smith agreed and said it was essential to keep focused on the competitiveness implications of energy use and sustainability. She discussed how the pioneering of horizontal drilling to access natural gas reserves revitalized the American manufacturing sector by providing cheap energy and lowering production costs, and Dr. Thomas Gardner of HP Federal echoed the importance of low-cost energy for domestic production. Dr. Terzic said that one of the reasons to prioritize hydrogen energy generation was because the U.S. is falling behind Europe in innovation in that space.

The Importance of Hydrogen

Participants continually returned to the importance of hydrogen as an energy source in a net-zero carbon economy. Mr. Jonathan King of Southern Company said that hydrogen is the most energy-dense fuel source that does not produce greenhouse gases, and is central to meeting Southern Company's goals of total decarbonization by 2050. He added that hydrogen is a potential replacement for lithium in fuel cells, and that it can be used to decarbonize industries that are not easily electrified, like paper, chemicals, and corn production, and thus not as amenable to solar or wind power. Ms. Wince-Smith noted that despite the importance of having a portfolio of renewable technologies, there are hidden costs to technologies like solar panels, the construction of which requires significant amounts of water and carbon. She said it was important to look at fields where breakthroughs were occurring, and that hydrogen was the most productive on that front. Dr. Terzic added that hydrogen was the least understood alternative energy by both policy makers and the general public, and that action was needed on education and addressing misconceptions around its use.

Nuclear and Micro-Grids

The security and resiliency of the national grid also emerged as a theme for discussion. Ms. Wince-Smith said that self-generation by individual households or communities could not provide a sustainable and reliable source of energy for the entire country, especially in times of crisis, and that a resilient grid was needed. Dr. Gardner advocated for "least-joules" manufacturing that relies on minimizing energy usage in the production process, and for the deployment of micro-reactors. He noted that nuclear technology is carbon free, and argued that the risks it posed were easily dealt with. He discussed work by Oak Ridge National Laboratory on developing miniature micro-reactors that are cost efficient to produce, including via 3-D printing, and could be distributed throughout the country. Dr. Gardner also called for a system of decentralized "micro-grids" to protect the grid from attack by localizing failures and preventing them from spreading. Mr. Christopher Geiger of Lockheed Martin shared a report by Lockheed on modular nuclear fusion reactors as an energy source.

Concluding Thoughts and the Road Ahead

Mr. Evans said that next week the group would return to the swim lane around innovations in the circular economy, and said he would share the day's Power Point along with the session summary. He encouraged members of the innovation swim lane to begin preparing thoughts and developing recommendations to discuss for next week's presentation, and said he would share more details about the discussion following a meeting the group Co-Chairs later this week. He encouraged members of the best practices and efficiencies swim lane to begin gathering their thoughts and using the recommendation rubric the Council team sent out last week to help develop them into actionable recommendations, as well. Dr. Terzic said that in future conversations he would like to explore in greater depth the idea of decarbonization as a goal, including identifying relevant subgoals necessary to achieve it, and the development of production benchmarks that can be incorporated into the permitting process for purposes of sustainability. He added that the recommendations he and Ms. Lippa developed were meant to catalyze conversation, and that he welcomed critique, expansion, and addition to them. Ms. Wince-Smith expressed interest in a presentation on self-healing, smart microgrids, and Mr. King said he could pull resources on the topic. The next meeting will take place on Monday, August 10th.

Working Group 2 Calls August 10

Introduction

The Honorable Deborah Wince-Smith and Mr. Chad Evans welcomed the group. Mr. Evans said that the day's discussion would be focused on exploring the concept of a national network of innovation centers around platform technologies for sustainability, developed by Co-Chair Dr. Albert Pisano of the University of California, San Diego in greater detail. Additionally, he discussed the upcoming two-week strategic reflection period, to be used for writing and policy recommendation generation, that will begin after this week of calls. During this time period, there will be no weekly Working Group discussions, but Co-Chairs will engage amongst themselves, and amongst the "swim lanes" for discussing particular topics they have chosen to lead, on developing policy recommendations. Members of swim lanes may meet as a group to generate policy recommendations, or members may work individually on recommendations before submitting them to the rest of their swim lane or the Council team. Upon the reconvening of the Working Group sessions on August 31st, the group as a whole will discuss the recommendations that have emerged and prioritize which ideas to flesh out into a final recommendation to be included in the Year One deliverables in December. Ms. Wince-Smith said that the Council team had sent out a rubric for structuring recommendations, and that this time was to be used for reflection and writing, not

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as a break from the Working Group's activities. Mr. Evans reminded the group that the Council sent out contact information for each swim lane to enable members to coordinate and exchange ideas.

Mr. Evans also provided an overview of the agenda of the other three Working Groups for the week. Working Group 1, which meets on Tuesdays, will discuss the upcoming strategic writing period and discuss swim lanes and topics to cover. Working Group 3, which also meets on Tuesdays, will continue to discuss international "rules of the road" and the opportunities for bilateral strategic engagement in the innovation-enhancing space to address global competitiveness challenges. Working Group 4, which meets on Fridays, will return to its swim lane on geographic and regional innovation and inclusion.

Ideas Matrix

Co-Chair Dr. Mohammad Zaidi of Braemar Energy Ventures, a Distinguished Fellow with the Council on Competitiveness, discussed his idea for a matrix that would map policy recommendations along the swim lanes denoted by the group (best practices, efficiencies, and innovations) and by subject. He identified five broad areas into which recommendations the group had already discussed fell: food and agriculture, water and natural resources, energy, materials, and community management of resources. Dr. Zaidi said this matrix would help the group identify areas with lots of policy recommendations, and would provide a way to organize the group's ideas as they move towards specific output to include in the Year One deliverables. He added that in some cases, the group's recommendations would focus on scaling up or standardizing an existing best practice, and in such cases the recommendations should focus on tackling obstacles to scaling and assigning roles to different stakeholders to accomplish that scaling. He also discussed the need to identify innovations in critical areas, such as alternatives to plastics. Here, he noted examples of solutions that have promise but have yet to be replicated on a large scale, and the need to find a way to do so.

Further Exploring Innovation Centers

Dr. Pisano began his discussion on innovation centers by emphasizing that they did not stand alone, and needed to fit into the matrix Dr. Zaidi described. He added that he had updates to make to his initial presentation from two weeks ago. First, he reminded the group that his background was primarily in advanced technology and engineering, and that he encouraged feedback and critique on strengthening the applicability of the innovation centers model outside of these disciplines to areas like agriculture and energy. He also discussed his conversations with industry stakeholders on partnerships, and the prevailing sentiment in the private sector that open-source models were not desirable due to complications over assigning and managing intellectual property. However, an open-interface model that would allow collaboration without revealing competitive advantages for individual firms remained popular. Dr. Pisano also highlighted the four key constituents in the innovation centers model: government, academia, industry, and the National Laboratory system. In particular, he noted that the nation's labs possess vital infrastructure for collaborative efforts, and they need to be able and allowed to open up that infrastructure to ensure these partnerships are successful.

Dr. Pisano discussed other important cautions, elements, and opportunities for the innovation centers model. He urged for the development or identification of a neutral, non-profit organization that would coordinate and oversee the innovation center partnerships, to avoid the appearance or reality of one stakeholder or set of stakeholders, such as the labs or a particular corporation, dominating proceedings. He added that he was working on an outline of a "roles and responsibilities" document spelling out duties for all stakeholders. Dr. Pisano also noted the opportunity facing the group with the upcoming election, including an opportunity to place the Year One findings in the hands of the organizations and administration officials who could implement them. He noted the Endless Frontiers Act being discussed in Congress, and campaign and transition team

interest in the Council's work. In particular, he noted that the innovation centers concept could dovetail with a proposed expansion of the budget and mandate of the National Science Foundation, becoming the National Science and Technology Foundation and receiving funding earmarked for technology. Finally, Dr. Pisano noted that the innovation centers concept could expand to include platform technologies beyond sustainability, such as wireless communication or AI and computation. He encouraged the group to suggest ideas for other technologies that could be the focus of an innovation center, as well as cautionary tales about how or how not to organize these partnerships. He noted there are existing programs and organizations, such as the Manufacturing USA institutes, with a similar focus, and said that the group needs to establish its own story and objectives before approaching them regarding collaboration.

Implementing the Innovation Centers Concept

Dr. Thomas Gardner of HP Federal said that often good ideas fail in implementation, particularly when budgets and revenue are tight. Given the expected fiscal conditions during the next few years, he recommended tying the innovation centers to as many existing programs and initiatives as possible, so they are funded as a continuation of an existing program rather than as a new project. He suggested folding the whole initiative into the Manufacturing USA program, and incorporating federal agencies like the National Institute of Standards and Technology (NIST), along with the National Academies for Science, Engineering, and Medicine and the National Science Foundation. Dr. Gardner also urged robust participation from as many different stakeholders as possible, as the initiative would lose support if it were perceived as a funding grab by the national laboratory system or for corporations. He said that the finer details of the project could be worked out later after an implementation plan had been established.

Connecting Stakeholders and the National Laboratory System

Dr. James Stock of the University of South Florida suggested developing two groups: one consisting of companies with expertise and a willingness to work with entrepreneurs, and one consisting of entrepreneurs and innovators who need support and resources to advance their ideas. A partnership could then match these companies and entrepreneurs, combining their resources and helping to bring ideas closer to commercialization. Dr. Thomas Kurfess of Oak Ridge National Laboratory discussed the uniqueness of the national laboratory system as a competitive asset, noting that no other country had a similar set of institutions. As valuable as the labs are, however, Dr. Kurfess said that the laboratories need to modify their operations to better connect with other pieces of the innovation ecosystem, fitting them together with other institutions like the National Science Foundation and the Manufacturing USA institutes, building an innovation ecosystem for the 21st century.

Sustainability and the Innovation Centers

Dr. Tensie Whelan of New York University asked for clarification on the connection between the innovation centers model and sustainable production and consumption. Dr. Pisano said that platform technologies could be leveraged in service of sustainability goals, including using technology to develop more resource-efficient production methods and developing the capacity for domestic supply chains in critical technologies, reducing transportation costs and material and energy usage. Dr. Whelan said that the innovation centers concept could fit across all of the swim lanes, and suggested that during the writing period group members should consider which innovation centers would be central to implementing particular sustainability recommendations. She also added that many universities have centers for sustainable business, and that they are connected by a network, the Network for Business Sustainability

(NBS), that could serve as a partner, and source of ideas, for the group as it moves to flesh out the innovation centers concept. Dr. Pisano added that if the innovation centers model is successful in facilitating sustainable production and consumption, it could be expanded to include areas of focus for the other Working Groups.

Dr. Maya Trotz of the University of South Florida suggested housing the innovation centers in high schools. She noted that the schools possessed the property and much of the needed infrastructure, many schools and students would benefit directly from sustainability innovations, including better access to healthy and sustainably-produced food, and that introducing students to innovation and sustainability could spark greater interest in STEM for a new, diverse generation of students. This in turn could help cultivate more STEM talent in the U.S. that would alleviate security concerns from reliance on foreign graduate students as researchers in advanced degree STEM programs. She envisioned a network of up to 24,000 innovation centers across different high schools. Dr. Pisano said this idea dovetailed with his previous suggestion of developing a simplified interface that would allow high school students to participate in the open-interface aspect of the innovation centers, via the development of a web-based portal that would allow people to access the facilities and resources of universities, companies, and labs.

Generating Ideas During the Writing Period

Dr. Carol Dahl of the Lemelson Foundation asked if the group had decided to narrow its focus within sustainability to the circular economy. Mr. Evans said the plan was for the group to focus deeply on one concept before moving on to others. Dr. Zaidi said that the circular economy could serve as a springboard to discussion of other topics, as the group's deliberations would provide a model for developing effective recommendations and identifying common challenges to any policy discussion. In particular, he noted the need to identify obstacles to scaling existing ideas and best practices, as well as the potential for applying technologies, like AI and advanced manufacturing, to the achievement of sustainability goals. Dr. Ricardo Ernst of Georgetown University advocated for greater focus on sustainable consumption, noting that consumers represent an important constituency to convince in mobilizing support for sustainability practices, and will be the end users for sustainable products. He also suggested collecting ideas from the university sustainable business centers that comprise NBS and building off of their existing work while also reaching out to engage in partnerships with them. Dr. Trotz noted there was already robust discussion on recovering resources within food and water systems in the sustainability field, and urged the different swim lanes not to silo completely during the discussion period.

Dr. Zaidi said that he would like to meet with the innovations swim lane during the writing period after having circulated existing recommendation ideas grouped in the recommendation matrix, in order to more effectively deliberate. He said he suspected many different policy areas and swim lanes will face similar issues, especially in scaling, around obstacles like up-front connectivity of stakeholders. The Honorable Branko Terzic of Berkeley Research Group, a Distinguished Fellow with the Council on Competitiveness, said that he and his fellow Co-Chair Ms. Stacy Lippa of Target were going to deliberate tomorrow on how to organize their swim lane on best practices and efficiencies, but that they would likely organize at least one meeting during the writing period to discuss and iterate on policy ideas with the group. Dr. Whelan suggested developing a shared document, like a Google Doc, that members of the different swim lanes could use to collaborate on ideas, including adding to and commenting on existing recommendations, to facilitate work during the writing period. Mr. Evans said the Council team could produce such a document, but encouraged group members not to wait if they already had recommendation ideas they wished to share.

Concluding Thoughts and the Road Ahead

Mr. Evans reminded the group that even though the focus was currently on the circular economy, group members with ideas in other aspects of sustainability should not hesitate to share them, and that it was valuable for members who felt out of their depth on the circular economy to share their insight and expertise on other topics the group should consider going forward. Ms. Wince-Smith particularly encouraged suggestions around the future of energy and the hydrogen economy, as well as on the topic of resiliency in supply chains. Mr. Evans added that the Council team would be able to provide logistical support for the different swim lanes in the form of preparing materials or facilitating meetings, and asked group members to let him know if they wished to join a swim lane or needed him to re-send any material. The next meeting of the group will be on Monday, August 31st.

Working Group 2 Calls September 14

Introduction

The Honorable Deborah Wince-Smith and Mr. Chad Evans welcomed the group. Mr. Evans said that the day's call would focus on providing overarching thoughts from the Council team on the strategic writing period, a deep dive into the recommendations from the Innovations in the Circular Economy Swim Lane, and a preview of the weeks ahead as the Council moves to consolidate and narrow down recommendations ahead of the release of the National Commission's Year One findings in December. Ms. Wince-Smith thanked the group for all of the effort the participants put into generating and refining recommendations during the writing retreat period.

Overview of Areas for Deeper Discussion

Mr. Evans outlined several areas the Council team felt needed deeper engagement and discussion following its review of the recommendations generated during the writing period, Phase I of the Working Group calls, and previous Council publications and reports. First, a greater emphasis on articulating the need for an organized approach to innovation policy, including a national leadership structure dedicated to confronting innovation and competitiveness challenges. In particular, more discussion of a federal body that coordinates and champions innovation policy within the Executive Branch would be fruitful. Second, clarification of the federal role

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in investing in research and development, including numerical targets for investment and priority areas to invest public dollars in. Mr. Evans noted that federal spending on R&D as a share of the economy has fallen from its 1960s high, even as the nation faces a challenge and an opportunity at least as great as the Space Race of the 1960s. Dr. Thomas Gardner of HP Federal noted that industry research had increased by a larger amount than federal research had decreased, and that the nature and definitions of "basic research" were changing. Mr. Evans clarified that the question revolved around federal investment, particularly bridging the gap between basic and applied research. He added that the Council saw a need to refine its messaging in this area. Dr. Albert Pisano of the University of California, San Diego said that while large investments were being made in innovation, the country should look not just at doing more of the same, but making structural adjustments so that current investment produces more "bang for the buck."

A third area for deeper engagement is the role of universities and national laboratories in technology transfer, and how to accelerate the widespread deployment of innovations developed in these institutions. A fourth is greater discussion around the future of work. While Working Group 4 has extensively discussed the future and future needs of entrepreneurs and innovators, the role of automation and robotics and the transformation of workspace have not been as thoroughly discussed. Fifth, the variety of challenges stemming from China, including intellectual property protection, engagement with Chinese students in U.S. research institutions and the undergraduate and graduate levels, and joint research projects with Chinese teams. Sixth, embedding resiliency into the economy, supply chains, and infrastructure as a driver of long-term innovation and competitiveness, especially in times of disruption like the current pandemic. Finally, a greater emphasis on diversity and inclusion, particularly criteria and toolkits, like the one developed by the Diversity and Inclusion Swim Lane in Working Group 4, that enable policy makers to think systematically about these issues. The Council will also look across the private sector for best practices and learnings to incorporate into the work of the National Commission.

Structural Change, Bold Ideas, and Technological Statecraft

Ms. Wince-Smith discussed the importance of restructuring the federal government to address challenges in coordinating innovation policy. After the September 11th attacks, the government overhauled its organization to create the Department of Homeland Security to better protect against security threats and enable the planning of a coordinated response to terrorism. Challenges of similar scale threaten the United States on the innovation front, but there is not yet a corresponding coordinated response, as key departments and agencies responsible for various aspects of competitiveness work in siloes rather than as a unit. The White House Office of Science and Technology Policy, for example, does not deal with regulatory policy, capital cost structure,

fiscal policy, trade policy, or antitrust issues, all of which deeply impact America's progress in science and technology. As long as the U.S. approaches problems in the same way, it cannot produce the innovative responses and solutions needed to rise to the challenges facing the country. Ms. Wince-Smith previewed the Council's Technology Leadership and Strategy Initiative Competitiveness Watch call this Thursday, during which the new head of the National Science Foundation, Dr. Sethuraman "Panch" Panchanathan, will discuss creative ideas for the transformation of the NSF for the 21st century.

Ms. Wince-Smith also reminded participants that the Council has a history of pioneering bold, transformative ideas that were ahead of their time, but that eventually became embedded in the public consciousness and inspired policy change down the road. Recent examples of the Council's pioneering work coming to fruition include recent proposals to double the NSF budget and to achieve a balance between investment in physical and life sciences. Ms. Wince-Smith encouraged participants to put out big, bold ideas for December's findings in order to chart a course for America's technological future. Finally, Ms. Wince-Smith discussed the myriad challenges posed by China, which extend beyond scientific research and into geopolitics. The Chinese government's attempts to draw the European Union towards China and Eurasia-based "Belt and Road" initiative trade and away from closer connections with the U.S. and maritime trade are a major challenge, as are supply chain security, debt-financed infrastructure investment, pervasive cyberattacks, and other illegal activity aimed at weakening the United States. To combat these measures, the U.S. must embrace "technological statecraft," seeking to work with our allies to maintain institutional norms and global policies that align with our interests and bolster our standing and influence in international organizations.

Overview of Working Group Recommendations

Dr. Mohammad Zaidi of Braemar Energy Ventures, a Distinguished Fellow with the Council on Competitiveness and a Co-Chair of the Working Group, provided an overview of the fifteen policy recommendations submitted by members during the strategic writing period. Dr. Zaidi grouped the recommendations into four categories. The first focused on establishing standards, ratings, and life cycle analyses for consumer products, and increasing public awareness of these measures and their linkage to sustainability issues. The second focused on future investments and innovations, including thematic innovation centers and consortia, and federal incentives for intellectual property relevant to sustainability technology. A third broad category dealt with the reduction, reuse, and conversion of waste into energy. These recommendations included generating hydrogen from industrial waste products, reducing plastic pollution, and developing early warning systems to reduce industrial waste. Finally, a fourth category of recommendations focused on developing the sustainability workforce of the future across disciplines ranging from business to engineering.

Dr. Zaidi said that the recommendations varied in their level of detail, and that roughly one third of Working Group members had directly contributed during the writing period. He added that the next step was to begin combining and narrowing the recommendations, and encouraged all participants to become involved in this process. He also encouraged anyone with an alternative schema for grouping the recommendations to share it. Dr. Pisano said that all of the recommendations discussed contained two components: a call to increase or accelerate an ongoing practice or innovation, as well as a new element to add to the status quo. He particularly singled out developing a sustainability workforce of the future as a key innovation that would enable the other technologies, ideas, and practices discussed in the recommendations. Dr. Thomas Kurfess of

Oak Ridge National Laboratory praised Dr. Zaidi's classification of the recommendations, and added that the National Laboratory system could play a major role in facilitating the innovations participants suggested. He urged the group to coalesce around a recommendation to provide the labs with funding and authority to help facilitate such projects. He also stressed the need to simplify the messaging around recommendations to make it easy for the public to latch onto.

Dr. Carol Dahl of the Lemelson Foundation noted that some recommendations were easy to implement in short order, often involving the adjustment or "tilting" of existing programs and policies to promote sustainability. Other recommendations were larger and more transformative, and would require long-term, sustained investment. She asked how to determine leadership responsibilities for these larger projects, and whether the group should focus more on building out blueprints for these major initiatives or more on developing easy-to-implement policies for the incoming administration. Dr. James Stock of the University of South Florida suggested presenting easy policy interventions for the beginning of the new administration, while outlining detailed short-, medium-, and long-term targets and plans for larger initiatives, lest the administration get impatient and abandon them. Dr. Kathleen Merrigan of Arizona State University noted that many administrations issue a raft of executive orders at the beginning of their terms, and that this would be an opportunity to pass many of the "easy lift" policies. Dr. Ricardo Ernst of Georgetown University advocated greater specification in the level of difficulty and expected impact for recommendations, and Mr. Evans noted that this was an area where participants could flesh out their recommendations more. Dr. Tensie Whelan of New York University said that while there were many valuable recommendations, they were scattered across different domains, and suggested establishing a set of priorities and problems to solve in order to develop more focused and cohesive recommendations. She gave the example of sustainable manufacturing, where the technology to reduce waste and create "closed loops" for the circular economy exists but incentives for the private sector to install this technology are lacking. Mr. Evans said he could discuss the matter in depth on a separate call.

Deep Dive into "Orphan Drug" Ideas for Sustainability

The group discussed in detail Dr. John Warner of Zymergen's recommendation for a set of policies similar to the Orphan Drug Act of 1983, focused on promoting sustainability innovation. Dr. Warner said that just as the Orphan Drug Act helped incentivize investment in drugs for rare diseases when previously the small potential market made such investment cost-prohibitive, a similar program for sustainability technology could overcome the barriers to widespread investment in these fields. The relevant aspects of the Orphan Drug Act to copy include a designated process for identifying and prioritizing unmet needs—which he argued existed already in H.R. 2051, the Sustainable Chemistry Research and Development Act—along with a series of interconnected provisions. These include tax incentives for research on sustainability, appropriations to granting agencies like the Department of Energy and National Science Foundation to fund research, a loan program to support small business loans, grants to K-12 and tertiary educational institutions to teach sustainability, and a patent exchange program in which innovators can acquire patents for other technologies in exchange for research on key sustainability technologies. Dr. Warner added that the Orphan Drug Act provided nearly 40 years of examples to learn from, and offered to share detailed examples of the provisions of the Orphan Drug Act with the group.

The Future of Energy

Ms. Wince-Smith discussed the importance of transitioning the country to net-zero carbon emissions, and of putting down numerical goals for clean energy. She stressed that resiliency and reliable

access to energy must be part of the equation, citing the challenges California is facing with blackouts at present. She also praised the Biden campaign's official endorsement of nuclear energy in its platform. The Honorable Branko Terzic of Berkeley Research Group advocated greater recognition of nuclear energy as a clean, adequate, and reliable energy source. He also suggested a return to physical inspections of utilities to ensure they had adequate power, and the construction of additional power plants, noting that having idle capacity was cheaper than dealing with electricity disruptions. Dr. Maya Trotz of the University of South Florida and Ms. Ciannat Howett of Emory University noted ongoing challenges for nuclear power, including the disposal of nuclear waste, the contested storage of waste on Navajo land at Yucca Mountain, and cost overruns and higher electricity rates associated with new nuclear plants in Georgia. The recent disaster at Fukushima plant in Japan was also discussed. Dr. Terzic expressed the belief that the primary challenges with nuclear power were political rather than technological, noting that smaller countries like Finland had managed to resolve these issues.

Concluding Thoughts and the Road Ahead

Mr. Evans laid out plans for the next week and the coming weeks between now and the National Competitiveness Forum in December. Later this week, the Co-Chairs will map out the next few weeks of calls, which will include deeper dives into more of the recommendations the group generated. Following this, the Council will move to its crystallization phase, in which it will prioritize recommendations, draft a Year One report, and circulate these drafts with the Commissioners, Advisors, Outreach and Engagement Committee, and strategic communications partners for feedback. During this period, the Council will engage periodically with members of the Working Groups to share content and secure additional feedback on the deliverables. Ms. Wince-Smith thanked the Co-Chairs for their work and leadership during the strategic writing period, and added that the Commission would continue its work in 2021 and beyond. She encouraged participants with ideas for deeper exploration in Year 2 to share them, noting that international trade and standards setting would be major focuses for next year as well. The next meeting of the group will be on Monday, September 21st.

Working Group 2 Calls September 21

Introduction

Mr. Chad Evans welcomed the group and said the day's discussion would focus on a deep dive into the recommendations developed by the Best Practices and Efficiencies Swim Lane, led by The Honorable Branko Terzic of Berkeley Research Group, a Distinguished Fellow at the Council on Competitiveness. In addition, Mr. Evans outlined the schedule for the Working Groups covering the period up to the December release of the National Commission's Year One findings. Next week will be this group's final weekly meeting, after which time the meetings will shift to every other week through Thanksgiving as the Council begins systematizing and prioritizing the recommendations developed by the Working Groups for the Year One report. During this time, the Council will be sharing the recommendations and its draft report with the National Commissioners, Advisors, and Outreach and Engagement Committee, and will share feedback from these groups with the Working Groups during the next phase of calls. The Council team will also engage with the Working Groups on specific issues, recommendations, and concepts when in need of feedback or expertise during this time period. The Swim Lanes can continue to meet during this time period, and the Council team will help provide support for those meetings as

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requested. The Council plans to go to print with the Year One deliverables by the end of November to the beginning of December.

Markets for Food Waste Recycling

The first recommendation developed by the Best Practices and Efficiencies Swim Lane was to evaluate the efficacy of new national standards or requirements for recycling, waste disposal, and reuse for rubbish and food waste by the creation of national markets. Dr. Terzic discussed the high volume of food waste in the United States, including food thrown out by consumers and food damaged during transportation and warehousing. He said that more waste leads to more disposal and recycling, and because of the energy intensity of food production, higher energy costs and greater carbon emissions. Dr. Helene Dillard of the University of California, Davis strongly endorsed this recommendation, arguing the country was already well-positioned to take concrete steps towards reducing waste, and noting the number of researchers working on this problem in academia and at the Department of Agriculture. She added that this recommendation links to concerns about supply chain sustainability, as much food waste occurs "at the farm gate" as crops are plowed under because there is no market for excess food or labor force to harvest it. Dr. Dillard called for better repurposing of food when there is no buying market, especially in the form of food banks, as doing so would drastically reduce emissions and waste. Mr. Evans said that this recommendation was a candidate for deeper evaluation as the National Commission proceeds into Year Two, and that it would be valuable to research existing best practices and ideas that the Council could champion.

Dr. Tensie Whelan of New York University said more specific details were needed on where the United States should invest and on technical considerations to make the recommendation actionable. She noted that anaerobic digesters were important for turning food waste into compost, but that a program to provide these digesters was scrapped by New York City due to costs. Tackling cost challenges will be a key component of any new sustainability programs. Dr. Thomas Kurfess of Oak Ridge National Laboratory asked where in the food production and distribution process most waste occurred, as well as how water usage factored into discussions of agricultural waste. Dr. Terzic said that there was tremendous water waste in agriculture, and pricing and allocation problems were a major contributor, with farms paying far less for water than residential consumers. Artificially low water prices encourage waste of water, and disincentivize investment in water-efficient technologies like drip irrigation over sprinkler irrigation. He added that he hoped policy makers could design attractive programs that would encourage private capital to invest in anaerobic digesters and other carbon- and waste-recycling programs, as municipal budgets were already under tremendous strain. Dr. Maya Trotz of the University of South Florida shared ongoing projects at the National Science Foundation focused on food, water, and energy waste, as well as the University of South Florida's program devoted to food and energy research. Dr. Dillard said that while there was waste throughout the food distribution chain, the largest cause was the lack of a market for much of the food that is grown. Mr. Evans said the Council would share work it had done on energy, food, and water usage in conjunction with the University of California, Davis. Dr. Kathleen Merrigan of Arizona State University said a lack of rendering facilities for animal waste meant that most animal waste was sent to landfills instead.

Life Cycle Analysis for Products and Services

Next, Dr. Terzic discussed a series of related recommendations around using life cycle analysis of the sustainability of products to help publicize information to encourage sustainable behavior by both producers and consumers. These include rating system for products to help inform consumers, the use of full life cycle analysis to measure the sustainability of products, and efforts to educate consumers on sustainability and its benefits. Dr. Whelan asked which stakeholders would be responsible for creat-

ing, analyzing, and sharing sustainability ratings, and discussed examples of holistic sustainability metrics like the Cradle-to-Cradle system developed by William McDonough and Timberland's Total Footprint analysis. She said that creating these metrics is difficult because of the lack of benchmarks and the difficulty of contextualizing ratings. Dr. Terzic said the idea was for government-designed product and service indicators for consumers, similar to the Energy Star designation for appliances. Mr. Noel Kinder of Nike said that Nike has used a tiered approach that tracks specific components of sustainability rather than developing a composite score, like the percentage by weight of recycled material in its products. He said that while certification was important, it was best to keep different metrics, like carbon footprint, water use, and recycled material, separate, and for labels and ratings to be simple and relevant to consumers. He gave as an example the "organic" designation for produce, and Dr. Merrigan said she would be happy to share insights into the development of the organic rating system, as she helped design the initial standards as well as the rules for their implementation during the Clinton Administration. She further directed participants to ReFED, a data-driven guide on food waste and solutions, for best practices to emulate.

Dr. Carol Dahl of the Lemelson Foundation called for the identification or development of a list of priority technologies for sustainability, which she said would help direct and coordinate federal research and investment into sustainability. She called for implementing a sustainability criterion in determining federal research projects to invest in, and highlighted the overlap between informing consumers about sustainability and the Innovation Swim Lane's recommendation for a sustainability workforce. Citing a Brookings Institution report recommending widespread sustainability education, she argued for an expansion of her previous suggestion to develop sustainability curriculum for specialized disciplines like business and engineering. Mr. Evans said the idea of integrated sustainability education was similar to discussions surrounding earlier and more frequent STEM engagement for students. Dr. Ricardo Ernst of Georgetown University elaborated on the consumer education recommendation, explaining that consumers should have a more active role in understanding and practicing sustainability. He said that initiatives are more effective when motivation flows from bottom-up in addition to top-down directions, and that educating consumers on the benefits they reap from sustainability will be essential to their embrace of sustainable behaviors. Dr. Dahl said education campaigns must begin at an early age to fully inculcate in consumers the importance of sustainability.

Hydrogen Transport, Storage, and End-Use Technology

The third recommendation developed by the group involved a national program of research and development for new energy transportation, storage, and end-use technology with respect to hydrogen. Dr. Terzic said that unlike in Europe, where there is extensive investment in scaling up hydrogen energy production as a replacement for fossil fuels, many U.S. states, notably California, are trying to dismantle natural gas distribution infrastructure and prevent the creation of new infrastructure, which will make it much more difficult for these states to adopt hydrogen energy. Most natural gas infrastructure could be upgraded and retrofitted at low cost to produce and transport hydrogen, which could be generated through either nuclear power or solar and wind power via electrolysis. Converting renewable energy into hydrogen gas offers a way to store excess energy and transport it easily, making abundant renewable energy much more viable. Dr. Terzic called for an effort to keep the U.S. competitive in hydrogen energy, noting that the small Department of Energy program on hydrogen was mostly focused on fuel cells. In addition to Europe, Dr. Trotz noted that South Korea was investing heavily in hydrogen, with plans to power three entire cities with hydrogen gas. Mr. Evans noted the overlap between this recommendation and Dr. Albert Pisano of the University of California, San Diego's recommendation for a set of consortia on researching sustainable technology. In addition, Dr. Sethuraman "Panch" Panchanathan,

the incoming Director of the National Science Foundation, argued at last week's Technology Leadership and Strategy Initiative (TLSI) Competitiveness Watch talk for the scaling and expanding of R&D programs that bring together universities, industries, and other stakeholder across the country. Mr. Evans said it was important to identify who to bring to the table to co-design and co-fund these programs.

Dr. Terzic said there were many natural constituents for a hydrogen energy initiative, including the solar, wind, and nuclear energy industries who could use hydrogen to store excess power, the pipeline construction industry who could convert their infrastructure for hydrogen transport and distribution, and the natural gas industry, who could convert methane into hydrogen. Dr. Terzic also noted the flexibility of hydrogen energy, as hydrogen could be created "in the field" and transported in gas-form through pipelines, or it could be converted from its source materials at distribution facilities. Dr. Pisano asked if hydrogen technology was an area where the U.S. should seek to collaborate with the European Union and other allies, and Mr. Evans said that much like with semiconductors, the global nature of energy supply chains put international cooperation with allies on the table.

Dr. Mohammad Zaidi of Braemar Energy Ventures, a Distinguished Fellow at the Council on Competitiveness, asked if hydrogen production via either electrolysis or pyrolysis was becoming economically viable. Dr. Terzic said he was not certain of the details, but that with intensive research by European companies and governments, hydrogen was becoming cheaper, and that a carbon tax would make it even more competitive vis-à-vis natural gas. Dr. Trotz added that accounting for the costs to human and ecological health of fossil fuels would change the cost-benefit calculus in favor of renewable energy sources like hydrogen. Dr. Zaidi suggested looking for ways to integrate waste and energy production recommendations in the pursuit of "clean integrated systems." He said that sustainability initiatives that focus on only one dimension of the problem often become bogged down in high costs. Dr. Terzic said that the principal challenge for hydrogen was finding a high-density storage mechanism at room temperatures.

Renewable Energy from Biodigesters

Finally, Ms. Shannon Lee of HP Inc. shared her idea for generating renewable energy from dairy production, in the form of biodigesters to turn methane into renewable energy, involving both the dairy industry and digital manufacturing. She explained that her research for HP focused on this topic, and that some dairy farms in the Pacific Northwest are experimenting with methane adjusters to create a closed-loop energy system. She said this process would create shared value for both local communities and the private sector. Dr. Terzic asked if there were pilot programs underway to test the viability of this idea, and Dr. Thomas Gardner of HP Federal said that Ms. Lee's work was related to HP's research into net-zero manufacturing. He added that the company was on the verge of announcing a major new environmental and sustainability initiative. Mr. Evans asked if this process could be scaled and expanded to other sectors, and Dr. Gardner said that HP's executive leadership had a broad vision for net-zero emission production, of which this recommendation idea was one realization.

Concluding Thoughts and the Road Ahead

Mr. Evans said the Council would send out a session summary and outline of the road ahead going into December, with more to come following a meeting with the Co-Chairs later this week. He added that the Council would begin scheduling the new biweekly sessions, and that they were likely to occur at the same day and time as the current sessions. He then thanked Dr. Terzic for leading the discussion and the group for its participation in the call. The next meeting of the group will be on Monday, September 28th.

Working Group 2 Calls September 28

Introduction

The Honorable Deborah Wince-Smith and Mr. Chad Evans welcomed the group. Mr. Evans said that the focus of the day's call would be clarifying and confirming the agenda for the next month and a half of discussions, as well as beginning the discussion of which recommendations to prioritize for inclusion in the Year One Call to Action in December, and how to evaluate and refine those recommendations. Ms. Wince-Smith added that it was important to develop a Call to Action that included actionable items for the incoming administration to quickly turn into policy, and encouraged the group to think big and bold in its ideas. She especially encouraged bold thinking in sustainability, and drew a parallel between the U.S. in drop in competitiveness in manufacturing in the 1980s due to a drop in quality management and the current situation where the U.S. is lagging in sustainability. Just as the Baldrige criteria spurred a substantial improvement in quality control practices across manufacturing as firms responded to incentives to integrate quality management throughout their production process, a similar focus on sustainability would enhance the competitiveness and reduce the environmental and natural resource impact of American manufacturing.

Ranking and Prioritizing Recommendations

Mr. Evans said that the group needed to separate recommendation ideas into those that will be further developed and refined for inclusion in the December Call to Action and those that will need to be explored in greater depth in Year 2. He asked participants to draw up a list of the recommendations or subsets of recommendations they felt should be the focus for the remainder of Year 1. Dr. James Stock of the

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University of South Florida suggested developing a matrix containing the top five or six recommendations as determined by the group, prioritizing those with universal application. He suggested having each column delineate a step on the road to actualizing each recommendation, explaining what needed to be done and its anticipated impact. The final column would summarize the overall impact from implementing the recommendation. He further suggested determining the recommendations to prioritize by surveying the group and having members rank their top five to ten recommendations.

Viewing Innovation Holistically

Dr. Mohammad Zaidi of Braemar Energy Ventures, a Distinguished Fellow with the Council on Competitiveness, said that many of the group's recommendations thus far had included best practices that were similar to many other organizations working in this space. While he praised the identification of these practices, he argued that to differentiate its recommendations the Commission should look at all of its suggestions through the lens of competitiveness, as well as thinking systemically. By tying recommendations to improved productivity and growth, and focusing on ways to integrate a focus on sustainability throughout the economy and production process, the Commission can add new value, especially if it explains both what needs to be done and the obstacles that currently prevent these ideas from being adopted at scale. Dr. Albert Pisano of the University of California, San Diego expressed support for both of these ideas, and suggested it might be useful to develop a "total innovation management" program to embed innovation and sustainability into business activities. Mr. Evans agreed and noted that merely increasing funding into existing structures would just perpetuate the status quo.

Dr. James Davis of the University of California, Los Angeles noted that the Manufacturing USA institutes regularly discussed the challenges facing the innovation system, and came to a consensus that greater democratization and distribution of innovation activity was needed. However, these discussions had struggled to identify the necessary markets, facilities, workforce, and culture needed to make these ideas reality, especially in combination with each other. He said that the Commission focusing on these items would provide significant value. Mr. Evans noted that an economist unaffiliated with the Commission had written a blog post about its work, and suggested it emphasize even more the link between innovation and long-term productivity and inclusive prosperity.

Democratizing and Universalizing Innovation

Dr. Pisano echoed the calls to democratize innovation, noting that America's universities alone could not provide the supply of innovators demanded by the market or needed by society, and said it was important to make it easier for innovators from all over to add "churn" to the economy, as well as to innovate beyond the service sector for the purposes

of remaining competitive internationally. Dr. Carol Dahl of the Lemelson Foundation noted that much innovation does not radically change quality of life, and called for a systemic process to identifying innovative ideas that fall through the cracks and are not realized. She also endorsed developing interactive working areas where established companies can interact with and support a broader pool of innovators. She said currently people innovate based on short term market incentives and convenience, rather than to solve society's most pressing problems. Dr. Dahl stressed the importance of creating incentives for businesses to invest in these challenges.

Dr. Zaidi noted that despite China's advantage in state-funded R&D, the United States was still home to most of the world's venture capital, as well as robust crowdfunding infrastructure that could be used to democratize innovation. He said that 90-95 percent of venture capital was poured into the same avenues and did not yield the ideas society needed. He encouraged connecting innovation to sustainability, and basing recommendation ideas on the entire funding landscape, not just federal dollars.

Focusing on Platform and Systemic Ideas

Dr. Tensie Whelan of New York University noted that several of the group's recommendations focused on platforms for collaboration and consortia, and on realigning incentives. These include Dr. Pisano's idea for a network of innovation consortia for sustainable technology, Dr. Dahl's "Patents for the Planet" recommendation aimed at incentivizing research into sustainable technology through IP incentives, and Dr. John Warner of Zymergen's suggestion for a sustainability-focused analog to the Orphan Drug Act to incentivize innovation there. Dr. Whelan noted that these ideas complemented each other, connected innovation to sustainability, and focused on systematic change. She encouraged the group to make these recommendations the focus of the Year 1 report out.

Concluding Thoughts and the Road Ahead

Mr. Evans said the main takeaway from the conversation was the need to develop tools to assess which recommendations the group should focus on going forward. He said the Council team would explore developing surveys, matrices, and other tools to allow members to provide feedback about their priorities. He said he would reach out again in the coming days in this regard. Ms. Wince-Smith thanked the participants for their contributions. The next meeting of the group will be Monday, October 12th.

Working Group 2 Calls October 12

Introduction

Mr. Chad Evans welcomed the group, and reminded participants that the Council team had sent out a survey asking members of the group to provide feedback on which recommendations developed during the Phase I and II calls and strategic writing period they would like to prioritize for inclusion in the Year One Call to Action and which ideas to reconsider in 2021. He added that the day's discussion would focus on allowing members to share their desired conversation topics for upcoming sessions, and said that several key issues were emerging that would require deeper discussion as the Council begins to work on the first draft of the Year One report. In particular, Mr. Evans highlighted opportunities for cross-pollination, such as the innovation centers concept developed by Dr. Albert Pisano of the University of California, San Diego, which has significant overlap with Working Group 1's mandate.

Sustainability Metrics

The Honorable Branko Terzic of Berkeley Research Group, a Distinguished Fellow with the Council on Competitiveness, noted that Amazon recently announced a new sustainability rating system to track the cradle-to-grave environmental impact of their products. He expressed interest in examining the system's methodology, and held it up as a possible model for an industry or national standard that the Commission could champion. Dr. Mohammad Zaidi of Braemar Energy Ventures, a Distinguished Fellow with the Council on Competitiveness, agreed it would be interesting to examine the elements Amazon takes into account in its ratings with a view to evaluating whether they are comprehensive enough. He noted there have been efforts by industry in the past to develop rating systems. Mr. Noel Kinder of Nike shared a press release indicating that the Amazon ratings will involve a composite of 18

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different third-party raters, and noted that having an industry-wide, systematic metric for circularity would be important as a neutral, trusted resource. He also advocated for a more harmonized approach than that taken by Amazon.

Dr. John Warner of Zymergen noted that the Commission's endorsement of a particular metric or rating system could come with commercial implications, and emphasized the importance of training organizations to meet whatever metrics are adopted. He said it was important not to get so focused on "reading the stopwatch" that the actual running of the race gets neglected, and also cautioned against only focusing on those items that are easiest to quantify.

Process Considerations

Dr. Carol Dahl of the Lemelson Foundation noted that the survey of recommendations used a 1-to-5 score to rate each item, rather than an ordinal ranking. She asked if the Council was prepared for the possibility that most or all of the recommendations will be labelled as high-priority, as well as the challenges of fleshing out recommendations the group has not discussed in depth. Mr. Evans said that the Council team was waiting on more survey responses before sharing the preliminary results with the group, and that ideas that are less fleshed out would be ideal candidates for the 2021 agenda. He also encouraged members of the group who had not yet taken the survey to do so. Dr. Zaidi noted there were two paths forward on recommendations: having the Council ask participants to fill in the gaps in their own recommendations now, or draft the report with the recommendations as they exist, while contextualizing them against the Commission's broader aims. In the second case, the Council could then return to the Working Groups and ask them to update the recommendations to align with the goals of the National Commissioners. Dr. Zaidi endorsed the latter approach, and Mr. Evans said the Council had already begun implementing this process.

New Approaches to Sustainability

Dr. Zaidi noted that on taking the survey he was struck by how many of the recommendations were ideas that had been around for years. He urged the group to focus on putting out new recommendations, and The Honorable Deborah Wince-Smith agreed, adding that they should be bold and transformative. Dr. Zaidi said one angle the Commission could pursue is that consumers will play a larger role than the federal government in driving sustainability via their choices in the marketplace, and that the government should act as an enabler rather than a driver. Mr. Evans agreed, and said that sustainability had become a much more democratized space, with consumer education being a key component of any sustainability initiative. Dr. Dahl said that focusing on a new approach to encouraging sustainable behavior could serve as a fresh angle on sustainability questions, as the needed policies haven't changed much, even as it becomes clear consumers and producers are not jumping on board. By focusing on changing

the pipeline of producers and consumers, the Commission could bring a new approach to sustainability while continuing to promote existing best practices.

Ms. Wince-Smith noted the connection between sustainability, justice and inclusion, and telecommunications infrastructure. She emphasized the disparity in access to broadband and other technology that could enable virtual work and collaboration and link urban and rural areas, and said that moving to a carbon-neutral environment would necessitate the incorporation of sustainability into new infrastructure. She called on the group to approach these issues as systemic and interrelated, with investments in sustainable infrastructure increasing economic opportunity and inclusion, improving access to cutting-edge technology, and increasing sustainability. Mr. Evans noted that the Year One report would include a macro statement by the Commissioners about the rapidly shifting national and global landscape, and the role of the Working Groups in addressing these shifts thematically. Within this context, the report will go deep into the recommendations through the lens of each Working Group to craft forward-looking policies that will lead to deep transformations.

Concluding Thoughts and the Road Ahead

Mr. Evans reminded the group to complete the survey, and said that initial results would be shared first with the co-chairs and then the whole group in the coming days. He said the goal was to eventually integrate and share the progress of all four Working Groups to allow for cross-pollination, and that the survey would be used to prioritize the group's focus in the weeks ahead. The next meeting of the group will be on Monday, October 27th.

Working Group 2 Calls October 26

Introduction

The Honorable Deborah Wince-Smith and Mr. Chad Evans welcomed the group. Mr. Evans said the Council team was in the beginning of drafting the Year One Call to Action, to be released at the National Competitiveness Forum in December. As such, the Council is focusing on strategic and unintentional gaps in the conversation to date that would help inform the larger report, identifying areas where participants could still weigh in over the next couple of weeks, and areas where the group should hold off on deeper discussions until 2021. Mr. Evans noted that he sent out a document outlining these items, as well as ideas from the first phase of Working Group calls this Spring that might warrant inclusion in December's Call to Action, earlier today. The Council's ask is for participants to read through the document and provide feedback on which topics need to be included or further discussed for Year One and which should be areas of focus for Year Two during the next several days.

Filling in Gaps

Ms. Wince-Smith outlined several areas that the Commission would explore in greater detail in Year Two with special relevance to the Working Group, especially those focusing around production and sustainability and their intersection with the triad of food, water, and energy. In food production, precision agriculture, advanced technology, sensors, and AI will be major focuses, along with a focus on water usage in agricultural and industrial production. In energy, the hydrogen economy will be a major focus. Ms. Wince-Smith emphasized that in addition to the

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recommendations released in the December Call to Action, these topics must be mentioned as areas of discussion for 2021 and beyond. She added that it would also be imperative to examine supply chains from the perspective of resiliency and security, rather than just cost and efficiency, and noted that the Council recently released a report on resiliency, Transform 2020, in conjunction with Industry Week. Ms. Wince-Smith also stressed the need for businesses to begin treating sustainability as a platform that is embedded into all business operations as a matter of course, similar to environmental safety and health and total quality management have been made standard parts of the production process. Mr. Evans outlined some of the areas where the Council team felt there were gaps, including biomanufacturing and the future of bio-based production with a sustainability lens. He noted that the Council had worked in the past in this space in conjunction with Lawrence Berkeley National Laboratory. Another area for consideration is sustainable consumption, as most of the group's discussions have focused on the production side of the equation.

Biomanufacturing

Dr. Thomas Gardner of HP Federal said his firm had recently hired a renowned expert in biomanufacturing, Dr. Trevor Hawkins, and offered to open a dialogue with the Council as it begins to explore this field in 2021 and beyond. Mr. Evans said that would be a valuable opportunity, and added that there was more to explore in the circular economy discussion, including issues around measuring financial benefits and improving investor understanding of the concept. Dr. John Warner of Zymergen highlighted several ongoing programs and initiatives in this space, including the recently launched BioMADE initiative, Establishing the Biondustrial Manufacturing Innovation Institute, and the ongoing Green Chemistry Awards and the Green Chemistry and Commerce Council, which makes the business case for green chemistry. Dr. Dahl connected the BioMADE project to Dr. Albert Pisano of the University of California, San Diego's idea for sustainability innovation consortia, and said it would be crucial to involve investors, accelerators, and existing industrial leaders in these projects to validate and eventually scale them. Mr. Evans highlighted that the BioMADE project was hosted by the University of Minnesota, whose president, National Commissioner Ms. Joan T.A. Gabel, features in a just-released Council video op-ed on the importance of partnerships for innovation.

Dr. Kathleen Merrigan of Arizona State University said that government food procurement represented an opportunity to drive sustainable innovations, including purchasing for schools, VA hospitals, federal cafeterias, and prisons, She noted that the Good Food Purchasing Center contains valuable resources on sustainable food procurement, and that the previous administration worked with the GSA to chance contract specifications for federal cafeterias. She also mentioned the USDA's BioBased program as a federal initiative that could use more support. Dr. Thomas Kurfess of Oak Ridge National Laboratory suggested using the COVID-19 pandemic as a frame for biomanufacturing discussions.

Broadband Access and the Digital Divide

Several participants, including Dr. Kurfess and Dr. Pisano, highlighted the issue of broadband connectivity in inner city and rural areas as a major challenge. Dr. Kurfess highlighted the economic and technological inclusion issues, essential to widespread sustainability, the digital divide raises, and Dr. Pisano noted that 5G and 6G infrastructure projects follow the money and traffic, leaving other areas behind. He observed that many students at UCSD were unable to take virtual classes because of insufficient bandwidth at home. Dr. Gardner said there were several broadband initiatives in operation, and that making connectivity universal was a question of cost, not technology. Dr. Pisano said it was crucial to emphasize that financial pressures meant the connectivity issue would not resolve itself on its own, and sustained investment would be necessary, espe-

cially given China's investment in rural broadband. He pointed out that within a ninety-minute drive of New York City there are communities without any high-speed internet infrastructure, and suggested turning every school into a broadband hub, an idea seconded by Mr. Noel Kinder of Nike. Dr. Merrigan noted that linking together existing broadband programs might be difficult, as their sponsoring bodies, like the Departments of Commerce and Agriculture, do not always work well together.

Ms. Wince-Smith said that Verizon was putting together a group to help the Council develop a set of recommendations on broadband and "net equality" as opposed to net neutrality, which Dr. Kurfess argued should be extended to digital equality more broadly. The Council has also had discussions with former FCC Commissioners on where resources for a universal "Broadband for America" push might come from, and the question of funding such projects has been a major discussion point for Working Group 3, as well. Dr. Gardner noted that the city of Chattanooga, Tennessee used its electric board to invest in gigabit broadband access for the entire town, as well as outlying rural areas. He added that HP was working with a startup there working to develop quantum internet, with a goal of making Chattanooga the first city with quantum internet access. Overall, the project has led to significant benefits to both small businesses and the general population, and Dr. Pisano asked how best to get the word out about projects that provide such proof of concept to encourage their emulation elsewhere. Mr. Evans said it would be great to connect Dr. Gardner and Dr. Pisano with the group in Working Group 3, led by Ms. Vickie Lonker of Verizon, on this issue, and said it would be fantastic if Chattanooga offered a model the Council could promote.

Concluding Thoughts and the Road Ahead

Mr. Evans reminded the group again that the Council team welcomed feedback on ideas members felt should be priorities for inclusion in the Year One Call to Action, ideas from the first phase of Working Group calls that should be revisited this year, and ideas that should be saved for more detailed development in Year Two. Ms. Wince-Smith signaled initiatives in social justice and in engineering curriculum that the Council would seek to develop in Year Two based on programs and projects underway at member institutions. The next meeting of the group will be on Monday, November 9th.

Working Group 3: Optimizing the Environment for the Nation's Innovation Systems

Working Group 3 Summary

The virtual Working Group sessions began on March 31st and completed this first phase on May 22nd. This Phase I of the Working Group sessions yielded insights and areas for further assessment ahead of the National Commissioner's meeting on June 16th, 2020. Below are highlights and themes from the Working Group.

Working Group members explored areas concerning capital, infrastructure and legal frameworks to support and optimize the entire system in which the nation's innovators and enterprises operate. And though the private sector takes the lead—applying strategies, technologies, business models and capital that address genuine market needs—there are critical roles local, state and federal governments must play.

- The Working Group focused on an initial challenge: what sort of policy recommendation (or set of recommendations) could unleash, free up the tremendous amounts of idle cash held by U.S.-based hedge funds, pension funds, private equity, and other entities to support the long-term, patient capital needs of non-app/non-software, innovation-based industries. The Group noted current venture capital models are insufficient to encourage such long-term investments, and that the focus of the National Commission's work should be on articulating a range of incentives, regulatory environment changes, and other solutions to free up that capital. For example, could incubation and accelerator spaces—coupled with venture and co-located with other national, shared innovation infrastructure (labs, unique and/or large tools, demonstration platforms)—help startups move up the exponential innovation growth curve?
- The United States must develop an infrastructure agenda that is framed around American strengths, values, and interests. This will require coordinating and harmonizing activities with our allies, as well as a combination of bilateral and multilateral approaches (like, revitalizing multilateral development banks). Working Group members suggested the United States develop means to co-invest, de-risk, and provide technical assistance to make large infrastructure investments worthwhile to private finance.
- Domestically, the COVID-19 pandemic has further exposed the infrastructure issues facing many regions of the country. For example, in Appalachia and other rural areas, K-12 schools lack the bandwidth and equipment to transition to remote learning. Working Group members also warned the rapid reorganization of work in response to the pandemic could leave certain parts of the country behind others, as people may be unable to work remotely. Working Group members noted that the lack of infrastructure—like broadband access—can make some investments difficult. The Working Group discussed ideas like creating a federal broadband authority to leverages state programs and public-private partnerships to achieve universal broadband access.

- The Working Group also identified the need to bolster regional competitiveness for national gain. Working Group members agreed that regional innovation needed to be a high priority on the national innovation agenda and that this requires metrics to demonstrate the value of widely distributed innovation. The Working Group discussed, for example, significantly expanding the Economic Development Administration (EDA)'s Build Regional Innovation Systems to Scale program.
- The Working Group also started to tackle the issue of expanding access to capital to traditionally under-represented innovators and entrepreneurs. The Group discussed expanding the Small Business Innovation Research (SBIR) program, with a particular focus on Minority/Women-Owned Business Enterprises (MWBEs). Working Group members also discussed the creation of a new federal equity capital bank, modeled after the State Small Business Credit Initiative created in 2010 that phased out in 2017. This program would include $10 billion in funding over 10 years to leverage state partnerships with the private sector to invest in underserved regions.
- Working Group members also considered the concept of place-based immigration visas to generate a flow of talent and economic activity to rural areas and small towns, revitalizing areas in demographic decline.
- Working Group members spent multiple sessions discussing the need to reexamine intellectual property, patents and anti-trust laws. Intellectual property (IP) was identified as an often-used mechanism to stifle innovation when patents are held by non-practicing entities—creating a chilling effect on innovation in that space. The Working Group committed to exploring ways to encourage licensees to commercialize technology and to promote active innovation.
- Working Group members did note that during the COVID-19 pandemic, the crisis opened up a reconsideration of traditional views of intellectual property protection. For example, the members cited many examples of ventilator makers opening up their intellectual property to enable mass production of needed medical equipment. Working Group members explored whether intellectual property protection should take into account the national interest during times of crisis. Additionally, Working Group members discussed whether there is a need to rein in firms using intellectual property claims to dominate markets and keep out new entrants.
- Historically, antitrust policy has been used to prevent patent claims for "standards-relevant" technology such as mobile communication innovations. The Working Group considered issuing a recommendation against aggressive antitrust enforcement if the expert consensus was

trending in that direction. Furthermore, Working Group members suggested developing a new executive branch agency to challenge hostile antitrust rulings from abroad and encourage widespread adoption of American antitrust policies.

- Working Group members discussed whether, on a global scale, there is a need for an international body to specialize in antitrust policy, similar to existing international organizations for white collar crime, narcotics trafficking, and securities fraud. Overall, the Working Group agreed that the entire topic of competition policy as an important enabling framework for innovation required additional thought and consideration.

To view video and read full transcripts of each Working Group session, log in to the National Commission Community Online Portal. Video and transcripts are available within Working Group Rooms.

Working Group 3 Calls March 31

Recapping Arizona State

Ms. Kathy Trimble summarized the Working Group's discussion at the January Launch Conference at Arizona State University. The group's discussions centered around three broad topics. The first was redefining "capital" to extend beyond mere financing, encompassing human capital, access to resources and facilities, and infrastructure, among other topics. The topic of intellectual property protection included debates over patent lifespan given the time it takes to bring products to market after they are patented, licensing structures and who owns and uses patents, and how the group could think about IP in different ways to maximize its value. Dr. Lee Cheatham of the Pacific Northwest National Laboratory emphasized the issues with existing IP policy in regulating digital innovations, and Ms. Trimble concurred, citing recent discussions around patenting advances in artificial intelligence. Finally, the group spent a significant amount of time discussing competition from China, although Ms. Trimble noted that the COVID-19 pandemic may shift discussions away from trade and toward financial and regulatory policy. The Honorable Deborah L. Wince-Smith discussed China's predatory debt-financing of infrastructure projects in developing countries and its Belt and Road Initiative, and expressed concerns about these actions, as well as China's violation of WTO rules for infrastructure financing.

Ms. Trimble then presented guiding questions for the group for today's call. These included how to increase America's entrepreneurial potential, how to enhance innovation, and whether the United States should consider adopting an industrial policy.

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Group Structure and Subgroups

Participants on the call agreed that having subgroups to take deep dives on topic areas of greatest interest to, or most aligned with the expertise of, participants would be the best path forward. Several subgroups were suggested. Dr. Rao Unnava of the University of California, Davis suggested a group dedicated to the first topic, as it is an emerging issue within academia. Schools across the country are developing entrepreneurship centers, but there is no coordination to enable them to make use of common resources or share ideas. He also cited the example of numerous disparate federal incubators as an opportunity for cross-pollination. Dr. Sunil Mithas of the University of South Florida seconded his call for subgroups. Dr. Cheatham asked if there were challenges that prevented the country from boosting its entrepreneurial potential, and whether the Working Group should focus on "what" questions in addition to "where" questions. Mr. Chad Evans highlighted the many recommendations the Council, and other groups, have made over the years, and that there is "low hanging fruit" that has yet to be enacted.

Several participants expressed an interest in an intellectual property subgroup. Dr. Lloyd Jacobs, formerly of the University of Toledo, shared that many universities are concerned with their level of return on investment from patents and technology transfer. Ms. Wince-Smith asked whether the regime for academic IP developed in the 1980s with the Bayh-Dole Act needed to be modernized. Mr. Tad Lipsky spoke of his background in antitrust law, and how antitrust policy has been used to prevent patent claims for "standards-relevant" technology such as mobile communication innovations, and that the group should consider issuing a recommendation against aggressive antitrust enforcement if the expert consensus was trending in that direction. He also brought up the controversy around non-practicing entities, sometimes derisively known as "patent trolls," as an area of focus. Ms. Wince-Smith described the entire topic of competition policy as an important enabling framework for innovation, and worthy of a subgroup, and brought up other competition issues such as non-tariff trade barriers.

Ms. Trimble asked the group if there were other topics that should serve as the focus of a subgroup. Dr. Mithas mentioned high-skill immigration and human capital as an important topic, because of the resources universities spend on nurturing foreign-born talent that they are not always able to retain due to immigration laws. Mr. Evans noted the overlap from this topic with the mandate of the second Working Group, which includes the future of work, and discussed the possibility of cross-Working Group subgroups as cross-pollination increases. Mr. Greg Pellegrino of Deloitte suggested focusing on supply chain resiliency in light of the COVID-19 pandemic, and mentioned that the stimulus bill includes a required government report on the resiliency of the nation's public health supply chain.

COVID-19 and the Council on Competitiveness

Mr. Evans discussed the upcoming Board and Executive Committee meeting of the Council, which includes the National Commission Co-Chairs, and that the meeting will include discussion of how the Council in general, and the National Commission in particular, will respond to the COVID-19 pandemic. He mentioned discussions in Working Group 1 about the immediate and longer-term impact of the pandemic, especially as it intersected with the Council's focus on resiliency and sustainability. Ms. Wince-Smith recalled the Council's thought leadership in the wake of the September 11 attacks on reconceptualizing resiliency as a driver of productivity rather than a cost of doing business, and the influence the Council's work had on the Japanese government's response to the Fukushima nuclear disaster. She also noted how this pandemic has highlighted America's lack of resiliency in its public health infrastructure, especially compared to other questions of national security. Mr. Pellegrino expressed the belief that the world has been changed by the pandemic, and that the Commission should remain alert as those changes unfold in order to respond effectively.

Industrial Policy and Related Questions

Ms. Trimble asked the group whether the United States should consider using industrial policy as a tool to deal with Chinese and other foreign competition. Dr. Mithas mentioned the threat posed by Japanese competition in the 1980s, and how the National Institute of Standards and Technology developed the Baldrige criteria for quality control to encourage competitiveness. He said that American companies have largely stopped adhering to the Baldrige criteria, but that it remains an important driver of competitiveness in other countries, and suggested the Council consider recommending a return to those standards. He also mentioned that the Baldrige Foundation is looking to increase its public engagement, and suggested the Commission consider partnering with them. Ms. Wince-Smith discussed her role in helping develop and deploy the Baldrige criteria, and how a lack of adherence by the software industry is responsible for much of its vulnerability to cyberattacks and need to patch flaws in its programs. Mr. Pellegrino questioned whether the World Bank's metrics for determining which countries possessed the most competitive environment for doing business was obsolete in today's digital economy.

Next Steps

Ms. Trimble encouraged participants to continue their conversations on the online collaboration platform. She also laid out the tentative topics for calls over the next few weeks, noting that the Council would accommodate any sub-groups that form from the larger Working Group discussions. Ms. Wince-Smith emphasized the importance of feedback from the Working Group members, and suggested that experts in particular subject areas help catalyze deep dives on topics by sharing basic background information on the issues at hand in future calls. Ms. Trimble reminded participants that summaries and transcripts of the calls would be shared to the online collaboration platform.

Working Group 3 Calls April 2

ASU Recap and Stage Setting

The Honorable Deborah L. Wince-Smith welcomed the participants and praised the level of discussion at the January Launch Conference at Arizona State University. She encouraged members of the Working Group to volunteer to lead discussions on "deep dives" into issues in their areas of expertise. She noted that this Working Group has an especially complex task because of the wide-ranging nature of its subject areas, particularly regarding "enabling" structures and systems that accelerate innovation. Mr. Chad Evans provided a calendar update, noting that the June in-person Commissioners' meeting will instead take place virtually, but that the Commission's Year One Findings are still scheduled to be released at the National Competitiveness Forum in December. Ms. Kathy Trimble summarized the group's discussions from the January Launch Conference, in particular the themes of broadening the definition of "capital" to include human capital, infrastructure, facilities, and other resources, and of making existing capital more efficient in driving innovation. The group also discussed intellectual property, including the patent life cycle, patent holders' use of patents, and patent licensing. Finally, the group discussed China and whether the United States should coordinate between the public and private sectors to compete with them in emerging technologies.

Access to Capital

Ms. Wince-Smith noted that startup firms often have difficulty attracting the interest of venture capital when trying to scale up their products, especially

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for high-risk, long-term investments in advanced manufacturing, infrastructure, and emerging technologies. Mr. Evans mentioned the work the Advanced Research Projects Agency-Energy (ARPA-E) has done in this space, and Dr. Cheryl Martin of Harwich Partners, formerly of ARPA-E, agreed it would be a good topic for a deep dive discussion. She also spoke about the difficulties startup firms are having accessing capital in general due to the ongoing COVID-19 crisis, and that this has major implications for innovation. Ms. Wince-Smith discussed recent correspondence from colleagues indicating that Chinese investors are approaching many cash-strapped American startups impacted by the pandemic. Ms. Ji Mi Choi of Arizona State University echoed Dr. Martin, saying that many startups in Arizona were being forced to pivot or contract due to lack of cash. She noted that some startups have been shielded thus far because their losses have mostly come in the form of paper valuation rather than actual cash flow, but that the situation is evolving.

Regional Issues

Dr. Ken Poole of the Center for Regional Economic Competitiveness detailed the regional impacts of the COVID-19 crisis, and of the recovery legislation intended to mitigate it. He said that states are very concerned with helping businesses survive the downturn, and that the Small Business Administration's Disaster Loan program has been difficult to access for startups and venture-backed businesses. He stressed the importance of supporting these firms in future recovery initiatives. Dr. Poole also noted the infrastructure issues facing many regions of the country the pandemic has revealed. In Appalachia and other rural areas, K-12 schools lack the bandwidth and equipment to transition to remote learning, and he warned that the rapid reorganization of work in response to the pandemic could leave these areas behind as people are largely unable to work remotely. As the COVID-19 pandemic begins to more deeply impact rural areas, this issue will become an increasing problem. Finally, he discussed the supply chain crisis affecting different regions of the country. Citing breakdowns in the medical equipment supply chain due to international suppliers of components and looming issues of food security, he advocated for greater domestic supply chain presence, for reasons of resiliency rather than protectionism. He also highlighted the privacy and data security problems facing the Bureau of Labor Statistics and other government and industry organizations as they migrate secure data to remote work environments on the fly. Dr. Jerry Blazey of Northern Illinois University shared Dr. Poole's concerns about regional responses to the pandemic, and expressed hope that upcoming relief legislation would not concentrate investment or recovery in a few geographic areas, but instead be widely distributed.

Infrastructure and Enabling Factors

A major theme in the discussion was infrastructure as an enabling factor for innovation, especially cyber infrastructure in light of the massive disruptions caused by the COVID-19 pandemic. Dr. Robert Bishop of the University of South Florida highlighted several issues facing academia in the wake of the crisis. These include the need for a vast expansion in remote learning and ensuring sufficient infrastructure to support fully online classes, as well as a rethinking of how universities deliver coursework given that the crisis has shown the viability of online instruction. He also discussed the financial ramifications of tuition-paying Chinese students being unable to return to American universities for the next school year due to the pandemic.

Ms. Wince-Smith brought up cyber threats in light of recent revelations of vulnerabilities in the Zoom platform for online collaboration and telework. Mr. Bates tied the emerging issue of cybersecurity in with the Council's 2018 publication Secure, which focused on improving cyber resiliency, and urged for the United States to develop a national cybersecurity plan. He said the current crisis is illustrating the dangers of not having a coordinated response to cyber threats. Ms. Vickie Lonker of Verizon noted that her company was identifying which elements of governance served as enablers or barriers to innovation and nimble response as a result of the crisis, which has

forced them to rapidly move capacity around networks to deal with a surge in activity due to remote work. Ms. Wince-Smith encouraged her to share Verizon's recent study on "cyber hygiene" practices because of their connection with the Commission's emphasis on resilience and infrastructure. Mr. Evans also noted that the shift to remote work has led to a rapid reorganization of work tasks and skills, and that the implications of such a shift were relevant to both the current group and the Future of Sustainable Production and Consumption, and Work group.

In discussing the COVID-19 pandemic, Ms. Choi discussed the role of intellectual property in crisis resiliency. She noted that ventilator makers were open sourcing their IP to enable faster production of necessary medical equipment. She raised the question of whether intellectual property protection should take into account the national interest during times of crisis, and whether similar rules should apply to IP withholding as apply to profiteering and other crisis behaviors.

Competition with China and Openness

Mr. Olin Wethington of Wethington International, LLC advocated for greater coordination between the government and private sector in strategic industries to combat China's attempts to secure primacy in emerging industries. He cautioned against adopting a full-fledged industrial policy or imitating the Chinese government, but urged strategic plans for sectors including biotechnology, IT and Communications, semiconductors, computing, and energy and environmental technology. Dr. Ken Poole of the Center for Regional Economic Competitiveness suggested incorporating this coordination as part of a national economic recovery response following the pandemic. Mr. Evans discussed the relevance of the Council's work with Deloitte on emerging technologies around the globe, and the strategic advantages possessed by different countries in each area. He noted that the study identified ways to improve productivity and capability in each area, and recommended incorporating it into the group's discussions on strategy.

Mr. Wethington also addressed the issue of technology transfer. He emphasized his support for an open system of data sharing and technology transfer, but urged the United States continue to fund and support organizations like the Committee on Foreign Investment in the United States (CFIUS) to prevent theft of intellectual property in critical technology areas. Ms. Wince-Smith discussed her conversations with Dr. Michael McQuade of Carnegie Mellon University, about the need to engage with allies, including the Five Eyes intelligence sharing program between the United States, Canada, Britain, Australia, and New Zealand. She compared the situation to international cooperation with allies during the Cold War and also mentioned Japan as a collaborator for sharing information and data.

Next Steps

Ms. Choi asked how the group should begin thinking about the end product of its work, including which areas to focus on, how many subtopics in each broad area, and the balance of background information for context on the problem and forward-looking solutions. Mr. Evans said that the goal was to have specific, actionable recommendations in the style of the Council's National Innovation Initiative from 2005, which contained nearly 80 detailed, implementable recommendations stemming from working group discussions. Ms. Trimble discussed the schedule and topics for upcoming calls, and said that starting next week the group will begin to engage in deep dive conversations on specific issues.

Working Group 3 Calls April 7

Setting the Stage

Ms. Kathy Trimble welcomed the group and encouraged them to use the discussion to help focus the Working Group's attention on key areas. The Honorable Deborah L. Wince-Smith introduced the kickoff speaker, Mr. Tad Lipsky, on the topic of antitrust enforcement and its interaction with intellectual property and innovation.

Kick-off Presentation

Mr. Lipsky began with a historical overview of antitrust policy in the United States, from the Sherman Antitrust Act of 1890 to the present. From the passage of the Sherman Act in 1890, U.S. regulators and courts have had significant antitrust enforcement powers, including the ability to prosecute antitrust violations as criminal, rather than civil cases. A "private attorney general" provision also enables private citizens who believe they have been wronged by anti-competitive action to file a civil suit, with the potential to be awarded treble damages if they win their case. These provisions, particularly civil suits, have become even stronger over the years with the emergence of class action lawsuits and broader discovery rights after World War Two, resulting in exceptionally costly verdicts and settlements.

A new era in antitrust policy began during the 1940s, when courts began to find that various intellectual property protections, including patent licensing, violated antitrust provisions. During the period from roughly 1947-1972, antitrust regulators and the courts were very aggressive in challenging the actions of U.S. companies, especially pertaining to intellectual property protection. However, during the 1970s, the U.S. economy began to falter and become less competitive, and economists and scholars identified a lack of IP protection stemming

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from aggressive antitrust enforcement as a major culprit. During the 1980s, courts began moving away from aggressive antitrust enforcement, and a bipartisan consensus began to emerge around a relaxed antitrust regime that recognized the importance of intellectual property in spurring innovation, and that relied on rigorous economic analysis in determining if companies were engaged in antitrust violations.

In recent years, foreign antitrust agencies, particularly in the European Union, have replaced the United States as the primary initiators of antitrust action. This newfound aggression is driven in part by concerns about patents for "standards-essential technologies", such as those relevant to communications and internet technology standards, as well as the rise of non-practicing entities, and controversial pharmaceutical patenting practices. However, these actions are disproportionately directed at American tech firms, such as Microsoft, Apple, and Google, and while some members of Congress want the United States to adopt these aggressive policies, Mr. Lipsky warned that doing so would be dangerous, as many of these challenges are rooted in protectionism rather than genuine antitrust action.

Mr. Lipsky advocated challenging the new, aggressive antitrust policies emanating from abroad by reasserting the consensus approach in the United States of prioritizing competition and innovation. He also stressed the importance of rigorous, case- and evidence-based evaluation of antitrust claims, and of an adversarial system where firms are allowed to defend themselves before a neutral judge. He further suggested developing a new executive branch agency to challenge hostile antitrust rulings from abroad and encourage widespread adoption of American antitrust policies.

Finding a Balance in Antitrust Enforcement

Dr. Sunil Mithas of the University of South Florida agreed with Mr. Lipsky's endorsement of evidence-based antitrust policy and the American approach of encouraging innovation and competition, but questioned whether the United States should look to bodies such as the EU for a balance between protecting firms and other stakeholders, like consumers. He noted that consumers, unlike large firms, are not well organized and have few means of making their voices heard on matters like privacy protections. He added that he agreed with Mr. Lipsky about the need to defer to experts and evidence in making antitrust decisions.

Mr. Lipsky responded that he agreed there were relevant concerns regarding privacy protection, labor standards, and other issues, but that these issues should be referred to distinct regulatory bodies, and that antitrust enforcement should focus only on competition policy. He characterized some privacy concerns as within the purview of antitrust policy, since companies deciding amongst themselves how to deal with privacy protection is as much of an anti-competitive practice as fixing prices amongst themselves. However, he urged for privacy protections as a whole to be viewed as a consumer protection issue. Mr. Lipsky argued that the strength of American antitrust policy was its explicit focus on issues of competition, avoiding politicization and conflicting or split mandates in favor of neutral economic analysis. He criticized the EU practice of invoking competition policy as a means of consumer protection. Ms. Wince-Smith agreed with this conclusion, and noted that European countries often cloak protectionist policies in the mantle of antitrust enforcement. She pointed out that nearly all antitrust enforcement actions in the European Union are aimed at American firms.

Measuring Innovation

Dr. Branden Brough of Lawrence Berkeley National Laboratory noted that current antitrust policy is focused on promoting innovation, and asked how innovation is best measured and quantified. Mr. Chad Evans discussed the work the Council has done in the past 20-25 years to identify metrics and proxies for innovation, beginning with its creation of the first global innovation index in the late 1990s. This first attempt to quantify innovation used metrics including scientific publications, patents, trade in high-tech industries, and other proxies. He also mentioned academic work around the same time period, including by current Commission Co-Chair Dr. Michael Crow of Arizona State University, on the components of national innovation systems. Mr. Evans noted that the Council's work inspired similar efforts by other groups to measure innovation, including the World Economic Forum. Mr. Evans also mentioned the Global Federation of Competitiveness Councils' Competitiveness Decoder tool, an online interactive tool that measures competitiveness around the world across 8 dimensions, including innovation. The decoder covers 200 countries over a period of 35-40 years and has 150 different metrics, from investments to policy decisions. The decoder also used AI to crawl over 40,000 government documents around the world to identify policies relevant to innovation and competition.

Antitrust Policy and Innovation

Mr. Tim Planert from the Council on Competitiveness discussed the role antitrust policy plays in either supporting or obstructing innovation. The current guidelines used by the Federal Trade Commission and the Department of Justice for prosecuting horizontal mergers as anticompetitive includes five elements. These include determining the degree of market concentration after a merger, identifying anticompetitive consequences from this concentration, identifying factors such as entry of new firms that counter these anticompetitive effects, considering whether the merger allows the firms to innovate more effectively together than they could on their own, and whether either or both firms would have to exit the market in the absence of a merger. Mr. Planert said that the latter two considerations illustrate a way in which antitrust enforcement could reduce innovation: by preventing firms from pooling their resources and capabilities to become more competitive against other market participants, and potentially causing the number of firms in the market to shrink if one or both firms cannot afford to compete on their own. On the other hand, antitrust enforcement can boost innovation if it prevents a merger that concentrates the market without improving either firm's innovative capacity. He also mentioned academic literature and remarks from a U.S. Deputy Assistant Attorney General that echo the conclusions implied in the above guidelines: antitrust decisions are optimal when made on a case-by-case basis.

Strength of Antitrust Enforcement and Criteria for Action

Ms. Vickie Lonker of Verizon asked how powerful the federal government's antitrust enforcement mechanisms should be. Mr. Lipsky responded that the government already possesses powerful tools for antitrust enforcement, and that it overused them during the 1947-1972 period. It was scholarly consensus that this aggressive approach was hurting innovation and American competitiveness that ushered in a less aggressive regime rather than a weakening of authority. Mr. Lipsky said that while there is some push for a return to these policies, which are the norm in Europe, the American system of case-by-case evidence gathering and opportunities for firms to defend themselves is optimal. As an egregious example of overzealous antitrust enforcement, he cited the mid-20th Century Alcoa antitrust case in the United States, where the firm was punished for expanding to meet increased demand for its products. Mr. Lipsky said that EU regulators were not that

aggressive, but they still are too eager to sanction large, innovative firms, including measures like banning customer loyalty programs. He also criticized the EU practice of unilateral administrative action, rather than an adversarial trial before a neutral judge, and the slowness of EU antitrust appeals, citing the case of Intel still fighting an antitrust claim from 2001 in EU courts. He concluded by reiterating that the optimal U.S. policy is to maintain the status quo of clear economic analysis and procedural fairness. Ms. Lonker asked whether the problems in antitrust policy stemmed from statutes themselves, or from the supporting policies regulators used to enforce them, and Mr. Evans suggested this would be a good discussion topic for the group.

Maximizing the Advantages of American Antitrust Policy

Ms. Wince-Smith asked about the antitrust policies of other U.S. competitors, particularly China. Mr. Lipsky responded that China has a drastically different legal regime, but that they engage in the same protectionist behavior as Europe. He added that in China firms face the added problem of a legal system that does not regard the adversarial process or defendants' rights as important, and that China uses its antitrust policies to engage in particularly aggressive protectionism and mercantilism.

Ms. Trimble asked whether the current U.S. antitrust regime represents a competitive advantage or disadvantage. Mr. Lipsky said that the status quo in the United States is very supportive of innovation and competition, and he praised current Assistant Attorney General for Antitrust Makan Delrahim as the "gold standard" in applying antitrust to IP and standards-essential patents. He cited Mr. Delrahim's background in patent examination and understanding of the role of antitrust enforcement on intellectual property as sources of this strength. Mr. Lipsky advocated for the United States to continue its antitrust enforcement regime, and to focus on encouraging other countries to adopt American standards, because in addition to the EU and China, countries like South Korea, South Africa, and Taiwan engage in similar patterns, and countries like France, the UK, and Germany prosecute U.S. firms through domestic antitrust agencies. He identified finding a way to spur action in foreign countries on this matter as a key policy goal. Mr. Lipsky concluded by discussing cases where foreign antitrust actions were so egregious that the U.S. president had to become involved, including President Clinton's intervention to prevent the EU antitrust enforcement body from blocking an innovation-boosting merger between two American defense contractors. He warned that having to rely on these kinds of interventions is not an optimal policy.

Working Group 3 Calls April 9

Setting the Stage

Ms. Kathy Trimble and The Honorable Deborah L. Wince-Smith welcomed the group, and introduced the kickoff speaker, Mr. Tad Lipsky of the Global Antitrust Institute at George Mason University's Antonin Scalia Law School. The session was primarily devoted to discussing antitrust policy in the United States and internationally in conjunction with and response to Mr. Lipsky's remarks

Kickoff Remarks

Mr. Lipsky provided an overview of the past, present, and future of antitrust and competition policy in the United States, and its relation to intellectual property in particular, and innovation and competitiveness in general. He began with the origins of antitrust policy in 1890 with the passage of the Sherman Antitrust Act, which he characterized as giving the government powerful legal tools to pursue antitrust enforcement. These included the ability for the Attorney General to seek a broad array of civil and criminal remedies for anticompetitive behavior, and the prosecution of antitrust violations as criminal, rather than civil, matters. Over time, these enforcement tools have become even stronger, with some antitrust violations treated as felonies and punishable by hundreds of millions of dollars in fines and decades-long prison sentences. Numerous companies have been broken up entirely as a result of antitrust action, including Standard Oil in 1911, the United Shoe Machinery Corporation in 1968, and Bell in 1984. Mr. Lipsky noted that firms display a powerful behavioral response to antitrust laws.

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Ms. Carol Ann Meares

The second era Mr. Lipsky discussed was the period from 1947-1972, which he characterized as the height of aggressive antitrust policy, driven by the growing use of antitrust violations to prosecute various intellectual property practices, including patent acquisition, licensing, and pooling. During this period, numerous business practices related to IP that had previously been routine were presumed to be automatically illegal, and combined with other policies hostile to intellectual property to dampen innovation. Mr. Lipsky said that by the 1970s, the U.S. economy was losing competitiveness against those of Western Europe and Japan, including economic shocks that led to wage, price, and foreign direct investment controls and the abandonment of the gold standard under President Nixon. In response, a body of academic literature began advocating for a new antitrust policy that used economic analysis of the effects of behaviors to determine if they undermined competition, rather than relying on automatic presumption. This practice, as well as the practice of allowing accused firms to defend themselves before a neutral judge, became staples of the bipartisan consensus that has emerged on antitrust policy in the post-1980 period.

In the present day, Mr. Lipsky noted that the post-1980 consensus still predominates, but that a growing number of voices in both the policy world and the antitrust community would like to see a return to the days of aggressive antitrust enforcement. He characterized this as dangerous to innovation and economic dynamism, and noted that the current consensus relies on stringent evidence for identifying practices that are actually anticompetitive. He also noted that the United States has been supplanted as the world's leader in antitrust actions by foreign actors, especially the European Union. He criticized the EU approach, which is similar to the "aggressive" approach formerly used in the United States, and which does not allow accused firms to plead their case or for adjudication by a neutral third party. He noted that the vague standards and lack of transparency in the European process prevent companies from defending themselves, and that most antitrust actions in the EU were directed against major American technology companies like Apple, Alphabet, Intel, and Qualcomm. Mr. Lipsky warned that were the United States to adopt this antitrust regime, it would harm licensing, mergers, and acquisitions when such actions were beneficial for innovation, and would damage the relationship between companies and their suppliers and customers.

Finally, Mr. Lipsky focused on the future of antitrust regulation. He urged not only for the preservation of the American consensus domestically, but also for stronger pushback by the United States against hostile actions by foreign antitrust agencies. He argued that many of these actions are pretexts for protectionism or industrial policy, and encouraged the creation of an executive branch agency in the United States responsible for confronting foreign abuses of antitrust enforcement.

Discussion

Mr. Olin Wethington of Wethington International, LLC asked what efforts the United States has made to engage in dialogue over antitrust enforcement with other actors, especially the EU and China. He also asked what role the Council could play in spurring such dialogue, whether through seminars and public debates or through private meetings with the White House, the National Economic Council, or the U.S. Trade Representative. Mr. Lipsky noted that there have been attempts at dialogue previously, including during negotiations over the Trans-Pacific Partnership, but cautioned that trade policy is not the best way to address anticompetitive behavior. He warned against ad hoc responses, such as interventions by the President or other high-ranking officials (though he noted instances of successful interventions by Presidents Clinton and Obama in stopping antitrust enforcement by foreign powers), calling for a body that would institutionalize these actions. Mr. Lipsky also cautioned against confrontation, noting that the countries and organizations involved would become defensive. He instead advocated pursuing close ties

with countries with similar attitudes toward antitrust, including the UK, Canada, and Singapore, and developing a common antitrust framework amongst them that becomes an alternative to the aggressive, EU-style model. Over time, the benefits of this model would become apparent and inspire emulation from other countries. Mr. Lipsky noted the success of this approach in aviation, where the United States pursued agreements with allies such as Israel and the Netherlands, and eventually succeeded in implementing its "Open Skies" principles around the world.

Ms. Wince-Smith asked if Britain's leaving the EU opened opportunities for bilateral action on antitrust between the United States and UK, and also asked about partnerships with Canada and Australia. Mr. Lipsky replied that there has been significant movement on this front in the antitrust community, but that things were still in the brainstorming and ideation stages. Mr. Tom Dailey, formerly of Verizon, asked whether there was contention about the inclusion of non-economic damages as antitrust violations. Mr. Lipsky said this was an area of active debate, and noted that a common criticism of U.S. antitrust policy is that it is "too narrow" in its economic focus. He criticized this argument as failing to appreciate that the economic dimensions of antitrust analysis focus on competition rather than mere output or prices, and that sometimes mergers and acquisitions can enhance innovation by boosting the innovative capacity of the merged firms. He cited a court decision in Delaware announced yesterday that reached such a conclusion. Mr. Lipsky further added that user data and privacy protections are a major point of contention in antitrust law. He said that Germany is debating amending its antitrust statutes to remove the requirement of "injury" to allow the prosecution of antitrust cases on privacy grounds, following a court decision that blocked such measures. Mr. Lipsky agreed that privacy was an issue requiring regulation, but urged that it be handled by a separate body, with antitrust agencies focusing only on economic considerations.

Dr. Branko Terzic of Berkeley Research Group asked about the practice of large firms like Facebook acquiring up-and-coming firms with innovative ideas that might emerge as competitors. Mr. Lipsky agreed there was validity to concerns about such behaviors constituting anticompetitive action, but urged caution in pursuing such cases. He said that while large companies can and do engage in predatory behavior to stop competitors from entering, many of those competitors' products and platforms become valuable because they are bought by firms with large market share. He added that many innovators count on being able to sell their startups to larger firms to make money off their innovations, and that a blanket prohibition on such acquisitions would harm the incentive for firms to innovate.

Dr. Rao Unnava of the University of California, Davis asked if the World Trade Organization could play a role in regulating global antitrust policy. Mr. Lipsky said that the WTO tried to do as much in the 1990s, but that the effort broke down because of a lack of trust and agreement among the member countries involved. He noted the WTO struggles even to prosecute price-fixing and cartel-like behavior. Instead, he suggested the creation of an international body that specializes in antitrust policy, similar to existing international organizations for white collar crime, narcotics trafficking, and securities fraud. Mr. Bill Bates asked if such an organization should be U.S.-led or predominantly international, and Dr. Unnava argued that it would need to be driven by the international community to secure buy-in.

Council Associate Carol Ann Meares asked whether platforms that make their services free to users, such as Facebook, could be prosecuted for antitrust violations. Mr. Lipsky responded that the U.S. legal system focuses on the competitive consequences of firm behavior, and that digital platforms that colluded on things like terms and conditions or privacy protections would be punished for antitrust violations even if their product was free to users, because of the negative effect on competition between platforms such actions would have. He noted that even predatory pricing cases are difficult to prosecute because the prosecutor must show that absent state intervention, the firm would have raised its prices after securing market dominance.

Mr. Dailey asked what role the EU's digital tax regime had on its antitrust actions against American tech companies like Apple. Mr. Lipsky agreed it was part of the EU's calculations, but that the EU constitution grants member states sovereignty over tax policy. As a result, it remains to be seen what the outcome of the EU's attempt to fine Apple $14 billion for repatriating profits to Ireland will be.

Conclusion and Next Steps

Mr. Chad Evans posed a question for the group to consider during subsequent online discussion and for future calls. He asked what the detailed plans for a U.S. agency to fight antitrust abuses from other countries would look like, including budget authority, structure, and which governmental bodies it would report to. Ms. Trimble reminded the group that materials will be posted online following the call, and that next week's calls will focus on the availability of capital from startup to scale-up.

Working Group 3 Calls April 14

Introduction and Kickoff Speaker

Mr. Chad Evans welcomed the group and provided some framing thoughts for the conversation. He noted that the working group on the Future of Sustainable Production and Consumption, and Work had discussed the lack of relief for venture-backed firms in the CARES Act, and flagged it as a relevant topic for the group. He also discussed the $1.5 trillion in reserves that venture capital sitting on, and asked how it could be productively deployed to support innovative firms during the COVID-19 crisis. Finally, he asked to what degree the government should be involved in financing and supporting innovative firms. Ms. Kathy Trimble introduced the kickoff speaker, Dr. Cheryl Martin of Harwich Partners, and former director of the Advanced Research Projects Agency-Energy (ARPA-E). Dr. Martin discussed the question of capital availability from start-up to scale-up, and delineated three components: Sources of funding, road maps for innovation, and non-financial resources.

Capital Funding: Venture and Other Sources

Dr. Martin said that venture capital has a place in funding innovation, but that it can also chase valuations over long-term innovation, and that depending on its view of the risk-reward balance, over- or under-fund particular projects. She contrasted traditional venture capital with "Venture studios" like Macquarie Capital, which sponsors demonstration projects and is willing to provide millions of dollars of funding for pilot programs in fields such as 5G, when traditional VC would be trying to reduce the size of its investment to minimize its risk. Dr. Martin

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argued that "skinnying down" VC investment in an enterprise to maximize the risk-reward ratio renders such funding useless, and praised the Manufacturing USA initiative for its ability to de-risk investments and attract substantive funding for venture capital through mechanisms like shared resources and infrastructure. However, she said some institutes were better run than others, for a variety of reasons. She also discussed her role in managing the loan program at the Department of Energy, and stressed the risks of the politicization of failure. Dr. Martin identified several shortcomings in the program, including its forbidding ARPA-E to fund pilot projects that could be converted into grants and written off if they failed. She also discussed valuable components of ARPA-E's programs, including the funding of a site to validate prototypes for new batteries developed by firms as part of a renewable energy initiative. Firms whose batteries worked could secure additional funding. She cited this as an example of the importance of inflection points and screening mechanisms for ventures to reduce risk. Finally, Dr. Martin suggested several improvements to the Small Business Innovation Research (SBIR) program, including roadmapping to help firms figure out an appropriate focus, qualified program managers with specific expertise in helping small business working full-time for the program, and co-horting of eligible businesses with other small firms seeking funding to enable knowledge spillovers and provide more incentive for VC to investigate programs. She also suggested waiving the requirements for matching funds during the early stages of ventures, as when ARPA-E adopted this waiver, fewer firms signed risky or unrealistic agreements with VC funders in order to secure investments. She noted that this policy was not popular initially, but did a good job reducing perverse incentives.

Road Maps for Innovation

Dr. Martin stressed the importance of "Road Maps" to help funders and firms understand the implications and uses of innovations, as well as the process for scaling them and bringing them to market. She characterized insufficient road mapping as a leading cause of loss of innovations to foreign competitors like China. Dr. Martin praised the Manufacturing USA institutes for facilitating some of this planning, but also urged them to improve in certain areas, especially the sharing of sub-maps across the different institutes and parties involved for greater coordination and collaboration. Such sharing would help the United States gain a greater understanding of its place in the global landscape and its position relative to competitors. She also encouraged the use of road maps to help identify how and when the federal government or venture capital should plug in to state and regional ecosystems.

Non-Financial Capital

Dr. Martin emphasized the importance of resources besides finance for fueling startups. She identified several ideas for improving the innovation ecosystem, including allowing SBIR participants to use funds for tech-to-market activities, and for dedicated senior technology advisers with experience developing and scaling innovations, rather than relying on volunteers for guidance. She warned that involvement by volunteers with insufficient knowledge of particular projects could do more harm than good for firms, and that programs like SBIR needed people who could "see the forest for the trees." Dr. Martin also urged the revival of a pilot program that ended in 2018 allowing startups to use "vouchers" to gain access to national lab facilities. She said that access to facilities is crucial for startups, and that these kinds of support help innovation "go further, faster."

Capital Facilitation at the Federal Level

Participants echoed Dr. Martin's views on federal support of innovation. Dr. Jerry Blazey of Northern Illinois University reflected on his experiences as a program manager for SBIR, noting he was struck by the lack of direction and overarching guidance, which led to mission-driven agencies co-opting the program to further their missions rather than the

intended goal of the SBIR program. He also agreed on the need for dedicated experts with backgrounds in the commercialization of technology, and for investment in the knowledge base of program managers. Dr. Martin elaborated on the benefits ARPA-E found in "co-horting" their SBIR recipients with their other venture projects, including knowledge spillover through interactions at joint demonstration fairs, and the generation of a critical mass of promising projects to fund, mitigating the risks of any individual project failing. Dr. Blazey suggested developing guidelines directing agencies how to structure their SBIR programs to make them uniform and focused on the goals of SBIR as a whole, rather than individual agency missions. Mr. Bill Bates asked if there were ways to encourage larger initial investments from venture capital, and if there were any issues participants noticed with the lab voucher program. Dr. Martin suggested helping firms understand the needs and goals of funders, and pointed to philanthropy as a driver of larger investments. She suggested that combined investments from different philanthropic sources could exceed the dollar value of any single VC firm's investments.

Geographic Considerations

Dr. Mike Cassidy of Emory University noted that in venture funding, the real action was often at the state level, and stressed the importance of getting capital funding, especially early stage capital, to flow outside of traditional hotspots like Boston and Silicon Valley. Dr. Branko Terzic of Berkeley Research Group suggested an exchange that would match innovators and entrepreneurs outside of traditional hotbeds with venture capitalists, particularly in places with significant university research. He said these locations often have lots of people with innovative ideas, but that they don't know the VC world, and the VC world does not know them. He listed biofuels and nanotechnology as areas where universities were doing groundbreaking research that could be of interest to venture capital. Ms. Ji Mi Choi of Arizona State University agreed with this idea, and drew on her experience helping ASU secure I-Corps investment to suggest a clearinghouse or database containing information on I-Corps and other grant recipients. Venture capital firms could use the database as a tool to find investment opportunities that have been "validated" by grant awards. She added that the I-Corps program expects universities to supply the administrative legwork to promote their innovations. Dr. Terzic suggested such infrastructure could ensure that investment in these ideas benefited the local economy by providing infrastructure to keep the project there, rather than "dragging" it to the location of the VC funder. Ms. Vickie Lonker of Verizon expressed concern about zeroing in too much on the geographic dimensions of funding, but expressed support for such a platform, using the example of Kickstarter as a model for connecting ideas with funding. Ms. Kathy Trimble agreed on the need for a broad focus, while also adding that it was important for all regions of the country to maximize their innovative potential.

Clearinghouses and Facilitating Structures

Ms. Choi further developed the concept of a database as a "one-stop shop" not only for venture capital firms looking for investments, but for entrepreneurs and researchers looking for funding sources for scaling their innovations. Such a platform would include information on different funding sources for innovators, as well as the terms, conditions, and eligibility requirements for each source. She noted that different projects require different levels of funding, and that "the right funding at the right time" can be the difference between success and failure for a venture. Ms. Trimble noted that such databases did not appear to exist, and that existing information on projects and funders was often piecemeal. She described the Department of Defense's online listing of projects, which does not give details beyond the title and funding levels of the project. She cited parties fearing the release of proprietary information as the cause of this secrecy. Dr. Martin described a similar lack of coordination and cooperation that doomed and attempt by signatories of the Paris Agreement to develop new batteries for renewable energy. Countries were not forthcoming with the information needed to keep the project together and enable collaboration due to concerns about protecting their ideas. Regarding a database, she suggested that creating something to "plug into", rather than something to "wire together" disparate existing components, was optimal.

States as Moderators and Facilitators

Dr. Lee Cheatham of the Pacific Northwest National Laboratory discussed the role states play as mediators between large, established firms and entrepreneurs. He noted that the state government of Washington has helped startups connect with giants like Boeing and Microsoft in the Seattle region, and spoke of capital access as a process or chain. Ideas are born and then transferred to various parties, and require funding at every step, especially during the period from prototyping to commercialization. He said that his lab often has the funds necessary to help firms scale the Valley of Death, but that a lack of knowledge of potential end users and use cases makes the investment not worthwhile. He concluded that capital was not only about money, but also about communication and the facilitation of relationships between entrepreneurs and potential clients.

Universities as Facilitators

There was substantial discussion of the role universities play as incubators of innovation and entrepreneurship. Ms. Anne Tucker of Georgia State University said that while academia is excellent at developing new ideas and conducting research on new technologies and processes, businesses are often better at identifying new or more efficient uses of existing resources and technologies. She also endorsed a common platform to connect innovators to funding sources, and said she had similar

experiences to Ms. Choi in relying on university back offices to promote innovations and facilitate tech transfer. Ms. Tucker added that because academic researchers face different incentives from entrepreneurs outside the university, the technology transition process is not intuitive for them, and there is insufficient institutional support for tech transfer. Ms. Trimble asked the group how universities could better support their innovators, and Ms. Tucker suggested having dedicated tech transfer experts, either working at a central institution connected with multiple universities or embedded within a university's administration, that could help innovators navigate the process. Dr. Choi saw parallels with this role in her work at Arizona State, and noted a belief among entrepreneurs that university-based startups are not "real" startups. She stressed the importance of increasing visibility and bridging the ecosystems between universities and the wider community to help both kinds of innovators learn from each other and benefit from access to each other's networks and resources. As an example, she described how ASU learned of the importance of dedicated mentors to work with startups, rather than sporadic volunteers who did not build long term relationships with firms, from this cross-pollination.

Dr. Cassidy stated that many university administrators do not believe it is their role to facilitate technology transfer, but only to license it to entrepreneurs from off-campus. However, he said that notion is changing due to changes in how venture capital operates and new thinking from innovative university leaders. He said it was especially important for universities to lead in tech transfer and startups outside of traditional venture capital hubs like Boston and Silicon Valley. Dr. Blazey added that many universities recognize the importance of tech transfer, but lack the resources to emulate larger universities like MIT or Arizona State in doing so. Dr. Cassidy agreed and added that state governments are now facing increasing pressure on their budgets from healthcare, infrastructure, and education costs, and that the federal government may increase again in importance as a facilitator of innovation. Mr. Bates noted the overlap between these issues and the problems discussed by the Council's University Leadership Forum, and that the forum had determined that joint action by university administrations in determining and adopting best practices in promotion and tenure to encourage innovation was key to its success. He also discussed the blending of STEM and the liberal arts to spur innovation, and the importance of having equality between the disciplines. Dr. Terzic noted that this re-imagining of the role of universities was bringing them full circle to the intent of the first land-grant universities in the 19th Century, which was to develop and incubate technology for use by agriculture and industry. Dr. Martin mentioned MIT's global Regional Entrepreneur Acceleration Program, which forces applicants to demonstrate collaboration across academia, industry, government, and funding sources, and said that current economic pressures increased the importance of incentivizing focus in entrepreneurs.

Working Group 3 Calls April 16

Introduction and Stage Setting

The Honorable Deborah L. Wince-Smith and Ms. Kathy Trimble welcomed the group and introduced the kickoff speaker, Dr. Anthony Margida of TechGrit. Ms. Wince-Smith expressed interest in discussing the use of hedge funds and private equity as a source of capital for entrepreneurship as part of the discussion, and Ms. Trimble added that the priming material in the read-ahead was not meant to constrain the scope of the discussion.

Kickoff Remarks

Dr. Anthony Margida of TechGrit discussed his experiences in both developing innovations as a scientist and in bringing innovations to market through his work at TechGrit and other initiatives in creating innovation ecosystems for the benefit of cities, communities, and corporations. He discussed in particular his experiences in Ohio, outside of the traditional hotbeds of venture capital and the geographic disparities in the allocation of investment. He noted two consequences of this disparity: some startups relocate to where venture capital firms are based and the local economy loses out on their value creation, or they never get off the ground due to insufficient investment. He argued that corporate accelerator programs have tremendous potential to reduce the risk of startup investment, but that they suffer from misconceptions and beliefs that they actually increase risk rather than mitigate it. Dr. Margida also discussed the industry disparity in venture capital, with tech companies receiving the majority of funding because the initial investment requirements are smaller, and the payoff faster, than in fields like

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clean energy, biotechnology, and advanced materials. He also noted that the Small Business Innovation Research (SBIR) program suffered from low success rates in commercializing technology, and that venture capital firms don't view receipt of an SBIR grant as an indicator of viability. He suggested that more could be done with the money invested in the program.

Dr. Margida elaborated on two successful initiatives in Ohio for building innovation ecosystems.

The first, the Ohio Third Frontier program made entrepreneurs-in-residence with extensive experience successfully scaling technologies available to mentor innovators, along with substantial funding for investment. The second, Innovation Fund Northeast Ohio, started at a community college and grants funding to startups at a stage where their capital requirements are too large to rely on family and friends, but not large enough or far along enough to attract the interest of venture capital or angel investors.

Dr. Margida concluded his kickoff remarks with an idea for a technology commercialization virtual marketplace, designed to help startups and small businesses in industries that are national priorities for technological progress. If startups could identify a market and a compelling technical solution to a problem in that market, they would receive both cash investment and access to and alignment with research facilities at a university or national lab. Established corporations would also partner with these startups after going through their own vetting process to ensure their commitment to putting together a package of assets for the startup. These include cash, access to an existing customer base, testing and manufacturing capabilities, and knowledge of commercialization and marketing.

The Small Business Innovation Research (SBIR) Initiative

Dr. Cheryl Martin of Harwich Partners said it was noteworthy that SBIR had a poor reputation among investors given its potential, and that changing these perceptions was a matter of will rather than funding or knowledge. She expressed interest in Dr. Margida's proposal, and asked him if there would be inflection points where investors could require signs of progress or benchmarks for continued support, and what companies would need to prove to secure this support. As an example, she discussed the Cyclotron Road program run by Lawrence Berkeley National Laboratory, which provides "exit points" along with easy origination documents to start the investment. She said that checkpoints and "swim lanes" were important to ensure accountability and focus participants on results, especially results aligned with national priorities.

Ms. Wince-Smith discussed her experience with SBIR during the period of competition with Japan in the late 1980s, and how many firms that received SBIR grants ended up being acquired by foreign companies because venture capital support for them dried up at "Phase 3." She stated the need for an organization to step in and assist these firms when their Phase 1 and Phase 2 funding dried up. Ms. Wince-Smith said it was important not to discard the entire SBIR program due to fixable flaws, especially when other countries have successfully emulated the SBIR model. Dr. Martin argued there needed to be more alignment around what Phase 3 for innovations should consist of, and that once a national consensus was reached it would be possible to direct funding at the state or regional level. Dr. Margida said there would need to be market validation for the value of an innovation at the Phase 1 and Phase 2 levels before any sort of Phase 3 funding was granted. He described how large firms have the ability to abuse their leverage in acquiring innovations from startups that desperately need cash and don't have alternatives in the form of an identified customer base.

Impact of Current Events on Financial Support for Investment Vehicles

Mr. Chad Evans said that private equity firms would likely receive assistance as part of the CARES Act or subsequent economic stimulus packages, as they do not fall under the "venture-backed" designation that was excluded from the first round of assistance. He added that private equity firms have access to the $600 Billion Main Street Business Lending Program, and that Apollo Global Management has pushed for a $100 Billion term asset-backed securities loan facility to purchase investment grade securities, especially in mortgage-backed or commercial real estate, to stabilize those markets. Mr. Evans also wondered about the potential for moral hazard in investment into private equity and other investment vehicles that were sitting on over $1.5 trillion in "dry powder" unused capital. Dr. Julie Meier Wright of Collaborative Economics wondered what the return on investment was for such practices, but also discussed her work helping California's public pension system fund investments in startups. She cautioned that most pension systems will remain underwater until the economy recovers, but that a small percentage of a very large fund can provide substantial capital to startups without endangering the pension fund investing in it. Dr. Wright also discussed the practice of "skunk works" at large corporations, which are dedicated funds for investing in innovations developed by startups. These aim to circumvent the dampening effects of bureaucracy and risk aversion on innovation at large firms. She wondered what empirical support there was for the efficacy of these ventures, and Mr. Evans linked to several studies and op-eds that demonstrated conflicting views on the practice.

The Role of States

Dr. Ken Poole of the Center for Regional Economic Competitiveness discussed the experiences of states in supporting venture capital through the State Small Business Credit Initiative that was established in response to the 2008 recession and sunset in 2017. He noted that currently, states are facing resource constraints and primarily support startups through "Phase 0" funding, but that the program showed states bring the most value in providing a supporting ecosystem for innovation. This includes public-private equity intermediaries to build innovative capacity outside of traditional startup hotbeds, and in building management and financing expertise among entrepreneurs in these regions. The primary use of public funding is to attract the attention of private capital by showcasing the opportunities for investment in "flyover country." He also noted that intermediary bodies can draw on public funding for investment while leaving the actual investment decisions in the hands of experienced venture capital investors, who have the capacity to make sound investment decisions and lack incentives to "pick winners and losers." Dr. Wright noted that the ongoing COVID-19 crisis means states will not be likely to spend money on new programs, and will likely cut existing ones. However, Dr. Poole suggested that future rounds of economic stimulus could include provisions for startup investment that leveraged state equity capital, even with budget cuts. He added that it is rare for states equity programs to rely on annual appropriations; they are generally given initial funding for quasi-public or public-private entities and expected to generate returns to finance continued activity. Dr. Wright emphasized that most capital is in the private sector, and that with states facing constraints due to the crisis and constitutional requirements for balanced budgets, they could leverage their resources to encourage private capital to invest in startups.

Intermediary Organizations and Connecting Ideas with Business Expertise

There was significant discussion about the construction of intermediary organizations and platforms that would connect innovators and ideas with the business expertise needed to turn those innovations into successful products and services. Ms. Christina Orsi of the University at Buffalo identified lack of business expertise as a primary driver of venture capital reluctance to fund university-based startups, and she urged the formation of intermediary bodies that would provide business expertise and mentorship to entrepreneurs while allowing universities to showcase investment opportunities for venture capital. She discussed three such initiatives. The first, the Harrington Discovery Institute, provides funding for the development of therapeutic breakthroughs by physicians and scientists, and helps them secure investment from pharmaceutical firms and venture capital to bring their innovations to scale. While Harrington operates on a national level, the Tri-Institutional Therapeutics Discovery Institute (TDI) provides the same funding and platform for innovators in the New York City area. Both of these investments are funded by philanthropy, but the recently formed Empire Discovery Institute (EDI) is a joint project of the University at Buffalo, the University of Rochester, and the Roswell Park Comprehensive Cancer Center, and received seed funding from the state of New York. In addition to providing seed funding and business expertise, the non-profit EDI is spinning off a for-profit arm that will attract venture capital to co-invest in promising discoveries that could turn into pharmaceutical treatments.

Dr. Rao Unnava of the University of California, Davis, discussed his experiences working with Ohio Third Frontier, and credited it with the emergence of Columbus as a rising center of entrepreneurship and top-ranked city for ease of doing business. He also discussed his experience with the university-startup nexus at UC Davis. He noted that senior faculty with intellectual property they don't know how to leverage, postdocs facing uncertain academic futures, and MBA students who want to start their own companies but are in the early stages of ideation all benefit from mentoring and expertise. He described how donors funded an institute at UC Davis's graduate School of Management that educates students on the process of innovation and helps them ensure they take the necessary steps to make their ideas viable. He further explained that because donors advised the school that it did not have the resources or expertise to try and spin off startups itself, it should let private venture capital take the lead in helping student innovators bring their products to market. As a result, UC Davis started Venture Catalyst, which helps introduce student entrepreneurs to bankers, lawyers, venture capitalists, angel investors, and other figures with the expertise and financial resources to help them scale their ideas. This program is run out of the school's Office of Research. He concluded by praising similar programs at the University of California, Berkeley, and warned that concerns about nepotism and favoritism should not discourage states and universities from experimenting with ways to steer funding to promising startups.

Dr. Robert Kazanjian of Emory University described Emory's recent partnership with Atlanta-based companies and Emory Healthcare to create a problem-driven innovation center to solve pressing issues in healthcare. He said the initiative was in response to questions about where funding for innovation ecosystems should come from, and that the center creates a nexus where large companies in the healthcare space could make their needs known, and leverage university research and testing facilities to prototype solutions and attract investment. The center would also bring in startups and connect them to healthcare clients interested in investing in their innovations. Dr. Wright discussed the success of the Connect program at the University of California, San Diego, which helps connect university-based startups to the expertise and funding they need. She credited the success of the program to its strong institutional support and the experienced entrepreneur running it.

The Role of Empirical Evidence in Validating Solutions

Dr. Sunil Mithas of the University of South Florida stressed that both governments and private investors will be skeptical of ideas, including platforms and innovation intermediaries, that are not backed by empirical evidence. He noted that much of the support for programs discussed on the call seemed to be anecdotal. Dr. Ann Gabriel of Elsevier described how her company had partnered with the University-Industry Development Partnership (UIDP) in New Jersey to collect data and provide evidence-backed recommendations for investment and collaboration opportunities. She predicted such services would be especially useful to states facing budget constraints as a result of the recession as they became more deliberate about their funding of initiatives. Dr. Margida concurred with the perception of universities as idea generators, and added that the ultimate proof of concept for startups was the successful cultivation of an engaged customer base that is willing to expend efforts to see the startup succeed. He said such validation from potential end users is the ultimate evidence that a startup or idea is viable, and as such is the primary driver of investors' decisions to fund things. He emphasized that the SBIR program was held back by the inability to provide this validation, and suggested that his platform could give startups such an opportunity through partnering them with "qualified corporations."

Other Sources of Innovation Funding

Dr. Unnava asked whether pension funds, especially large public pension funds, could be a source of capital for startups. He noted that private equity firms receive investments from state pension funds, and that this approach allows states to leverage the greater expertise of private equity investors and the relative lack of bureaucracy there to generate higher returns than the pension fund managers could on their own. He wondered if this model could extend both to venture capital firms and to funding coming directly from states, with the public investor providing funding and earning a return but not making the investment decisions themselves. He acknowledged a risk of moral hazard, but also noted that private equity investors had a strong incentive to pay attention and exercise oversight of pension funds because of their size.

Tax Policy

Dr. Poole asked what role tax policy, especially the Research and Development (R&D) Tax Credit, could play in incentivizing investment in startups. Ms. Wince-Smith also expressed interest in tax provisions, noting that many companies are not in position to make use of the R&D credit, and suggested adjustments to carried interest policies among other vehicles for encouraging investment behavior. She also noted the value countries like Australia, Brazil, and Singapore have derived from sovereign wealth funds. Dr. Wright discussed her work in California developing a tax preference at the state level for investment in "patient capital" at small firms to encourage greater investment in innovative startups. She said that while the credit had sunset, it incentivized greater investment in small firms and long-term projects, and said it was a good idea in principle to have preferential tax treatments for long-term capital investment that could yield disruptive innovation.

Conclusion and Next Steps

Ms. Wince-Smith encouraged the group to translate the discussion and ideas from the day's session into concrete and actionable recommendations, warning them not to lose an opportunity to develop novel solutions by failing to build on discussions. She expressed interest in further exploring the question of idle capital in the hands of hedge funds, pension funds, and private equity, and how it could be used to spur investment in innovation. Ms. Trimble announced that the topics for next week's discussions would be intellectual property, patents, and technology transfer.

Working Group 3 Calls April 21

Introduction

The Honorable Deborah L. Wince-Smith welcomed the group, and Ms. Kathy Trimble introduced the two opening speakers, Dr. Lee Cheatham of Pacific Northwest National Laboratory, and Dr. Lloyd Jacobs, President Emeritus of the University of Toledo.

Framing Questions for the Future of IP and Tech Transfer

Dr. Cheatham identified three considerations for the group in developing recommendations for better IP and tech transfer policy, drawing on his experiences in academia, industry, and the national laboratories. First, there has been a significant shift toward digital technology, and even hardware has built-in software components. He identified a mismatch between current intellectual property law and this reality, as hardware is still governed by patents, but software is governed by copyright. This discrepancy creates challenges for commercializing digital research, especially when software is developed in conjunction with government research or funding and requires government approval to obtain even copyright protections. Second, there are many stakeholders involved in the intellectual property and commercialization process, including universities, labs, industry, the government, and regulators. To expand the quality and quantity of ideas and technologies that emerge out of the innovation ecosystem, coordinated action by these groups will be essential and no single player can advance major changes. Dr. Cheatham encouraged the group to contemplate new kinds of organizations that act as intermediaries between different stakeholders and focus on transitioning ideas

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and technology from one stakeholder to another as they mature. Finally, Dr. Cheatham discussed how the nature of commerce is changing, and warned against matching technology to an outdated model of commerce. Discussing the supply chain disruption caused by the COVID-19 pandemic, as well as the emergence of new competitive threats, he called for new norms and requirements for sharing intellectual property and basic research. He also identified institutional barriers that obstruct prompt action in response to crises, like a lack of indemnification for private sector organizations with innovative responses to the pandemic that prevents them from advancing their ideas. He suggested that the group visualize the future of business and use this vision as a guide for developing new regulations and standards.

Universities and Commercialization

Dr. Jacobs emphasized the centrality of university culture and incentives to the question of technology transfer and intellectual property. He stated that universities by and large do not have commercialization or tech transfer "in their DNA" and find it incompatible with their cultural identity. However, financial stresses on universities, as well as changes in the education landscape due to the rise of online learning and the digitization of the knowledge base, will force many institutions to consider greater engagement with industry. Dr. Jacobs noted that a gulf persists between academia and corporate America, which he said has also shied away from investment in the academic world. He cited medical schools, which embed multi-billion dollar institutions within a university, as a model for university-industry interface, and discussed the challenges in encouraging a mindset shift within academia. Universities tend to be risk averse, and faculty enter academia for "the contemplative life" rather than the commercial world. Nevertheless, Dr. Jacobs called for universities to embrace globalization and digitization, while acknowledging that these transitions will be particularly difficult for older generations.

Changing Institutional Incentives

Ms. Carol Ann Meares of TechVision 21 stressed the difficulties in changing organizational cultures due to the rules, procedures, personnel practices, and incentive structures that develop in response to existing norms. These structures are linked to each other, and many institutions simply fold when confronted with significant disruption because they are unable to adapt. She asked if the country needed to fund new kinds of research and development bodies in which to instantiate these changed norms. Dr. Jerry Blazey of Northern Illinois University suggested providing funds to universities to help them change their cultures. He said cultures at academic institutions do not change by fiat because of deeply ingrained incentive structures, and suggested adopting a model successfully used by institutions to increase their student and faculty diversity for enhancing universities' capacity to transfer technology and commercialize knowledge. This method involves funding a self-study by the university that allows it to identify the specific changes it needs to make, and providing additional funding to enable it to enact those reforms. Dr. Blazey and Ms. Wince-Smith both noted that universities currently face incentives to create new knowledge, but not to commercialize it, and Dr. Jacobs stated that successful technology transfer does not naturally "trickle down" to laboratories and academic departments and change the culture.

Mr. Bill Bates discussed the Council's work with the University Leadership Forum, comprised of more than 40 presidents and chancellors of universities. He described university leaders' receptiveness to changing academics' incentives via adjusting the tenure and promotion process to encourage greater transfer of innovation rather than simply publishing research. However, he also reported a consensus that many universities would have to implement these changes at the same time to alter norms, rather than adopt a piecemeal approach.

Adjusting Patent Laws

Ms. Vickie Lonker of Verizon identified several ways to improve existing patent laws. She described industry's view of universities as being motivated to develop patent war chests and fight commercialization of their discoveries and called for the leveraging of university capabilities to help develop business. She advocated new legislation that would not grant windfalls in the form of royalties or damages to patent holders who did not advance their research into products or allow others to do so, and for Congress to reassess patent damage policy and other incentives for patent holders to "get rich quick" via lawsuits rather than through socially beneficial commercialization. Finally, she called for more flexible patent laws, noting that different industries had different time horizons from innovation to product launch. Adjusting patent length and terms by industry would encourage maximal innovation and successful commercialization over the current system that makes no distinction between products as diverse as pharmaceuticals and software.

Co-Development and Facilitating Collaboration

Dr. Cheatham touted co-development of technologies by universities, government, and industry as a promising method of accelerating knowledge commercialization. Getting input from industry helps researchers develop innovations with commercial applicability and appeal, and collaboration on goals provides a road map for the innovation process and the deployment of resources. He also reiterated the importance of updating the IP system to account for the digital world, and better match IP laws to market and community needs. Ms. Trimble discussed the call from the Developing and Deploying at Scale Disruptive Technologies Working Group at the January Launch Conference at Arizona State for "boilerplate" technology transfer agreements. She asked if the group should further pursue this idea, which would expedite IP negotiations and facilitate more collaboration between universities and industry, accelerating the commercialization of knowledge.

Strengths of the Current IP System

Mr. Tad Lipsky of Lathan and Watkins, LLP characterized the IP challenges facing innovators as "second order" compared to the hostility antitrust regulators displayed toward intellectual property in the 1970s. He particularly praised the reforms from the 1970s through the 1990s that expanded IP protection and facilitated commercialization, including the Bayh-Dole Act, the creation of circuit courts for patents, and the criminalization of trademark theft. He also stressed the importance of regulators recognizing the mutualistic symbiosis between IP and antitrust law, and praised current Department of Justice practices in adjudicating antitrust cases. Mr. Lipsky did identify current challenges in the IP world, including the need to discourage presumption of antitrust violations when members of standards-setting bodies for technologies have interests

in licensing a technology, urging the use of contracts between innovators and standards-setting bodies to resolve disputes. He also discussed problems with antitrust settlements under the Hatch-Waxman Act, which make pharmaceutical antitrust litigation much more difficult to resolve. Dr. Cheatham agreed that the U.S. IP system was overall in good shape, but called attention to issues surrounding the IP space. He described the importance of long-term energy storage for future energy innovation, and how it would be beneficial from economic and national security standpoints to secure U.S. leadership in this area. However, most of the expertise and research on energy storage comes from abroad, which presents challenges to the development and protection of American intellectual property in this sector.

Future Cross-Pollination Opportunities and Closing Charge

Ms. Trimble discussed the potential for cross-cutting discussions on these topics involving members of Working Group 1 and Working Group 3, with a view to fleshing out ideas and turning them into recommendations. Mr. Evans discussed the Council's previous work in conjunction with IBM on intellectual property and technology transfer, and said he would make it available on the online portal. Ms. Wince-Smith issued a dual challenge to the group: to make modifications to the IP system that don't eliminate its strengths while also seeking bold transformation of the innovation landscape, in light of the Commissioners' charge to the working groups. She called for recommendations for industry as well as academia and government, and urged them to consider the implications of the rapid reorientation of universities toward the digital world in the wake of the COVID-19 pandemic. Ms. Wince-Smith further emphasized the need to rein in firms that use intellectual property claims to dominate markets and keep out new entrants, and of secure IP rights to entice venture capital investment in innovations. She warned that the current rate, scale, and scope of innovation are insufficient to withstand challenges from U.S. competitors, especially China.

Mr. Evans asked the group to consider some additional key data related to the day's conversation. In particular, he encouraged participants to revisit some of the National Commission's early concept papers, the 2018 "Clarion Call" and primers—with a mind toward thinking how recommendations from this group might help meet some of the overarching challenges posed by the National Commissioners, like: how can the United States increase its innovation capacity ten-fold? Mr. Evans noted—reflecting on the day's WG conversation around tech transfer, better engagement/partnerships between industry and universities, etc.—that despite an improved industry-university relationship, corporations still currently invest less than 1 percent of their R&D investment into university research. Why is that? Are there factors or barriers contributing to this amenable for policy prescription?

Working Group 3 Calls April 23

Introduction

Ms. Kathy Trimble welcomed the group and framed the discussion, bringing up issues of intellectual property, patents, and technology transfer. Mr. Bill Bates emphasized the growing relevance of the Working Group's discussions to current events and the concerns of the business, academic, and policy communities. Ms. Trimble introduced the two opening speakers, Dr. Lloyd Jacobs, President Emeritus of the University of Toledo, and Dr. Lee Cheatham of Pacific Northwest National Laboratory.

Tech Transfer and University "DNA"

Dr. Jacobs characterized the central problem of university tech transfer as one of academic culture. He said universities don't have a drive to commercialize and transfer innovations as part of their "intrinsic culture" or "DNA", and view the "life of the mind" as taking precedence over knowledge commercialization. As a result, it is difficult to make substantive progress on technology transfer until the academic world undergoes a cultural shift. He added that fiscal pressures of universities, which have been growing for decades, have accelerated in the wake of the COVID-19 crisis, changing public attitudes about the value of higher education, and declining enrollment by American high school graduates in traditional four-year colleges. Dr. Jacobs identified technology transfer programs as especially vulnerable to budget cuts due to universities seeking to address short-term fiscal shortfall and their belief that such activities are secondary to their primary purposes. Yet another obstacle Dr. Jacobs identified was the need for both academia and industry to focus resources on repairing disruptions to supply chains, human cap-

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Ms. Carol Ann Meares

ital networks, and relationships that were interrupted by the pandemic and economic crash, which he predicted would take precedence over shifting university attitudes toward commercialization.

Dr. Jacobs also talked about the road forward to greater academic embrace of tech transfer. He described academic culture as risk-averse and noted that simply setting up offices for technology transfer would not "trickle down" into the broader university culture. He identified university-affiliated hospitals as a model for academic-commercial integration, as they are highly valuable commercial entities embedded within university medical schools. He also urged action from multiple stakeholders, including government organizations, academic organizations like the APLU, individual universities, and groups like the Council, to encourage a culture change in academia. He stressed that the globalization of knowledge will make it more difficult for innovators to capture all the benefits of their ideas, and called for greater willingness on the party of industry to become involved in the academic space.

The Shifting Nature of Tech Transfer and the Global Marketplace

Dr. Cheatham identified three trends and obstacles for the group to consider regarding intellectual property and knowledge commercialization. First, he outlined the increasing importance of digital technology and the embedding of data, software, and computing in nearly all research and experimentation. However, "hardware", or physical technology innovations, are governed by a patent system, while software is governed by copyright, and this asymmetry in IP policy makes it more difficult to usher innovations incorporating digital technology into the marketplace.

Second, Dr. Cheatham described the large number of stakeholders that are involved in different stages of knowledge commercialization, including universities, national laboratories, companies, investors, intermediary organizations, and regulators and government officials. He stressed the importance of increasing the quality and quantity of ideas that make it from the lab to the market, and he called on stakeholders to work together to expedite this process. Dr. Cheatham suggested making "handoffs" from one stakeholder to another transparent and simple, clarifying expectations and roles, and incorporating bidirectional feedback. He also stressed the need to inform innovators, whether entrepreneurs or academics, of the market value of their ideas, to align their incentives and refine their knowledge. He suggested developing organizations that could help stakeholders coordinate these activities.

Finally, Dr. Cheatham emphasized how dramatically the economic landscape has changed in recent years, and how the current crisis has exposed weaknesses in America's supply chains, as well as legal and regulatory barriers to innovation and resiliency. He noted the difficulty of research organizations in deploying innovations to address COVID-19 because of a lack of indemnification and a liability regime that is not well-suited to rapid response to crises. While acknowledging the importance of these protections, Dr. Cheatham called for greater flexibility, and urged the group to visualize the future of the economy before developing solutions, lest it design an obsolete set of recommendations.

Spurring Industry Investment in Universities

Mr. Chad Evans noted that companies spend at most 1 percent of the R&D budget on partnerships with or investments in universities. He asked why that was, and if this lack of involvement impacted universities' attitudes toward tech transfer. He referenced the CRISPR gene-editing technology as an analogy for changing "institutional DNA" and making universities more enticing to industry, which could potentially affect the technology transfer experience. Dr. Rao Unnava of the University of California, Davis added that such partnership, coupled with a share in returns to investment in knowledge commercialization for industry, might dramatically alter incentives and multiply America's global technology leadership.

Foreign Governments and Technology Transfer

Dr. Unnava discussed the problem of foreign governments, especially China, requiring innovative American companies to transfer their technology to access their markets, giving them the ability to copy American innovations and build competing firms that capture the value generated by American ideas. He suggested developing a partnership framework in which American companies agree to share their revenues with foreign governments earned in those markets rather than transferring their technology. Ms. Trimble noted that existing technology transfer frameworks are better suited to hardware than software, and discussed the government's challenges in developing innovative tech transfer models. She suggested that different sectors might require bespoke public-private partnership models to optimize tech transfer, and added that foreign markets add complexity because of the involvement of more government actors, like the State Department. Ms. Trimble also concurred with Dr. Unnava's concern with protecting American IP even as innovations are scaled and brought to global markets.

Dr. Jacobs said that this issue was one of the most important facing the country. He said that building supply chains requires cooperation, and that the U.S. government has officials taking positions that are worrying for advocates of robust global competition. He noted the tension and tradeoffs between cooperation and competition in the international space, and said the COVID-19 crisis and economic downturn would accelerate the importance of the issue. Dr. Jacobs also praised Mr. Evans and the Council's previous initiatives in the international arena around cooperation and competition, and said they were highly relevant to the group's discussions.

International Supply Chains and International Students

The Honorable Deborah L. Wince-Smith discussed several interconnected challenges facing universities regarding international students. She noted that universities had more autonomy than national labs in developing strategic partnerships and licensing technologies, and that this resulted in a global network for education and academic research. She also underscored the importance of enabling capital to build production facilities and incorporate them into supply chains, and the manner in which the current crisis is realigning America's trusted partners for key components of its supply chains. Ms. Wince-Smith discussed the national security implications of American universities' reliance on Chinese graduate students and researchers in light of the Communist Party of China's directive to students abroad to gather intelligence during their studies, and of the growing licensure of American university technology to Chinese investors because of their willingness to provide substantive funding. She contrasted the significant Chinese graduate student population with the difficulty students in other countries, like Brazil, have in securing opportunities at American institutions, and urged universities to examine their supply chains along with corporations. Similarly, she discussed the importance of expanding access to the university innovation ecosystem across American society, both geographically and demographically, to generate inclusive prosperity. She discussed the mandate from the Commissioners to move innovation beyond "pockets" of the country.

Innovation as an Output

Dr. Jacobs argued that universities, and American society as a whole, should view innovation as a product or output with its own supply chain. He said that the innovation supply chain required an understanding of the human capital involved in creation of the product and the relationships between different

actors. He urged greater analysis of the vulnerabilities of this supply chain, and how more fine-tuned supply chains were more vulnerable to disruption. As an example, he cited the challenges faced by universities that had come to depend on foreign graduate students for tuition revenue and research capacity, a result of their attempting to economize on "inputs." He drew further parallels between the dangers of America's antibiotic supply chain relying on China and security threats in its innovation supply chain. He stressed the importance of keeping all of America's innovation supply chain under American control.

University Cultural Shifts

Dr. Robert Kazanjian of Emory University agreed with Dr. Jacobs' characterization of academic culture, but described a gradual shift in the outlook of younger faculty regarding commercialization, including an expectation that they will have outlets for bringing the products of their research to market. He said this observation had made Emory introspective about academic culture, and noted that every university possesses different strengths and opportunities for technology transfer. While Emory does not have an engineering school, it has significant innovative capabilities in healthcare, drug development, medical device development, and public health, and generates lots of intellectual property in those areas. However, the school struggles to move those innovations to market and is seeking partnerships with industry and other organizations in the Atlanta area to accelerate tech transfer. Dr. Kazanjian also discussed the disconnect between faculty who are intrinsically motivated by intellectual property and those who are not, and the need to provide greater incentives for the latter group. He said that currently patent revenues are split evenly between the university's general budget, the researcher's department budget, and the researcher themselves. He added that the school was working on identifying other funding sources, both public and private, to help move its technology into the marketplace. Dr. Jacobs echoed Dr. Kazanjian's statement about a cultural shift, noting that millennials in academia were more receptive to this new mindset than older generations.

The Importance of Industry Feedback

Dr. Branko Terzic of Berkeley Research Group discussed his personal experience with the value of industry and end-user feedback for innovators. From 1996 to 2006, he served on an advisory committee of utility and electricity company executives organized by Battelle corporation, where the company showcased technologies developed by its affiliated national laboratories and asked for feedback on industry applications. Dr. Terzic described how industry input enabled the commercialization of many of these technologies because industry members from "outside" fields saw greater potential for innovations in their sector than for the technology's intended application. Although the program was eventually discontinued, Dr. Terzic said it accelerated the commercialization of technology, and that developing similar opportunities for feedback from potential customers could help innovators attract the investment needed to commercialize their intellectual property.

Lessons from Arizona State's Technology Transfer

Ms. Ji Mi Choi of Arizona State University discussed the school's success in, and lessons learned from, its technology transfer programs. She emphasized the importance of commitment from university leadership and alignment of incentives for faculty. Since faculty are traditionally motivated by teaching awards, academic publication, and research grants, incorporation of technology transfer and innovation into promotion and tenure decisions are crucial for aligning incentives, as is removing penalties for emphasizing tech

transfer over other academic and research activities. She also spoke of the importance of ASU's building bridges with the broader entrepreneurial ecosystem off campus, enabling both groups to impact each other and exchange knowledge. Such collaboration also provides far greater funding for technology scaling and commercialization efforts than the university could possible achieve on its own. She also noted the role student desire for entrepreneurial opportunities has played in catalyzing cultural change, but cautioned that ASU still faced obstacles. These include the structure of programs like the Small Business Innovation Research (SBIR) initiative, which prevents students or faculty involved in startups spun-off from university research from being eligible for university health insurance and other benefits. Students also face pressure to obtain an immediate return on investment for their degrees rather than taking the risk of founding a startup, and professors often reach promotion and tenure milestones before an investment in knowledge commercialization has had time to pay off.

Tracking and Evaluating Technology Transfer in Academia

Dr. Kazanjian also described student demand for entrepreneurial opportunities at Emory, and noted that school provides incubators and institutional support even though students retain all the proceeds from their ideas. Ms. Choi noted that at ASU, student-founded startups are more numerous than university-owned startups, and that there is no established metric for schools' entrepreneurial output. Existing attempts either rely on schools' reported data from degree programs, which excludes student startups in fields outside their major, or on tracking the alma maters of startup founders and investors, which includes companies founded without any institutional support from the founder's school. Dr. Kazanjian called for universities to begin comprehensively tracking the number of startups founded by students with university support, but acknowledged that different schools would likely use different metrics that complicate direct comparisons.

Concluding Thoughts

Ms. Wince-Smith thanked the participants for their discussion, and announced that next week's calls would focus on attracting patient, long-term capital to finance innovation, especially from outside the venture capital world. She noted that the United States is at a disadvantage in this arena relative to countries with sovereign wealth funds, and noted that the Export-Import Bank of the United States is unable to provide long-term financing for domestic infrastructure projects.

Working Group 3 Calls April 28

Introduction

The Honorable Deborah L. Wince-Smith welcomed the group and introduced the featured speaker, Mr. Olin Wethington of Wethington International LLC. Ms. Kathy Trimble framed the discussion, centered around U.S.-China competition, with a comparison of the strategies in the game of chess and the Chinese game of Go, which is based on encircling the opponent until they exhaust their resources. She emphasized that the U.S.-China relationship is centered around strategy and the contest for power.

Framing the Discussion

Mr. Wethington opened by noting the United States faces unprecedented challenges to the post-WWII global order it leads, surpassing even the threats from the Cold War and terrorism, as those were primarily security threats, not challenges to American economic or soft power. He said that China has an innovation ecosystem and value system that is incompatible with those of the United States and its allies, and that it wants to export these systems around the globe, using its financial resources to write the rules for a new technology-based and infrastructure-connected order. He charged the group to design policy recommendations with China in mind and to ensure that the future of innovation remains in the United States. Mr. Wethington called the preservation of the liberal, democratic, market-based order crucial, and said that while it has advantages in population, wealth, geography, cultural power, and popularity, it lacks political willpower and strategic plans for concerted effort. He called for much greater leveraging of America's allies and channeling of influence through institutions to ensure the rules

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of the global economic and geopolitical order reflect American interests and values. He identified five major areas for policy recommendations regarding competition with China: infrastructure, international institutions, standards setting, trade and intellectual property, and multilateralism.

Infrastructure and Connectivity

Mr. Wethington characterized China's "Belt and Road Initiative" as a competitiveness challenge of the highest order. He said it is tied to China's tech development policies, and that China openly speaks of a "digital silk road" and a "maritime silk road." China is striving for a world of connectivity and easy money backed by Chinese investment in infrastructure abroad, and wants to shift the global economic environment away from current international norms and practices to Chinese norms. Mr. Wethington warned there was a dark side for countries that accept Chinese financing for infrastructure development, including a degrading of rules and standards, unsustainable debt, lack of transparency in financing, procurement, and regulation, and geopolitical threats. Chinese investments amount to a staggering $500-600 billion across 130 different countries, and control of infrastructure, especially in developing countries, is central to China's geopolitical strategies.

In response, Mr. Wethington urged the United States to develop an infrastructure agenda that is framed around American strengths, values, and interests. He called for coordinating and harmonizing activities with our allies, and said such a strategy would not require large new budgetary outlays. He urged a combination of bilateral and multilateral approaches, including revitalizing multilateral development banks, and mobilizing their resources and the resources of private companies to invest in infrastructure projects around the world. In particular, he suggested the United States develop means to co-invest, de-risk, and provide technical assistance to make large infrastructure investments worthwhile to private finance. Mr. Wethington also advocated using groups like the G7 and G20 to pursue negotiations and develop standards for international lending. He noted the United States' past success in creating new standards for international investment, and that many countries, not just the United States, are threatened by China's attempted dominance of global infrastructure.

International Institutions Impacting Competitiveness

Mr. Wethington discussed China's desire for an active role in international governance, and its desire to shape the norms and values of the UN and other international bodies. He pointed out that four out of fifteen UN organizations are led by China, and that Chinese officials occupy senior positions in other international bodies, especially those concerning innovation and competitiveness. China uses its place in these organizations to seek endorsements of its role and of the Belt and Road Initiative, and has signed more than 25 memoranda of understanding securing partnerships and coalitions to achieve its economic and geopolitical objectives. Mr. Wethington warned that the United States cannot leave a void in these institutions, and that the United States must especially increase its engagement in institutions with effects on innovation and competitiveness. He further emphasized the importance of a larger U.S. role in the standards-setting process through common action with like-minded countries, better use of existing institutions, and more effective diplomacy with respect to personnel.

Standards Setting

Mr. Wethington called for greater linkage between industry and government in the standards-setting process for new technologies. He said such proactive participation was essential to counter well-funded Chinese attempts to influence global standards, and he warned again of the dangers of a personnel vacuum in international diplomacy.

Trade and Intellectual Property Protection

Mr. Wethington stressed the United States must continue to endorse the liberal, open market order, and domestically must reinforce the bipartisan consensus emerging around the importance of reciprocity in trade policy. He said the United States must use trade policy to protect American firms from anticompetitive Chinese practices and alter China's behavior, as well as shield American interests from the impacts of some of these sanctions. Mr. Wethington urged penalties and sanctions for foreign actors engaged in theft of intellectual property, and said he expected such punitive actions, which have increased in recent years, to continue increasing.

Multilateralism

Finally, Mr. Wethington urged the United States to bring together a coalition of like-minded countries and use their collective leverage to establish new arrangements around emerging technologies. He called for an emphasis on economic statecraft, and for securing bipartisan support for defensive actions to prevent adverse technology transfer. While acknowledging that limiting the damage from Chinese technology acquisition was more feasible than stopping it, he strongly urged protections against the transfer or acquisition of critical technologies and limits on foreign acquisitions of companies possessing critical technologies. Mr. Wethington also urged the broadening of the definition of critical technologies in concert with America's allies, especially biotechnology. He said that a multilateral regime will be more effective in controlling the leakage of critical technology than a unilateral one.

De-globalization and Decoupling

Mr. Chad Evans noted that U.S. tech companies derive over $100 billion in annual revenue from China, accounting for nearly 25 percent of their total revenue, and asked how decoupling would impact America's short-, medium-, and long-term competitiveness given the benefits many companies reap from the status quo. Similarly, Mr. Tom Dailey, formerly of Verizon, asked about "forking" of supply chains for critical technology, such as 5G. Mr. Wethington predicted that companies would begin decoupling of their own volition due to changes in market dynamics, as the factors that impelled American firms to locate in China in the first place are shifting. He noted that China is pursuing indigenous technological development in many of the same spaces as U.S. tech companies, and that they have been decoupling and engaging in industrial policy for quite some time, a process to which American firms are now waking up. He did not think the United States would be able to seriously challenge China's growing economic strength, but that the United States could manage it through carefully crafted policies that minimize the damage to American firms stemming from changes in supply chains. Mr. Wethington particularly urged sanctions and encouragement or requirement of relocation for U.S. supply chains in cases where China engages in theft of IP or forced technology transfer. To reduce the economic damage to American firms from such sanctions, he suggested creating a transition window to give them time to identify alternative supply chains. He also warned that in many technologies China possesses significant market power to shape standards and norms, and that the United States must counter this through collaboration between government and industry.

The WTO and Other Multilateral Organizations

Ms. Wince-Smith asked what opportunities there were in revitalizing the World Trade Organization as a vehicle for advancing U.S. economic interests. Mr. Wethington noted that the WTO has thrived on other countries deciding that preserving the U.S.-led economic order is important, and said that joining with our allies to manage these institutions and establish their values is key to U.S. competitiveness. He said that while the WTO has shortcomings, the alternative is chaos and fragmentation, and stressed that

it would require hard diplomatic work to reestablish the importance of the WTO and push its multilateral capacity into new arenas.

Mr. Wethington continued, saying that the Trans-Pacific Partnership would have provided a substantial opportunity for enhancing American soft power in East Asia, and reminding the group that the United States retains significant influence around the world, including in Europe and Japan, which along with the United States dominate global financial institutions and multilateral development banks. However, with China deploying massive financial resources around the world, the lack of an American counter has created a vacuum in this space. He emphasized again that the American response would require multilateral action with our allies.

Mr. Dailey noted the U.S. retreat from international fora and its reduction in funding of the State Department, which feared left a gap in standards setting bodies that China was exploiting and using to expand its Belt and Road Initiative. Dr. Rao Unnava of the University of California, Davis noted that only a handful of countries can afford major infrastructure and technology investments, and asked if the United States should split countries into groups when it came to bilateral or multilateral agreements and protection of critical technology, as common rules would not work for everyone. He suggested that it may be beneficial to have rules encouraging greater openness to developing countries, helping them develop, and stronger scrutiny of investments from countries like China.

Academia and China

Dr. Robert Bishop of the University of South Florida asked how academia should address its interactions with Chinese academia and industry. Mr. Wethington noted that the United States has benefited from openness in its academic system, but that going forward it should define criteria for how collaboration takes place. He said there was benefit in exposing Chinese students and researchers to American thinking in the humanities and social sciences, as well as the general culture of academic independence. However, there should be limitations on access to critical technology and the basic research that undergirds it. He added that the United States must not be naïve about the Chinese government's attempts to control, influence, and direct Chinese student populations on American campuses, and that the United States must act to prevent malign activity by the Chinese government that damages academic freedom and U.S. interests. Finally, Mr. Wethington suggested establishing a pattern of reciprocity regarding Chinese access to American institutions of higher education, noting that China restricts foreign students' ability to study science and technology in China, and he called for publicizing and highlighting China's restrictions of academic freedom- domestically and abroad- to the United States and international community.

U.S. Investment in Key Technology

Mr. Evans asked about U.S. investment in key technology. He noted that for advanced microelectronics, the only manufacturers of the leading edge 7nm fabs are Samsung (in South Korea), TSMC (in Taiwan), and Intel. This is a decline from the 8 leading edge manufacturers ten years ago, and means that two of the three remaining players are within striking distance of China. He noted that loss of U.S. leadership in advanced microelectronics was an existential threat, and that the cost of a single fab facility could be more than double the annual budget of the National Science Foundation. He asked what the U.S. innovation ecosystem looked like in fields where large-scale, long-term investments were needed, and if the United States could afford to "go it alone" in these endeavors, especially those that require supplies of advanced and rare materials. Finally, he asked how to unleash the capital that is sitting in hedge funds, private equity, and other non-venture capital sources in service of these investments.

Mr. Wethington responded that capital will go where it sees returns and low risks, and said it would be important for the government to de-risk investment for technologies with key health, safety, and national security implications. He called for policy makers to be more receptive about underwriting the risks of long-term capital, and toward developing incentives and regulatory regimes that encourage this investment. Dr. Cheryl Martin of Harwich Partners said it was important to identify how government actions in support of investments impacted firms' perception of risks, through basic research support, the creation of consortia, or other methods. She also cautioned that while some of those risks could be identified and reduced, others would remain unknown. Finally, she noted that other countries, including Japan and South Korea, were looking at the same kinds of investment decisions, and how the U.S. government addresses these challenges will interact with how other countries make decisions about underwriting risks, and vice-versa.

Concluding Thoughts

Mr. Wethington said that he hoped the group would take the ideas and policy proposals discussed today and deepen them, and Mr. Evans underscored the importance of public-private partnerships in addressing strategic challenges. He also encouraged the framing of the "societal burden" of de-risking long term investment as one of societal opportunity to secure American leadership in critical advanced technologies.

Working Group 3 Calls April 30

Introduction

The Honorable Deborah L. Wince-Smith welcomed the group and introduced the opening speaker, Mr. Olin Wethington of Wethington International, LLC. She discussed his experience in the Departments of Commerce and the Treasury, the White House, international trade law, and private business experience. Mr. Chad Evans said he was interested in hearing thoughts on the U.S.-China relationship, especially those pertaining to decoupling and supply chains, U.S. regulatory policy, and maintaining American leadership in global institutions. Ms. Kathy Trimble framed the U.S.-China relationship in the context of two popular strategy games: chess for the United States, and Go, a long-term game based on encirclement, for China.

Framing Remarks

Mr. Wethington opened by noting that the U.S.-led post-World War II international order faces unprecedented challenges from China's rise. While previous threats, including the Soviet Union and terrorism, were primarily of a military and security nature, the challenge presented by China is across the board, encompassing economics, security, values, and international leadership. He said that China has a distinctive approach that is not compatible with or hospitable to U.S. norms and values, and that it wishes to export these values around the world. Given China's desire to write the rules for new technologies and its aggressive use of infrastructure investment to further geostrategic aims, Mr. Wethington suggested policy responses in five areas: international infrastructure development, international institutions,

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global standards setting, trade policy, and intellectual property protection. He stressed that the United States must act bilaterally and multilaterally with its allies to sustain the liberal, democratic, market-based international order. He further emphasized that while this order has advantages in population, geography, financing, and institutions, it lacks the will power, functioning political processes, clear priorities, and commitment to multilateral action it needs. Mr. Wethington described multilateral processes that channel U.S. influence through institutions reflecting American interests and values as crucial to efforts to maintain global leadership.

Infrastructure Investment

Mr. Wethington discussed China's Belt and Road Initiative, begun in 2013, at length. The Chinese government has invested over $500 billion in over 140 countries, many of them developing countries, for infrastructure development. This investment is designed to create a new era of connectivity and easy money for China, part of a "digital silk road" that will give them influence on rules, standards, and norms in partnering countries, as part of a strategy to shift global norms and institutions away from American interests and toward their own. Many of these infrastructure projects violate international standards governing procurement, financing, debt sustainability, and regulatory transparency, and provide China with substantial leverage over developing countries, for whom infrastructure development is a top political and economic priority.

In response, Mr. Wethington said the United States should lead a multilateral effort rooted in American strengths and interests. He urged combining unilateral, bilateral, and multilateral actions, and noted progress on this front in recent years. The Export-Import Bank of the United States has been given authority to match China's export financing terms for projects, and the U.S. government recently created the International Development Finance Corporation. Mr. Wethington also noted that multilateral development banks are controlled by the United States and its allies, and possess significant capital for infrastructure investment. He called for a concerted effort to mobilize these resources, along with providing technical support, to invest in infrastructure projects in developing countries. In particular, Mr. Wethington urged the clear adoption of standards around financing, procurement, and regulatory transparency that reflect the values of the United States and its allies. He also cited the actions of the G20, while chaired by Japanese Prime Minister Shinzo Abe, as a precedent for using existing platforms to reinforce current norms around financing and investment in international markets.

International Institutions

Another prong of China's strategy for influence is through the appointing of Chinese officials to lead specialized UN agencies, where four out of fifteen are led by China, and there are Chinese officials in high-ranking offices in many others. China uses personnel placement to steer international organizations and revise norms of global governance, as well as to seek endorsement for initiatives like Belt and Road. Through over two dozen memoranda of understanding with different agencies and governments, China is leveraging deft coalition building to steer the international institution system toward the promulgation of illiberal values. Mr. Wethington warned that the United States cannot cede ground to China in this space, and must prioritize magnifying its influence in international institutions. He urged the United States to engage in the same personnel placement strategy, affirmatively put forward its own interests, and insist on transparency and independent outside oversight of the decisions of all international institutions. He also suggested using America's financial leverage when appropriate to tie funding to specific policies. Mr. Wethington concluded his discussion of international institutions with two contrasting examples in recent months. On the success side, U.S. diplomacy prevented a Chinese-backed candidate from being chosen to head the World Intellectual Property Organization. On the challenge side, Chinese influence has been evident in the response of the World Health Organization to the COVID-19 pandemic.

Global Standards Setting

Related to its pursuit of influence on international organizations is China's desire to set new global standards for technologies and institutions. Among the standards setting bodies China where China has secured leadership are the International Standards Organization and the International Telecommunications Union. Mr. Wethington called for coordination between U.S. industry and the U.S. government in reasserting U.S. leadership in these bodies, and in generating support for such measures by framing them in terms of national security and military development.

Trade Policy

Mr. Wethington noted that both the United States and its allies in Europe and Asia are concerned with China's trade policies, and that this shared interest should override differing preferences for a response. He cited the Commission's work as particularly valuable in framing the national agenda in this area, and encouraged a two-pronged approach. First, the United States should endorse the growing bipartisan consensus around demanding reciprocity from China in trade policies and barriers. Second, the United States must not be afraid to incorporate leverage in negotiations when it has the ability to do so, while taking care to shield American companies from the effects of these sanctions. Here Mr. Wethington again encouraged multilateral, coordinated action and coalition-building to shape and secure the long-term rules of the international trading system. He described this "multilateral statecraft" as building economic security into institutions, arrangements, and global norms.

Intellectual Property Protection

Finally, Mr. Wethington discussed the necessity of taking defensive action to limit the damage from Chinese theft or acquisition of American intellectual property in critical technologies. He warned that the United States must not be naïve, and noted that a bipartisan consensus is forming among U.S. lawmakers on the importance of limiting Chinese investment in critical American technology. He further urged broadening the definition of "critical" technology, warning that too many important sectors of the U.S. economy were heavily dependent on the Chinese market, with serious implications for America's long term economic and national security. While he did not advocate returning to the bloc-based arrangements the United States used during the Cold War, Mr. Wethington encouraged multilateral action to strengthen global intellectual property standards. He also argued there was room for sanctions and penalties for violators of American intellectual property, especially given clear evidence of Chinese malfeasance.

Chinese Use of Antitrust Policy as Leverage

Ms. Wince-Smith asked how the Chinese government was leveraging competition and antitrust policy to act as a non-tariff trade barrier and facilitate acquisition and control of key technological innovations. Mr. Wethington replied that while China has not yet been aggressive in this regard, it has incorporated competition considerations into its formal legal processes, and is aware of its potential for offensive action. He noted that China's competition policy differs significantly from that of the United States and Europe, favoring "national champion" firms in key sectors that enjoy special protections and support from the government at the expense of competition. Mr. Tad Lipsky of Latham & Watkins LLP and George Mason University concurred with this assessment. He noted that because the Chinese government has so many points of regulatory control, their de jure competition policy, which resembles international norms in terms of its provisions, is in practice vastly different from the United States. He characterized China as lacking a substantive legal system, with all decisions being made by senior members of the Chinese Communist Party and no judicial independence. Mr. Lipsky described how China uses its anti-monopoly laws as leverage

to attain concessions from multinational firms that benefit its interests, even when they have little to do with competition policy. As an example, he cited China's forcing two multinational companies to divest from a copper mine in Latin America as condition for allowing their merger. Similarly, China uses these powers to require the inclusion of Chinese investors in foreign direct investment projects, a practice akin to Japan's mercantilist actions in earlier decades. He noted that the lack of judicial independence in China makes true antitrust policy futile, as there is no transparency and no ability to appeal decisions made by administrators. Finally, Mr. Lipsky said that China uses its legal system to encourage the disclosure of foreign intellectual property to favored Chinese customers.

Decoupling

Ms. Trimble asked how recent tensions between the United States and China, as well as recent economic developments, would impact the process of decoupling U.S. investments and supply chains from China. Mr. Wethington responded that he believed decoupling to be a naturally occurring process, driven by a rise in the costs of producing in China and security concerns by U.S. companies. He noted that China became popular for manufacturing and assembly because of labor costs, which will increase as China becomes wealthier, and believed these would combine with security concerns to encourage U.S. companies to seek other emerging markets for new ventures, as well as redirect existing investments to those markets. He added that U.S.-China interdependence will not completely cease, especially for technologies without national security implications and where American firms are heavily dependent on the Chinese market for survival. He also said that China has been decoupling from American and other foreign investment for years, seeking to exclude foreign firms in areas where it has acquired indigenous innovation capabilities, including the recently launched Made in China 2025 effort. Finally, he warned against taking too aggressive an approach to decoupling, and suggested not thinking of investment decisions in those terms.

U.S. Economic Investment in China

Mr. Evans asked if current tensions with China would undermine the United States' long-term innovation capacity and productivity. He noted that American companies like Intel and Apple generate up to 25 percent of their revenue in the Chinese market, and wondered how this impacted America's short-, medium-, and long-term competitiveness. He also asked if American and Chinese investments in R&D were truly complementary, with America concentrating on basic research and China focusing on experimentation and application. Ms. Wince-Smith noted that America's pharmaceutical supply chain had been "hollowed out" and relocated to China, and connected this to America's punitive liability laws. She noted a similar phenomenon for medical devices and equipment, and observed that the one market segment where China still depended on American manufacture was for cancer drugs. However, she predicted that China would begin to exclude foreign drug manufacturers once they developed capabilities in this field. Revisiting the issue of reciprocity, Ms. Wince-Smith noted that the U.S. supplies cloud computing services to Chinese companies with a presence in the United States, but that China does not do the same for foreign firms invested in the Chinese market.

Dr. Ken Poole of the Center for Regional Economic Competitiveness asked how the United States could be proactive in managing supply chains currently based in China. He noted that re-shoring all production could impact the price level, and asked if there were other emerging markets, such as Vietnam or India, that the United States should prioritize. He also asked whether the federal government should incorporate national security considerations, rather than just cost, into its procurement policies. Mr. Wethington observed that the United States has regulatory processes in place to make case-by-case decisions about supply chain security. In some industries, it may not be necessary or desirable to forbid investment in China or partnership with Chinese firms like Huawei. He praised the U.S. regulatory system as offering a versatile framework for these rulings. Dr.

Poole asked if health security and economic security should be included as part of national security decisions regarding supply chains, and Mr. Wethington agreed on the need to broaden the definition of "critical technology." In particular, he asked if bioscience and biotechnology should be included because of their implications for healthcare innovation. He also said other legal authorities could be invoked in particular circumstances to prohibit transactions that damage U.S. national interests.

The International Trade Commission

Dr. Branko Terzic of Berkeley Research Group asked if there was a role for the International Trade Commission in enforcing reciprocity with China on trade issues. Mr. Wethington replied that the ITC was primarily designed to handle countervailing duties, antidumping, Section 201, and other "conventional" international trade disputes. He said it lacked broader regulatory authority, and that the Departments of Commerce, the Treasury, and Defense would be better suited for handling these issues. Ms. Wince-Smith asked if the ITC's authority could be broadened to give it more regulatory powers, and Mr. Wethington said this was possible, but that the process would need to be carefully thought out, as the ITC's members operate independently from the U.S. government.

Concluding Thoughts

Ms. Wince-Smith thanked the group for their conversations, praising the emergence of concrete recommendations. She connected the group's discussions with Working Group 1's debate over the optimal structure of Congressional committees for leading technology development initiatives. She noted that the government rapidly reorganized itself in the wake of the September 11th attacks, creating the Department of Homeland Security, and encouraged the group to be bold in its recommendations. She added that besides the executive and legislative branches, the group should develop recommendations for the private sector and universities. Ms. Wince-Smith discussed the virtual meeting of the Council's University Leadership Forum on Tuesday, in which university leaders discussed the reliance of many institutions on the tuition paid by Chinese students. She encouraged the conception of universities as important economic engines, and spoke of the necessity of balancing openness and the liberal research enterprise with national security concerns, even regarding basic research. Finally, she called for increasing America's own research capacity and for partnering with our allies on the issues discussed. She said the Council has close relationships with Japan and Australia, and is seeking stronger ties with Canada, Britain, and others.

Working Group 3 Calls May 5

Introduction

The Honorable Deborah L. Wince-Smith welcomed the group and introduced the featured speaker, The Honorable Branko Terzic of Berkeley Research Group. She discussed his background working as a commissioner for the Federal Energy Regulatory Commission (FERC) and in the private sector for Deloitte, and his expertise in utilities and power generation. Mr. Chad Evans announced two changes for the working groups in the weeks following the June 16 virtual meeting of the National Commissioners. First, a fourth working group will be created to focus on questions of work and entrepreneurship, with the second working group focusing on the future of sustainable production and consumption. Second, working group calls will move to once per week and be led by co-chairs chosen by the Council. These calls will focus on data-driven discussions and aimed at generating actionable policy recommendations. They will be preceded by a primer with background reading and policies for the group to discuss and debate.

Overview of Opening Presentation and Basics

Dr. Terzic opened his presentation with an overview of electricity generation. He distinguished between energy, defined as the capacity to do work, and power, defined as the rate at which energy is generated. He characterized electrification as the single greatest technological transformation of the 20th Century, responsible for improving the standard of living around the world. He further noted that the North American electrical grid is the most complex

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machine ever invented. However, because of its reliance on fossil fuels, the grid is a major contributor to pollution and climate change, and because of our growing reliance on electric power, the consequences of a blackout or cyberattack on our electrical system are devastating. Dr. Terzic said that the increasing digitization of the electrical grid makes us increasingly vulnerable to such attacks.

Stakeholders in the Electricity Industry

After the introduction, Dr. Terzic described the major parties in the electric industry. He said that while previously utilities were responsible for all three phases of power generation- production, transmission, and distribution- these functions are now separate. There are approximately 3,200 utilities involved in electricity production, transmission, and distribution, with 200 shareholder-owned companies accounting for 70 percent of U.S. electricity customers. The other 3,000 are rural or tribal electricity cooperatives or municipally-owned utilities. Four major federal agencies are responsible for the construction of hydroelectric dams for flood control, irrigation, and power generation: the Tennessee Valley Authority, the Bonneville Power Authority, the Southeastern Administration, and the Southwestern Power Pool.

Utilities are run as regulated monopolies, with jurisdiction split between federal and state regulators. State regulators set retail rates and control construction, distribution, and transmission for consumer usage. They are also in charge of overseeing the construction of new generators. The Federal Energy Regulatory Commission oversees natural gas pipelines, transmission for third party access, and the wholesale electricity market. The electricity market has never undergone a full deregulation, and certificates are needed to conduct transactions in both the consumer and wholesale markets. Further, the national grid is fractured, with different regional subgrids that use different rules and standards, including different definitions of kilowatt hours. Of note is the Energy Regulatory Commission of Texas (ERCOT), which controls a grid covering most of the state and is not connected to the rest of the national grid. Outside of ERCOT, utilities buy and sell electricity on bilateral contracts overseen by FERC.

History of Electricity Regulation

Dr. Terzic said that in the 1980s, electric utilities in every state had vertical monopolies that owned power plants, distribution, and transmission facilities. These utilities were overseen by state commissions. However, in the 1990s a wave of restructuring occurred and 15 states (Arizona, Texas, Michigan, Illinois, and most of the Northeast and Mid-Atlantic) moved to a competitive system, alleging that monopolies had failed to properly manage the construction of new plants. In these states, utilities sold their plants and focused on distribution, and consumers could buy electricity on FERC-regulated, competitive wholesale markets. The federal government retained the ability to intervene in these markets, including requiring refunds and setting price floors and ceilings. In California, the competitive electricity market failed in 2001-02 and was repossessed by the state. However, Dr. Terzic said this stemmed from a poorly designed market, rather than moving to a competitive system per se.

Dr. Terzic also discussed the beginnings of electricity regulation. Much like telephone service and natural gas, electricity was initially considered a luxury, with the financier JP Morgan becoming the first customer of home electric power. However, just as regulated monopolies emerged when railroads became essential for the 80 percent of the population that lived on farms in the late 19th century, by the time electricity became seen as a need, a regulatory framework emerged. Early regulation was influenced by the "Wisconsin idea" championed by politicians like President Theodore Roosevelt and Wisconsin Governor Robert LaFollette, and rested on the belief that experts acting without political pressure could objectively and scientifically determine the cost of service for monopoly producers in the absence of markets.

Cost Elements and Innovation Barriers Facing Utilities

Dr. Terzic identified four cost components facing utilities, which he said mirrored every other industry. The first, operations and maintenance, includes R&D expenditures. The second, depreciation, includes capital recovery over the economic life of equipment. The other elements are taxes and return, the latter of which is defined as a base rate investment multiplied by the rate of return.

Dr. Terzic connected many of the barriers facing utilities seeking to innovate to these four components. Capital investment is very difficult for utilities because of the lengthy approval process required for "first mover" investments in untested technology. Firms want to see another utility go first rather than assume the high initial investment costs themselves. Regulators also face pressure from consumer advocates not to approve R&D activities, as these are chiefly financed by raising rates. There is also a prevailing mindset that utilities are retailers and thus have no need for R&D. Finally, existing depreciation policy does not allow for timely recognition of obsolete technologies, with consumers again resisting attempts by utilities to raise rates in order to pay off the costs of upgrading their depreciated equipment. All of these factors act as obstacles that discourage utilities from innovating.

In response to these concerns, Dr. Terzic discussed an article he wrote for a trade periodical describing how these policies combined to delay the adoption of digital telecommunications infrastructure for a decade, as companies like AT&T could not get permission to write off mechanical switches. Due to the sluggishness of municipal regulators, small towns leapfrogged larger municipalities in their telecom infrastructure, going from 1920s era technology to digital infrastructure while larger cities remained on 1970s era technology. Dr. Terzic also emphasized that retail corporations do engage in research, citing Wal-Mart's opening a research facility in India. Finally, he noted that various mechanisms, including state commissions and FERC surcharges on interstate pipeline tariffs, were used to fund research on new methods of electricity generation and distribution. However, regulators increasingly found the approval process unwieldy, and most of these mechanisms disappeared with the advent of unbundling after 1992. Dr. Terzic observed that FERC still retains the power to collect surcharges on gas pipelines, but has chosen not to reinstate this policy.

The Importance of Lateral Transfer

A major theme of Dr. Terzic's presentation was the importance of lateral transfer, or the adoption of an innovation in one industry for use in another, for the electricity industry. He noted that many great discoveries and inventions, from Kepler's laws of planetary motion to Gutenberg's printing press and Darwin's Theory of Evolution, were inspired by similar processes. In the electric industry, Dr. Terzic cited nuclear reactors, initially developed for use on submarines, jet turbines, which have been adopted from aircraft to generate energy by power plants, and lithium ion batteries, developed initially for phones but then adopted by cars and from there utilities. In every case, utilities saw an application for the technology that addressed an unmet need, and modified for use in the electrical grid. Dr. Terzic noted that lithium ion batteries will likely become obsolete, as the next wave of batteries will need to be cheap and capable of quick transmission of energy.

The Future of Electricity and the Internet of Things

Next, Dr. Terzic shared projections for the future of the electric grid. With the advent of sensing technology and the Internet of Things, Dr. Terzic predicted that houses would be able to generate their own energy and buy and sell it through the grid. Devices would use AI to automatically make decisions about energy use, storage, and sale based on inputs from individual consumers. He noted, however, that there could be cost allocation challenges, as some components of this new grid, like electric vehicles and smart buildings, would be owned by consumers, while some, like smart meters and electric vehicle

charging stations, would be owned by utilities. Dr. Terzic noted that the assets currently held by utilities need not remain their exclusive jurisdiction, and identified situations in which challenges might arise, like neighbors' devices interfering with each other or a failure of a privately owned part of the grid spilling over to shared sections.

Dr. Terzic also discussed the role of federal programs in innovation, particularly the Advanced Research Projects Agency-Energy (ARPA-E). He praised the agency's investment in entirely new technologies for electricity generation that were too early state for private investment, but stressed the need to effectively transition these inventions to the marketplace. He also discussed the difference between short-term and long-term innovations. Some innovations, like solar energy, are older but did not find a market use until the emergence of climate change as a threat. Others, like nuclear power, solve immediate needs but were implemented before the long-term impacts were fully understood.

Incentivizing Innovation

Dr. Terzic concluded his presentation with a discussion of policies necessary to incentivize innovation. He called for tax incentives and regulatory changes to encourage greater capital investment by utilities, along with more federal partnerships for joint investment. He also called for extending these tax and regulatory incentives to cover R&D by utilities, along with a formal recognition that R&D is an essential component of all businesses, including retailers. Finally, he called for new depreciation rules that allows utilities to more quickly replace assets that have become obsolete. Dr. Terzic observed that current policies actually incentivize utilities to take on debt, as doing so minimizes their capital costs.

The Role of Self-Regulation

Mr. Greg Pellegrino of Deloitte was struck by the role voluntary standards-setting and self-regulation had played in the evolution of the electricity industry. He mentioned the example of insurance companies and appliance makers developing safety standards that led to a vast improvement in product safety in the late 19th Century, and cited cars as an example of damage in the form of safety hazards stemming from an unwillingness of industry to self-regulate for decades. Dr. Terzic discussed the emergence of Hartford Boiler as a certifier of safety for boilers, which were prone to exploding and killed thousands of Americans every year in the 1890s. In addition to combining with insurers to fund the development of safer technologies and standards, the company invested in inspectors who would certify boiler makers, which became a precondition for insuring them. Because of consumer demand for boilers that met safety standards and could be insured, this self-regulation drastically improved their safety.

Dr. Terzic described a similar process that occurred during FERC's restructuring of the natural gas industry. Rather than writing a new, complicated set of standards as power generators joined distributors in relying on natural gas, FERC allowed industry to put together a committee of experts to suggest regulations for the agency to review. Although FERC retained final decision making power, the experts convened by the North American Energy Standards Board developed most of the regulations and standards around natural gas pipelines.

Current Vulnerabilities and Threats

Dr. Lloyd Jacobs, President Emeritus of the University of Toledo, asked if the grid was keeping pace with the country's current demand for energy, and how vulnerable the U.S. grid was to disruption. Dr. Terzic said that prior to the COVID-19 crisis, the grid had more than enough capacity to satisfy domestic energy needs, and that he advocated having as much excess capacity as possible, as the costs of storing it paled in comparison to the cost of blackouts triggered by cyberattacks or "Black Swan" events. Dr. Terzic added that digitization and sophistication increase cyber vulnerability, and argued for the incorporation of analog redundancy into the grid. He noted that when Russia launched attacks on Ukraine's electricity system, field crews were able

to turn switches back on manually, but a fully digital grid cannot be turned on except through software. He discussed technologies that allow people to start cars remotely and Amazon Alexa, and warned that those systems could be co-opted by hostile actors for eavesdropping and remote manipulation of vehicles and other devices plugged in to the Internet of Things. He further warned that during the COVID-19 crisis, attacks on America's cyber infrastructure have increased fourfold.

Opportunities for Action and Future Developments

Ms. Wince-Smith asked how the United States could turn the COVID-19 crisis into an opportunity to improve the resiliency of the grid. Dr. Terzic said the increase in cyberattacks came with potentially devastating consequences, such as an attack shutting off power to essential facilities like hospitals. Dr. Terzic encouraged the U.S. government to treat cyberattacks from foreign powers as tantamount to military strikes or terrorist attacks. He emphasized that many federal agencies, as well as utilities themselves, have devoted significant resources to preparing for these threats and developing responses. He also noted continued federal support for nuclear programs, carbon capture, and carbon sequestration, although he characterized the results of the latter two initiatives as mixed.

Dr. Cheryl Martin of Harwich Partners, formerly of the Advanced Research Projects Agency-Energy (ARPA-E) discussed an ongoing initiative that allows prior ARPA-E funding recipients to come in with new partners for demonstration projects. This initiative is aimed at scaling up promising technologies, and she said that the agency is broadly focused on developing means of identifying candidates for scaling earlier in the development cycle. Dr. Martin also reported that ARPA-E continues to receive federal funding and a gradual budget increase, and continues to have a broad research portfolio.

Dr. Terzic identified modular nuclear reactors as a potential arena for development and investment in the near future. He describe the existing Nuclear Regulatory Commission safety review process for new nuclear plants as unconscionably long, and expressed hope that smaller, modular reactors would partially obviate this. He also highlighted hydrogen as a storage mechanism for energy. By using hydrogen technology to run fuel cells, jet turbines in power plants, and internal combustion engines, energy producers and consumers could drastically reduce greenhouse gas emissions, and major cities like New York could become large scale buyers of hydrogen technology due to a reluctance to expand the natural gas distribution infrastructure. Dr. Terzic touted the potential of hydrogen for storing energy until it was needed.

Concluding Thoughts

Ms. Wince-Smith said the conversation had yielded many potential policy recommendations. She also expressed hope that the country could use the recognition of the need for regulatory reform prompted by the COVID-19 crisis as a starting point for other important regulatory reforms.

Working Group 3 Calls May 7

Introduction

The Honorable Deborah L. Wince-Smith welcomed the group and introduced the featured speaker, The Honorable Branko Terzic of Berkeley Research Group. Mr. Chad Evans announced two important changes to the work of the Commission following the June 16 virtual meeting of the National Commissioners. First, a fourth working group focusing on the future of entrepreneurship and work will be created, with the second working group focusing on the future of sustainable production and consumption. Second, beginning the week of June 22, Working Group co-chairs as nominated by the Council will be being leading once-weekly discussions focused on generating actionable policy recommendations from the discussions of the groups. Each session will be accompanied by a primer containing background information and specific policies for consideration and debate.

Basics of Electric Utilities

Dr. Terzic began with an overview of the structure and history of the electricity distribution system in the United States, drawing from his experience managing utilities and serving as a commissioner at both the state and federal levels. He differentiated between energy, or the capacity to do work, and power, or the rate at which energy is generated for use. Dr. Terzic cited the Federal Reserve Bank of St. Louis, which characterized electrification as the most important technological development of the 20th Century, in underscoring the importance of electricity

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to the economy, and emphasized that this importance will grow as more and more devices become connected to the grid. He attributed the unprecedented prosperity of the modern age to electricity, pointing out that 20 kilowatts of electric power, the minimum household capacity in the U.S. building code, provides as much energy as 260 human laborers. He added that the North American grid is the largest, most complex machine every invented by humans, and noted that it has been a significant contributor to climate change given its reliance on fossil fuels for energy generation. Further, Dr. Terzic warned that our increasing reliance on the grid makes the United States increasingly vulnerable to cyberattacks.

A History of the Electric Industry

Dr. Terzic explained that the electricity industry has four components: power generation, transmission, distribution, and marketing to consumers. Prior to the late 1980s, the electricity industry in every state was vertically integrated, with utilities having monopoly power over all components of the production and distribution process. Since that time, however, these functions have separated, and it is possible for different companies to control power production, transmission, distribution, and marketing, a model that has taken hold in many states.

Regulating Electricity

Dr. Terzic delineated the roles played by state and federal regulators in managing electricity distribution. Retail electricity is overseen by state public service commissions, including the building of plants and transmission lines, the quality of service, connection and disconnection, and approving investments by utilities. The wholesale market, governing sales between utilities, is regulated by the Federal Energy Regulatory Commission (FERC). Unlike most industries, the wholesale electricity market has not undergone deregulation since it was established in the 1930s. Unlike in the competitive financial, real estate, or commodity markets, FERC regulators can set prices, order refunds, and otherwise intervene in or overrule market transactions and dynamics. Wholesale markets are regional, with the largest ones covering California, New York, the Mid-Atlantic, the Northeast, and the Midwest, respectively. The Texas grid, run by the Electricity Regulatory Commission of Texas (ERCOT) is not connected to the rest of the North American grid, and as such is regulated by the Texas Public Service Commission rather than FERC. Further, some regions, like the Southeast and Northwest, do not have regional wholesale markets at all.

Beginning in the late 1980s, fifteen states began creating competitive retail markets, as a result of technological advances and a growing belief that utilities were being inefficient in their construction of power plants and exceeding costs in developing nuclear facilities. This move transferred retail market regulation from the state to the federal level, but did not result in deregulation. Under this system, utilities had to sell of their generation facilities and focus on production and distribution. They now could deliver power to customers for a regulated fee, and power generators competed for the right to sell wholesale to utilities.

Dr. Terzic described the roots of utility regulation, which stem from the “Wisconsin Idea” championed by Wisconsin Governor Robert LaFollette in 1912. The Wisconsin Idea held that in the absence of market signals, independent experts free of political pressure could scientifically determine the fair value of a service provided by a monopoly. Originally designed to deal with monopolized railroads in an era where 80 percent of the population were farmers who relied on railroads to ship their crops, this model was extended to telephone service, electricity, and natural gas during the 20th Century.

Dr. Terzic then discussed the process by which regulators manage utilities. He characterized utilities as having the same four cost categories as any other enterprise. The first, operations and maintenance, includes research and development spending. The others are depreciation, taxes, and returns on investment, the last of which is defined as the

initial level of investment multiplied by the weighted average cost of capital. Dr. Terzic highlighted that R&D spending, depreciation of obsolete equipment, and overall investment are all relevant to innovation. However, he noted that regulators generally do not consider R&D to be a normal expense for utilities.

Barriers to Innovation by Utilities

Dr. Terzic identified three barriers facing utilities that discourage innovation. The first is the requirement that all R&D be approved by regulators. Because any investment requires risk due to the possibility of the new technology not working, firms need the possibility of greater market share and higher revenue as a reward for their investment decision. However, because utilities' rates are regulated, they are unable to capture any additional revenue from their investments, and in fact their competitors benefit from adopting new technologies that result from this investment without spending on research.

A second barrier to innovation is the requirement of regulator approval for general operation and maintenance spending. Because of the mistaken belief that retailers do not invest in R&D, regulators are reluctant to allow utilities to raise their rates to cover R&D expenses, especially in light of pressure from consumer advocates. In this vein, Dr. Terzic cited Wal-Mart's opening of a research facility in India in 2011 as evidence that retailers do conduct R&D research.

The third barrier Dr. Terzic identified is regulators' reluctance to allow for quick depreciation of technology that becomes obsolete, again because the costs of replacing equipment must be recouped in the form of higher rates. He discussed his academic paper, "Innovation Requires Capital Recovery Recognition," in which he argues that the unwillingness of regulators in large cities to recognize the obsolescence of third-generation telecommunications infrastructure led to them receiving digital telephone service a decade after rural areas and small towns did. Utilities in these areas, which were still on first-generation technology, had their investment requests approved because the obsolescence of their technology was more obvious to regulators.

In spite of these obstacles, Dr. Terzic noted that some states provide support for research in electricity generation. However, he said this funding pales in comparison to the support that was formerly provided by federal and state governments for such research from the 1970s to the 1990s. State regulators formerly approved funding for the Electric Power Research Institute, and the federal government used a surcharge on the transmission of natural gas through pipelines to fund the Gas Research Institute. However, with the move to competitive markets for wholesale electricity and natural gas, both institutes were dismantled as power generators claimed the funding for these projects was eroding their revenues. Dr. Terzic disagreed with this contention, and noted that there is nothing stopping either FERC or state public service commissions from reestablishing these policies.

Lateral Transfer and Innovation

Dr. Terzic discussed the importance of lateral transfer, identified by the author Arthur Koestler as the process by which innovations in one area are adopted by another sector that sees uses for technology beyond its original purpose. He gave examples of such transfer throughout history, including Darwin's Theory of Evolution, Gutenberg's printing press, and Johannes Kepler's synthesizing physics and astronomy to develop a theory of orbit trajectories that resolved major issues in astronomy. These came from combining two earlier theories, the wine press, and the theological conception of the trinity, respectively. Dr. Terzic then provided three examples of lateral transfer in electricity technology, one of which was ambiguous in its impact and two of which were positive.

The first example of lateral transfer in electricity generation was the adaptation of nuclear reactors on submarines for terrestrial power generation. Here, Dr. Terzic noted that while reactors on submarines had to be small, compact, and light, the main concerns for nuclear power plants simplicity, cost, and reliabil-

ity. He speculated that the nuclear industry would have fewer problems than at present if they had designed purpose-built reactors from scratch rather than trying to adopt naval technology.

On the positive side of the ledger, Dr. Terzic discussed how utilities realized that jet engines from aircraft were a highly efficient source of power generation. Although initially only used to support peak usage, gas-fired jet turbines eventually became the predominant means of generating power at fossil-fuel based plants due to their superior energy efficiency. Finally, lithium ion batteries, developed for telephones, formed the basis of electric vehicles, including Tesla, which aggregated thousands of light, energy-dense, and portable batteries to produce electric motors for its cars. This innovation was then used to spur research on batteries that can store intermittently generated renewable energy, like solar and wind energy. Dr. Terzic observed that for electricity generation, concerns about weight, energy density, and portability were secondary to cost, reliability, and non-toxicity.

The Next Grid and Questions of Ownership

Dr. Terzic outlined the future of the electric grid, which he said would be characterized by far more devices requiring access and by two-way flow, as households will be able to generate their own energy that could flow into the grid. He mentioned that many cities have declared moratoriums on new natural-gas powered homes, and warned that significant improvements in AI and rebuilding of infrastructure were necessary to safely manage this new reality. He also raised the question of ownership of the infrastructure for this new grid, and whether utilities should own all the components or if private individuals should own some of them. He cited the FCC's refusal to allow local phone companies to install cable lines as a reason for the delayed introduction of cable television, following pressure from Hollywood.

Issues in Technology Development

Related to the future of energy are the stakeholders in the development of new technology. Dr. Terzic praised the Advanced Research Projects Agency-Energy (ARPA-E) for its work funding revolutionary ideas in energy generation, transmission, and storage that are too early to attract private investment. He also emphasized the importance of the national laboratory system in developing new energy technologies. Dr. Terzic added that while he supported nuclear energy, there are serious concerns about the long-term impact of nuclear waste and the cost of building new nuclear plants that must be addressed.

Incentivizing Investment

Dr. Terzic closed his remarks by identifying policy levers for encouraging innovation by utilities. These include tax and regulatory incentives to make capital investments and official recognition that R&D expenses are a legitimate cost of service for utilities, allowing them to recoup them through higher rates. He even suggested requiring utilities to include R&D spending as part of their operations and maintenance expenses, and also suggested federal partnerships for research as a means of spurring innovation. Finally, he called for better recognition of obsolete technology by regulators, to allow utilities to depreciate outdated equipment more effectively. Mr. Bill Bates noted that Dr. Terzic's recommendations on legitimizing R&D rate increases and depreciation were previously supported by the Council in Accelerate (2018), but that they remained relevant for the group's consideration. Dr. Rao Unnava of the University of California, Davis asked if marketing and social cause contributions by utilities were considered part of the utility's returns or if they came out of maintenance and operations. Dr. Terzic said that regulators allow utilities to include these expenses as part of operations and maintenance when they are aimed at consumer research to improve reliability or customer service, but not for boosting sales or other purposes.

Policy Changes and Pushback

Mr. Bates asked what the political obstacles were to implementing the recommendations Dr. Terzic outlined. He responded that because utilities are the only service providers whose ability to raise prices is affected by public testimony, people blame utilities for adding to increased costs of living that are primarily the fault of other sectors raising their prices. He said it was crucial to illustrate for the public how investments by utilities in replacing depreciated equipment and conducting R&D would lead to improvements in energy generation and transmission that would benefit them in the long run. He noted that the "Wisconsin Idea" included the right of regulators to raise rates if they felt it was in the public interest.

Ms. Julie Meier Wright of Collaborative Economics discussed the issues of Consumer Choice Aggregators (CCAs), which act as intermediaries for buyers of electricity by making purchasing decisions on the behalf of consumers. She noted that these entities compel participation from customers and do not produce any energy themselves, making them a likely target for public resentment if they implement unpopular policies, like purchasing more expensive renewables and raising rates. Dr. Terzic agreed that involuntary membership in CCAs was an issue, and characterized them as a "solution looking for a problem." He noted that individual buyers already have the right to purchase energy from particular sources if they want to, and that CCAs justify their decisions as being based on optimal long-term public policy.

Mr. Bates asked if the federal government could intervene to supercede patchwork state responses to utility R&D, and Dr. Unnava asked if it was necessary to develop an entirely new management framework instead of shoring up the old system. Dr. Terzic said there was precedent for federal intervention in the Public Utility Regulatory Policies Act (PURPA) and Fuel Use Act, both in 1978. Intended to prevent the exhaustion of natural gas and oil supplies, these acts forbade the use of natural gas for any purposes other than home heating and cooking, required states to build power plants with nontraditional fuel sources, and began introducing competition to power markets. They also required states to investigate inverted or flat utility rates, real time pricing, and other energy management policies.

Broadband Infrastructure

Dr. Ken Poole of the Center for Regional Economic Competitiveness asked why there was insufficient political will to provide universal broadband access in a similar fashion to previous efforts at rural electrification. He wanted to know if there were restrictions preventing broadband companies from using the same infrastructure that was used for the transmission and distribution of electricity to install fiber optic lines. Dr. Terzic said that while a majority of the 3200 utilities in the United States are rural cooperatives financed by specialized federal agencies or municipal corporations, the 200 investor-owned utilities supply 70 percent of America's electricity market. He

compared this to the situation in the telecommunications industry prior to the breakup of AT&T, in which most of the 2600 telephone companies were locally owned and operated, resulting in a federal program to install "last mile" telephone service in rural areas. He suggested a similar program for broadband access, and doubted that the capacity of the existing infrastructure to handle fiber optic cables was an issue. He noted that the COVID-19 pandemic had laid bare the problems with widespread internet access in the United States, and that questions remained about what speed of broadband transmission was needed.

Cyber Vulnerability and Government Responses

Ms. Wince-Smith asked about the United States' increasing vulnerability to cyberattacks, and Dr. Branden Brough of Lawrence Berkeley National Laboratory asked what role ARPA-E and the national lab system had in maintaining and securing America's electric grid. Dr. Terzic said that as more devices come to rely on the electric grid, an attack disabling it would have increasingly dire consequences. He warned that new digital grid technology could not be manually restarted following a cyberattack, further increasing vulnerability to actions by nations such as Russia, China, Iran, and North Korea. He cited the example of Russia planting software in the Ukrainian grid that it used to remotely trigger a grid shutdown in December of 2017 as an example of the kinds of enemy actions that could paralyze the United States, and noted that during the COVID-19 pandemic cyberattacks had increased fourfold. Dr. Terzic praised the concerns of both utilities and government agencies, including the Departments of Defense and Homeland Security, ARPA-E, and the National Laboratories, for their investments in combating these problems. He said that the most important step for the United States to take was to make it clear that cyberattacks aimed at our financial system, water supply, grid, or other critical infrastructure will be interpreted as acts of war, and responded to in the same fashion as a missile strike. Ms. Ann Gabriel of Elsevier said that academic publishers are increasingly turning their attention to cyber vulnerabilities on platforms like SciHub.

Concluding Thoughts

Ms. Wince-Smith thanked the participants for their discussions, and Mr. Evans reminded the group again about forthcoming changes to the Working Group discussion process. Ms. Trimble reminded the group that next week's calls will feature presentations from Dr. Ken Poole of the Center for Regional Economic Competitiveness. Ms. Wince-Smith also asked how the country could use the opportunity for reform in the wake of the COVID-19 crisis to accelerated the development of a national integrated, self-healing smart grid.

Working Group 3 Calls May 12

Introduction

The Honorable Deborah L. Wince-Smith and Ms. Kathy Trimble welcomed the group. Ms. Wince-Smith noted that the Council was affiliated with several experts in regional innovation, and that it was crucial to develop a strategy for regional diversity and inclusive growth going forward. Mr. Chad Evans also expressed interest in the day's discussion topic, adding that it was a passion of the Council and that he also wanted to discuss investment and infrastructure needs at the regional level. Ms. Trimble then introduced the featured speaker, Dr. Ken Poole of the Center for Regional Economic Competitiveness.

Overview and Framing of Regional Innovation Challenges

Dr. Poole opened his remarks by discussing the importance of recognizing that the U.S. economy is comprised of hundreds of regional economies, something he said was illustrated in the widely differing effects of the COVID-19 pandemic and the resulting economic crisis around the country. He said that while universities, the private sector, and nonprofits all play a role in building regional innovation ecosystems, state and local governments play an especially important role. While some of this is through their regulatory regime and business environment the principal impact they have is in their efforts to

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Ms. Anne Tucker
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The Honorable Deborah L. Wince-Smith

Mr. Chad Evans

Mr. Bill Bates

Ms. Kathy Trimble

Mr. Gourang Wakade

Mr. Chris Reigelsperger

Mr. Tim Planert

develop and support new technology and transition it into the marketplace. He characterized the roles state governments play along six broad categories: investment in applied research, technical workforce development, infrastructure, technology diffusion, equity capital markets, and equity of access.

Investment in Applied Research

Dr. Poole discussed the ways in which states and regions help to commercialize technology and facilitate its adoption within the regional economy. He noted that universities were an important part of this process, and also cited state-level initiatives like Pennsylvania's Ben Franklin Partnership and Ohio's Third Frontier. He said many of these initiatives are cluster-focused and concentrate on developing technology important to a sector that is already established in the region, like the Water Council in Milwaukee, Wisconsin that draws on the city's proximity to the Great Lakes. Dr. Poole also identified New York's 28 regional Centers of Excellence around individual technologies, the BioStL initiative in Missouri, and the Oregon Innovation Council as state-based technology efforts. These projects generally start as government-funded initiatives but grow to include private financing as part of a public-private partnership model.

Technical Workforce Development

Addressing the skills gap and improving technical curriculum is a major challenge area for states. Dr. Poole cited curriculum that lags technological advances, siloing of nontraditional students and traditional curriculum from technological advances, insufficient engagement with industry, inadequate digital literacy, and a lack of response to the growing need for skill hybridization as contributors to workforce development challenges. He emphasized the importance of the K-12 system and of regional colleges and universities to fostering technical skills, and said the system was suffering from a "missing middle." However, Dr. Poole said that states were in the process of modernizing their curriculum, developing models to give credit for experience and reduce classroom time, and secure greater input from the technology sector in overhauling their curriculum.

Related to these issues, Mr. Evans discussed the Council's membership in Science Is Us, a coalition of over a dozen national organizations working to highlight the importance of investment in and promotion of STEM in the educational system. He noted that STEM fields account for $2.3 trillion in annual federal tax revenue, 69 percent of U.S. GDP, and nearly two thirds of all jobs. Further, 59 percent of STEM workers don't have bachelor's degrees, illustrating the outsized role that technical education plays in the U.S. economy.

Infrastructure

Dr. Poole highlighted three major infrastructure challenges to innovation: energy, broadband internet, and air transportation. He said that states were already investing heavily in clean energy technology, contributing $700 million in direct investment in 2019 and $900 million in 2020. States are investing in a variety of technologies in order to establish regional advantages in particular sectors and target funding to areas that would not otherwise attract private capital. Dr. Poole also stressed the importance of smart grids to innovation.

Broadband access has proved a major challenge for regional development, especially in rural areas, and Dr. Poole warned that because of data collection flaws, the problem is likely worse than is currently reported. He said that the FCC considers an area to have access based on proximity to regional broadband infrastructure, rather than verifying whether or not residents can access the system. This is further exacerbated by the lack of competition in many areas that do have broadband access, with only one provider whose costs and quality do not induce high adoption rates.

Another infrastructure challenge is air transportation. Dr. Poole said that many areas are not near airports with flights to a wide variety of areas, and that air service concentration leads to over-congestion in certain areas and lack of access to investment opportunities for others. He warned that venture capital and outside investors are not interested in regions they must take multiple flights to reach, and without in-person networking and knowledge transfer, innovation and investment are stifled.

Technology Diffusion

Dr. Poole discussed two large initiatives in regional technology diffusion. The Manufacturing Extension Partnership, which includes 1400 field agents in all 50 states and has been in operation for more than three decades, provides valuable assistance in helping manufacturers adopt new technology. However, Dr. Poole said the program's $140 million budget is not sufficient, and noted that the Obama administration tried to double the program's funding but could only secure a small increase. The Manufacturing Extension Partnership embeds staff into regional centers to identify new technology that is particularly relevant to smaller companies. Another program is the National Manufacturing Innovation Institutes, which are currently a patchwork of regional initiatives. Dr. Poole said the goal for this program is to scale up to the national level.

Equity Capital Markets

The concentration of venture capital into a handful of markets in recent years has been a driver of regional divergence in economic growth. From 1995 to 2015, the share of venture capital investment in Boston, New York, Silicon Valley, and Los Angeles went from 51.4 percent to 77.8 percent. Dr. Poole characterized this shift as stemming from the venture capital's desire to find quick, high returns, and lack of interest in "patient" capital. He outlined several different junctures for state intervention from early stage seed funding up to commercialization, but said there were several "valleys" in the development process, all of which revolved around scaling. Dr. Poole described several policies states use to attract investment, including tax credits for R&D and angel investing, product development grants, and ecosystem support, including funds to increase capital and programs designed to mentor in-state talent to invest in and manage equity capital. He also discussed the provisions for state support of venture capital in the 2010 federal stimulus bill, which provided $1.3 billion to states before its provisions expired.

Equity of Access to Innovation

Finally, Dr. Poole outlined the ways in which states seek to increase access to innovation networks and ecosystems. States engage in initiatives to encourage new entrepreneurs through programs to recognize talent in underrepresented populations and through the creation of maker spaces and accelerators. They also use pitch competitions, reverse-pitch problem solving contests, innovation vouchers, and expedited prototyping programs to promote technology adoption and product ideation. Finally, states provide business management and technical assistance to help develop the expertise and experience necessary in the local population to fuel an innovation ecosystem.

Dr. Poole concluded his presentation by discussing the challenges he experienced in getting state and local governments to fund and support innovation initiatives, due to the perception that innovation only benefits metropolitan centers at the expense of other areas. Mr. Evans discussed the Manufacturing USA institutes, and the role they play in creating a "tapestry of capabilities", as well as a shared national innovation infrastructure that plays a key role in the development and application of products. He discussed a suggestion from a Working Group 1 discussion that the government pivot to funding technologies in the "valley of death", adding that even a small investment there could have a substantial impact.

The Importance of In-Person Networking for Innovation

Dr. Branden Brough of Lawrence Berkeley National Laboratory wondered if the COVID-19 pandemic would change the value of in-person interactions to innovation. He observed that technology meant that entrepreneurs could pitch their ideas remotely rather than in-person, and added that while physical meetings were still preferable, using remote meetings as a complement could reduce the need for travel. Mr. Evans responded that the question was an interesting one, but noted that research as found that unplanned, "water-cooler" meetings are as important to innovation as planned encounters. He said he would be interested in seeing any evidence that emerges on the value of virtual interactions.

Dr. Poole said that it was likely the role of virtual meetings with investors was going to grow even prior to the COVID-19 crisis, and added that while stakeholders should open to incorporating this technology, it would not completely replace the serendipitous interactions that are key to forming connections and building the trust necessary to encourage investment of money. He said that one reason venture capital investors want their firms to relocate is so they can have more face-to-face interactions, and that this relocation of talent is the biggest drive of venture capital concentration. Mr. William Eggers of Deloitte said that virtual reality technology, including online avatars, would soon make it possible to recreate the experience of physical meetings remotely.

Air Service and Transportation

The Honorable Branko Terzic identified the deregulation of the airline industry as the driver of air service concentration, noting that when airlines were no longer required to serve small areas to operate in larger areas, they eliminated most direct flights to those locations. Dr. Poole said that while some subsidy programs for air service still existed, the current "hub and spoke" model produced dual problems of congestion in some places and under-service in others, and said policy makers needed to think strategically about where to subsidize air service and the appropriate distance between major aviation hubs. Dr. Terzic also mentioned the potential of electric airplanes, which require less maintenance and fuel. Dr. Poole said these vehicles could serve as the basis for "air taxis" that would fly passengers to customized routes, similar to services like Uber or Lyft.

Mr. Eggers noted that Deloitte had done studies on passenger drones and flying cars, and Ms. Wince-Smith discussed the Council's engagement with Skyworks Global, which is working on similar technologies. Dr. Brough expected high quality embedded reality technology, like MagicLeap, would mature and scale before flying cars, but Mr. Eggers predicted flying cars and drones would start scaling within the decade, and even be accelerated by the COVID-19 crisis. Mr. Evans noted that many VR, AR, and XR companies were already joining to form a trade association.

The Effects of Recession on State Innovation Investments

Mr. Eggers asked what effects cuts to state budgets in light of the economic crisis would have on state and local programs to boost innovation. Dr. Poole predicted that these programs would be among the most severely affected, and that those that remained would primarily rely on fiscal policy, including tax incentives. He characterized this trend as ineffective since people are not motivated by tax breaks in the future during times of immediate economic distress. He also praised the State Small Business Credit Initiative from the previous economic downturn, as it re-energized technological investment and helped create new infrastructure in states that normally would not invest in it. Dr. Poole further cautioned that direct state investment in technologies carries concerns of "corporate welfare", and that elected officials prefer to invest in projects that have returns within an election cycle, rather than long-term efforts that could take a decade or more to bear fruit.

Developing Supporting Infrastructure

Ms. Wince-Smith asked Dr. Poole where he would invest if he could triple the Economic Development Agency's investment budget. Dr. Poole said that while there has been some discussion around picking a handful of locations for intensive investment, he would prefer to support the organizational infrastructure that brings together companies and technologies and allows for pre-competitive investment and development. He said that the agency has historically invested a lot in entrepreneurship and management training, but not in technology, and that providing support for cluster initiatives and infrastructure around convening and developing new technology would be the most valuable use of resources because these are areas regional governments struggle with.

Regional Innovation Initiatives

Ms. Christina Orsi of the University at Buffalo cited a Brookings Institution proposal to identify secondary markets with significant innovation indicators and directing intensive federal investment toward building up their regional ecosystems. She asked if this was an initiative the group should investigate or support. Dr. Poole said that he would not want federal officials picking the regions to invest in because so much of the necessary structures for successful regional innovation projects are outside of their control. He said any such program would need to identify regions that had already established the capacity and commitment to making an initiative work in specific technology sectors. Ms. Orsi said such programs could include funding requirements and other signs of commitment and infrastructure, and Dr. Poole noted that while states like New York, Pennsylvania, and Ohio have made serious investments in innovation, other states have talked about it but have not put up the resources. He said there was growing pushback against programs that did not provide proof of results, and urged the development of metrics and objectives to meet before proceeding with any projects.

Broadband Access

Ms. Vickie Lonker of Verizon discussed challenges in extending broadband access. She said that Verizon had had surprising success in providing wireless service for remote work and education, and urged against treating broadband like a utility. She said that competition was essential to ensuring continued innovation in broadband technology, and cited the improvements made in satellite, fiber, 5G, and other technologies in competitive broadband markets. Ms. Lonker discussed the challenge of securing long-term regional support for a public-private partnerships to develop broadband infrastructure, noting that new administrations led to changes in support or objectives.

Mr. Thomas Dailey of Dailey Strategic Advisors LLC and formerly of Verizon mentioned the challenges his clients have had in getting support from the FCC in organizing a joint bid with other small firms to put together a broadband system in rural areas. He said many small companies often have parts of the needed infrastructure and could connect all the components by partnering with each other, but they lack the platform to do so. He added that part of the challenge is in figuring out ways to make broadband access economically viable, noting that all potential broadband technologies, including satellite technology, have limitations. Mr. Dailey said that other regulatory requirements also get in the way of technology deployment.

Dr. Poole said that his organization has worked with clients in Appalachian who are unable to work from home during the crisis because of insufficient broadband infrastructure. He again warned that inadequate FCC data was painting a misleading picture of broadband access and making it impossible for these regions to secure assistance because they are incorrectly deemed to already have access. He urged investment not only in "last mile" broadband infrastructure, but also "middle mile" infrastructure, and said that if the United States was able to put electricity in every household, it should be able to do the same for broadband. He concluded by observing that many stakeholders are frustrated by the lack of a clear path forward under the current regime of federal program execution.

Concluding Thoughts

Ms. Wince-Smith closed the discussion with a description of the heavy-handed approach China took to economic development in Shenzhen, near Hong Kong. Due to heavy subsidy and a long tax-free period for manufacturing investments, the region went from empty fields to a metropolis home to nearly every major multinational company and boasting high tech manufacturing and supercomputing facilities. She said that while the approach the Chinese government adopted clashes with American values and culture, it was important for the United States to be similarly bold in generating inclusive economic transformation, rather than making incremental improvements. She noted that there were trillions of dollars sitting in hedge funds and private equity that could be deployed to revitalize growth across the country, allowing the United States to leapfrog into the future. While agreeing that universal broadband was key to regional development, she noted that the Economic Development Administration also had money and functioned as a signal to the market with its investment decisions. Finally, she challenged the group to come up with bold ideas to discuss at the next session on Thursday.

Working Group 3 Calls May 14

Introduction

Mr. Bill Bates and Ms. Kathy Trimble welcomed the group to the call, and introduced the feature speaker, Dr. Ken Poole of the Center for Regional and Economic Competitiveness. Mr. Bates noted that the issue of regional innovation was of particular importance and interest to the Council, and that he looked forward to hearing Dr. Poole's policy recommendations for developing regional innovation ecosystems.

Framing Remarks

Dr. Poole said that because the national innovation ecosystem is so vast and complex, it would be like "boiling the ocean" to address it in totality, and emphasized the important role that different states and regions play in fostering their local innovation ecosystems. He noted that while most of his remarks were centered on states, the private sector, nonprofits, laboratories, and universities also played a role in regional innovation policies. Dr. Poole said that while states exert some influence on innovation through their regulatory regimes, they primarily impact innovation ecosystems through focused investment in developing components of those ecosystems that are targeted to local or regional interests. He grouped this issues facing states and other sub-national governments into six broad areas: investment in applied research, the skilled technical workforce, knowledge sharing infrastructure, technology diffusion, capital concentration, and equity in capital access.

Investment in Applied Research

Dr. Poole said that states focused on commercializing research and in generating and disseminating new ideas in areas of economic need. He gave the example of university research centers of excellence,

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The Honorable Olin Wethington
Wethington International

Mr. Bruce Sommer
University of Illinois Springfield

Dr. Roland Stephen
SRI International

The Honorable Branko Terzic
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which are guided by both federal and industry priorities, and which direct investment into locally relevant research. He also discussed state and regional technology partnerships, including Pennsylvania's Ben Franklin initiative and Ohio's Third Frontier program. Dr. Poole then discussed state and regional cluster initiatives, which are pre-competitive alliances in industry to research solutions to common challenges and means of aggregating markets and product demand. Examples of these specialized initiatives include the BioStL program in Missouri, the Oregon Innovation Council, and New York's 28 centers of excellence spread throughout the state.

The Skills Gap and Technical Education

Dr. Poole discussed several problems with existing technical education programs, and emphasized that middle-skill positions were at least as important to the technical workforce as PhDs and entrepreneurs. Among the challenges he cited were curriculum that lags technological advances, a lack of response to the demand for hybrid skill sets, the siloing of non-traditional students and traditional curriculum from technological advances, insufficient digital literacy, insufficient engagement with industry, and workforce development boards that are not responsive to the needs of industry. Dr. Poole said that regional colleges and the community college system are crucial to the technical education pipeline, and that states are currently undertaking many initiatives to overhaul the technical education system. These include changing the governing structure of workforce boards to make them responsive and accountable to industry, improving and emphasizing STEM curriculum, increasing the amount of technology in the classroom, overhauling curriculum with industry input, and recognizing experiential learning and competency with credentials that allow students to accelerate their degree programs.

Knowledge Sharing Infrastructure

The three major infrastructure challenges Dr. Poole discussed were those of energy, the internet, and air service. He said that clean technology and smart grids have affected which technologies society prioritizes and revolutionized how companies are delivering and accessing energy. He highlighted the massive urban/rural divide in broadband access, and said that existing data understated the extent of the crisis because of poor data collection methods used by the FCC that overestimate broadband connectivity. He further added that areas with broadband service often have no competition between providers, and that high costs and lack of perceived need lead to low adoption rates in many parts of the country. Air service is highly concentrated in metropolitan centers, which makes the in-person interactions and knowledge exchange that are crucial for sparking innovation and providing the networking with funders that entrepreneurs need much more difficult for people living in rural areas. While technology can help connect people outside of the major venture capital hubs, it will never replace physical meetings, and before the COVID-19 pandemic large airline hubs were congested while regional air infrastructure was underutilized.

Technology Diffusion

Dr. Poole said states spend significant resources on diffusing existing innovations to markets, and highlighted two programs in particular. The Manufacturing Extension Partnership, a project of the National Institute for Standards and Technology (NIST) consists of 51 centers in all 50 states and Puerto Rico, with 1400 experts working with local manufacturers to help them adopt new technology and smart business practices. The Manufacturing USA institutes consist of 14 industry-based centers that develop technology and connect smaller companies with innovations. There has been some connection between these two programs, with Manufacturing

Extension Partnership field agents embedding in Manufacturing USA centers, but overall there is no unified strategy for deploying these resources, resulting in a "scattershot" approach across agencies.

Capital Concentration

Another major challenge for states is attracting venture capital funding outside of hotbeds like Silicon Valley, New York, Los Angeles, and Boston. Dr. Poole noted that between 1995 and 2015, these four regions went from attracting 51.2 percent of all venture capital investment to 77.8 percent of all venture capital investment. He said this was driven by venture capital's search for fast, high returns, which are more common in software than in the long-term, patient investment opportunities found in other regions of the country. Dr. Poole said states have multiple potential points for intervention, and that there were multiple bottlenecks where venture capital concentrated, including in the later stages of product development. In response, states are increasingly funding early-stage research and development, but struggle with scaling issues because the small investments they make do not attract high levels of venture capital. Those projects that do get funded often face pressure to relocate to be nearer their funders. Of note, Dr. Poole said the most common tool for states to attract capital is fiscal policy, which is challenging during an economic downturn when the tax base is dwindling. However, he also praised state efforts to build management capacity and keep talent home, in order to develop venture capital ecosystems locally. These efforts attempt to use, develop, and keep equity funding within particular communities.

Equity in Capital Access

Dr. Poole discussed state efforts to broaden the demographics of entrepreneurship. States are developing maker spaces and accelerators, along with networking programs, designed to find and foster entrepreneurial talent from underrepresented communities. Other initiatives include pitch competitions, innovation vouchers, and other programs designed to promote technology adoption and product ideation. States are also investing in providing business management and technical assistance, to help members of underrepresented groups turn their ideas into business propositions, attract funding, and effectively manage startups. These initiatives also include cyber awareness and preparedness training.

Ten Recommendations for Addressing Regional Competitiveness

Following a charge from Tuesday's session, Dr. Poole listed ten recommendations to bolster regional competitiveness. First, he advocated making regional innovation a high priority on the national innovation agenda, and urged the development of good metrics to demonstrate the value of widely distributed innovation. In this vein, he also advocated significantly expanding the Economic Development Administration (EDA)'s Build Regional Innovation Systems to Scale program, and tied it into a proposal by the Information Technology and Innovation Foundation and the Brookings Institution to invest significant capital in "second tier" metropolitan areas to turn them into innovation hubs. Dr. Poole suggested modifying this proposal to one of matching funds for emerging cluster networks with partners in the state or metropolitan area, and to spread funding to as many areas as possible. Third, Dr. Poole advocated expanding federal and state investment in boosting technical development and deployment capacity among small firms. This would also require a massive expansion of scouting, rapid prototyping, and technological problem solving for manufacturers. Fourth, he suggested expanding the SBIR program, with a particular focus on Minority/Women-Owned Business Enterprises (MWBEs). A fifth recommendation was the creation of a new federal equity capital bank, modeled after the State Small Business Credit Initiative created in 2010 that phased out in 2017. This program would include $10 billion in funding over 10 years to leverage state partnerships with the private sector to invest in underserved regions.

Dr. Poole's sixth recommendation was creating a federal broadband authority that leverages state programs and public-private partnerships to achieve universal broadband access. He said that if the government was able to electrify every household in the United States, it should be able to implement broadband in every household. He said rural areas in particular needed stable broadband, and that wireless was not doing an adequate job, while 5G was likely to pose geographic challenges. Dr. Poole also called for better distributing air service to second-tier metropolitan areas, and for better ground connectivity between second tier areas and major airline hubs. As part of this, he recommended turning local airports into logistics centers. To boost workforce development, Dr. Poole called for $500 million in funding for competency-based technical education. He noted that most companies, especially for middle-skill positions, care more about particular skill sets than they do credentials. Relatedly, Dr. Poole's ninth recommendation was to create a fast-track student loan forgiveness program for students willing to teach in-demand STEM skills to underrepresented regions at the K-12 and community college levels. Finally, Dr. Poole called for place-based immigration visas to generate a flow of talent and economic activity to rural areas and small towns, revitalizing areas in demographic decline.

Causes of Startup Failure and Stagnation

Dr. Rao Unnava of the University of California, Davis asked how many startups that failed in the "Valley of Death" simply didn't have marketable ideas, and how many died because of insufficient access to working capital or network connectors. Dr. Poole said that often companies, don't die, but their ideas stagnate and never turn into products because they cannot get audiences with the funders who could help them realize their ideas. Dr. Roland Stephen of SRI International said there were multiple bottlenecks facing startups, including early and later on in the process. He stressed the importance of business talent to successful startups, noting that a great idea isn't the same thing as a great product. He also listed funding gaps as a major obstacle for startups. Dr. Stephen also observed that the regions of the country outside of venture capital hotspots are often better suited to actually scale products than those hubs are themselves. These regions have factory facilities and skilled workforces, but most startups productize overseas. He encouraged forging connections between these regions of the country, and said the shock to supply chains from the COVID-19 crisis may provide an opportunity to jumpstart that process.

Barriers to Entrepreneurship for Women and People of Color

Ms. Rachel Jagoda Brunette of the Lemelson Foundation said that many women and people of color report the lack of an adequate safety net for entrepreneurs as the biggest obstacle to their starting a business. She noted that leaving an employer to found a startup means giving up benefits like healthcare or childcare, and asked how providing more of those resources could mitigate risk in an innovation ecosystem, and if there were regions that could serve as models for these programs. Dr. Poole said childcare was an especially important issue, due to the undersupply of quality childcare at affordable prices, and he said subsidization would likely be required. He also observed that the increased unemployment benefits during the COVID-19 pandemic would be sufficient to allow people to become entrepreneurs rather than immediately look for a job, and expressed interest in watching whether the economy sees a surge in entrepreneurship after the crisis ends. He also agreed healthcare was a major obstacle to entrepreneurs leaving their existing jobs, but said he wasn't sure exactly what policies would best address these issues. Dr. Stephen said that healthcare needed to be decoupled from employment, and Dr. Poole agreed while adding that transportation issues for lower-income people were also a concern. He said that there are quite a few people from lower socioeconomic strata who have ideas but do not have the financial security to turn them into businesses. Ms. Jagoda Brunette said she was glad the group was discussing these issues, because regulatory issues that affect people's ability to mit-

igate risk have significant downstream effects on entrepreneurship, even when they don't appear to be directly connected.

Fiscal Constraints and the Need for Prioritization

Ms. Meier Wright said that due to the fiscal stresses to both states, which have to balance their budgets each year, and the federal government, it was not going to be possible to implement all of Dr. Poole's recommendations in the short term. She encouraged the group to think of ways to prioritize them, as well as turn their focus to state-level initiatives, as she did not see the political will or interest in innovation policy at the federal level right now. Dr. Poole agreed on the need to prioritize, but noted that the government is currently spending large amounts of money without an overarching strategy or careful consideration. He said many initiatives could be funded by redirecting existing spending to more considered ends. Ms. Choi added that many rules and regulations with a profound impact on the innovation landscape do not cost anything to change, such as altering the eligibility rules for SBIR/STTR grant recipients. She said that current bylaws force university employees who spend a majority of their time working for startups that spin out of university research to lose their eligibility for university employer benefits, discouraging researchers from becoming entrepreneurs. Dr. Stephen said this was emblematic of the federal government's tendency to err on the side of overregulation to keep people from taking advantage of federal funding. He said he would rather see a system that was more open ended, even if it led to more abuse, because it would not throttle entrepreneurship and innovation with a "thicket" of regulations.

The Credibility and Messaging Challenge

Dr. Poole said that one of the biggest challenges in getting support for innovation initiatives at the state level was that previous initiatives did not result in the benefits, especially new jobs, that politicians were promised. He discussed Utah, which shut down its innovation initiative after its promoters failed to provide evidence of new jobs created, which he characterized as a misrepresentation of the real benefit of innovation investments. He urged the group to improve upon current messaging around the economic outcomes of innovation investment, including training the workforce of the future and extending capital to small businesses. He noted the political pressure to enact policies with immediate effects, and offered these metrics, as well as greater broadband access, as relevant innovation initiatives with the time horizons necessary to interest office holders. Ms. Meier Wright agreed that the proponents of innovation have created credibility problems by "promising things in the wrong way," as Dr. Poole put it. She described California's ongoing $3 billion stem cell initiative that touted results within six years, even though it normally takes a decade or more for life sciences investments to come to fruition.

Broadband Access

Ms. Meier Wright said that the challenges in transitioning to remote work and education during the COVID-19 pandemic were highlighting the need for better broadband connectivity. She said it should be very high on the group's list of priorities, and warned that the "last mile" on infrastructure installation was currently not economically feasible for the private sector. Dr. Poole said he was facing similar challenges working with Appalachia, and emphasized the role connectivity plays in connecting talented people outside major urban centers to the tools they need to realize their potential. Ms. Choi added that the United States could not achieve an inclusive, technology-driven economy without equitable broadband access. Mr. Bates observed the juxtaposition in the discussion between the need for greater broadband access and the need for more air service. He discussed the challenges facing airlines, including discontinuations of service and layoffs, which he said could exacerbate air service challenges in smaller areas while also making broadband access even more important.

Concluding Thoughts: Framing Recommendations

Mr. Bates said that the idea behind this phase of Working Group calls was to generate a broad universe of potential recommendations, and then whittle down specific priorities after receiving feedback from the Commissioners and transitioning to a model of co-chair led discussions. He added that the Commissioners' mandate was for impactful, bold ideas, but said the group needed to include both short-term and long-term solutions. Dr. Poole said that in his recommendations he had opted not to incorporate fiscal constraints, but instead focused on what scale new and existing programs would need to reach to make a measurable impact. He cited the Economic Development Agency's Build Regional Innovation Systems to Scale program as an example of a program that was too underfunded to make a difference at just $20 million annually. He further added that several other agencies had similar programs that were scattered and underfunded. Ms. Meier Wright suggested framing the report as a response to a charge for big ideas, prioritized according to the immediate conditions created by the COVID-19 pandemic. She also urged including details on how to build accountability into and guarantee returns on investment for new programs. Ms. Choi said the group should be clear about the current funding needs and desired future funding levels programs, especially those administered by the states, will require. Dr. Poole observed that as large as the numbers being discussed were, the U.S. economy is $20 trillion annually, and that it wasn't possible to steer something so large with lightly funded programs. He added that by better leveraging metrics, the group can best illustrate the positive impacts of programs and build support for them. Ms. Trimble said that these themes were emerging in the discussions of the other working groups as well, but from different angles.

Working Group 3 Calls May 19

Introduction

The Honorable Deborah L. Wince-Smith and Ms. Kathy Trimble welcomed the group, and Ms. Wince-Smith introduced the featured speaker, Ms. Julie Meier Wright of Collaborative Economics. Ms. Wince-Smith discussed Ms. Meier Wright's extensive experience in the field of innovation-led economic growth, including her service as Secretary of Trade in the administration of former California Governor Pete Wilson, where she had a substantial impact on the business environment for high-value investment and job creation. Ms. Meier Wright also served in economic development agency, of the city of San Diego, which has long been a leader in fostering a regional innovation ecosystem, and was studied by the Council in 1999 as part of its initiative on regional innovation.

Featured Remarks

Ms. Meier Wright opened her presentation by emphasizing the importance of the Council's work in encouraging national competitiveness, and noted that this imperative resonates with both political parties at all levels of government. She reminded the group that competition is global, and that competitiveness challenges require sustained effort to solve. However, she also urged action in areas like immigration reform, where policy changes could yield an immediate competitiveness impact. Ms. Meier Wright warned against complacency, noting that Britain had dominated the 19th Century as an unquestioned economic and political leader just as the United States had done for the 20th Century, but eventually ceded its global leadership. With China seeking to dominate the 21st century in a similar fashion, the United States cannot assume it will escape relative

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decline if it does not take steps to ensure its own competitive standing. She also cautioned that competitiveness cannot be based on wishful thinking, lest regions waste millions of dollars on futile initiatives. She said she hoped to build her presentation on the remarks of Dr. Ken Poole of the Center for Regional Economic Competitiveness, who presented last week.

Ms. Meier Wright said that avoiding wishful thinking required an inclusive convening process featuring the right people and leaders, using good data and metrics, and focused on what is real, sustainable, and fundable. She emphasized the importance of location, even arguing that "the place is the product" and warning that a flawed regional ecosystem means a loss of market share or economic failure. She added that currently just 1 percent of U.S. counties account for 30 percent of all economic growth. To build regional innovation ecosystems, stakeholders should use SWOT (Strengths, Weaknesses, Opportunities, and Threats) analysis, and clearly define the boundaries of their economic region and assess its assets. These include universities and companies located in the region, the supplier base, the existing workforce, and the physical infrastructure. Ms. Meier Wright said that adhering to this process builds the ownership and sustainability necessary for a strong business development plan.

Ms. Meier Wright discussed best practices in regional innovation, drawing on her work with the California Economic Strategy Panel, the Center for the New Economy, the Center for the Global Economy, the California Economic Summit, and the Cali Baja Bi-National Mega Region initiative. Commonalities in these successful endeavors included a data-driven understanding of regional economies, building on regional assets and strengths, and working across political boundaries and jurisdictions. She also stressed the long time-frame necessary to develop a robust innovation environment, tracing San Diego's development from the early 1900s to the present decade. Similarly, the North Carolina Research Triangle was the product of decades of sustained vision and commitment that lasted longer than any political term of office, and took decades to bear fruit. Over the years, however, North Carolina evolved from a tobacco and textile producer to a high tech hub with a robust innovation economy. Ms. Meier Wright said the required timeframe was not well understood by most observers. She also discussed the specific innovation ecosystem in San Diego, which has a massive cluster of 50-70 elite research institutions centered around the University of California, San Diego (UCSD). She said the Torrey Pines Mesa area is among the densest concentrations of research enterprises in the world, and generates $14 billion annually in economic product and sustains 100,000 jobs.

Ms. Meier Wright concluded her remarks with an overview of common characteristics of successful regions. Successful innovators have a welcoming attitude, nurture entrepreneurs of all kinds, and promote seamless interaction between industry, labor, government, research labs, and academia. These regions also align workforce development programs with economic development goals and remain on the cutting edge of scientific research. She closed with a reminder that other nations covet what the United States has and are rapidly making up ground, again emphasizing the danger of complacency.

Maintaining Innovation in San Diego

Ms. Wince-Smith asked what concerns the San Diego region faces as it seeks to leapfrog into the next generation of innovative industries. Ms. Meier Wright noted that the area's strengths in life sciences and wireless communication had positioned it well for the future of telemedicine and personalized medicine, especially following the COVID-19 pandemic. She did observe that companies in the region were concerned about maintaining the quality of the workforce, a lack of affordable housing that forces frontline responders to COVID-19 to commute long distances into the city, and ongoing infrastructure challenges that include roads quality, secure water supplies, and an airport with only one runway. Ms.

Meier Wright expressed optimism regarding an innovative university-industry partnership UCSD to address workforce development, and also recalled successful initiatives that arose from stakeholders sharing concerns at the California Economic Strategy Panel's meetings, including the creation of a world-class business school at UCSD. She also noted that addressing challenges is a continuous process with no finish line, and said it was important for stakeholders to be on the lookout for new issues that arise.

Sustaining Long-Term Investment

The Honorable Branko Terzic asked how regions without existing innovation ecosystems could ensure sustained commitment to economic development initiatives, given the challenges of coordination multiple political jurisdictions and the turnover in elected officials. Ms. Meier Wright said the process varied from region to region, but that bringing together public sector, private sector, and academic voices and giving them input from the beginning was key. She said the private sector plays an especially important role because they have a vested interest stemming from their investments in the region. She noted that UCSD's business school was established with the support of the founder of GenPro, who had committed $250 million to the San Diego area. She added that there is often a need for training and economic base analysis in areas without robust innovation ecosystems, and that during this exploratory period it is critical to establish a collaborative process encompassing all stakeholders and developing passionate champions who are willing to see the project through.

The Importance of Collaboration

Ms. Vickie Lonker of Verizon said the infrastructure concerns facing San Diego provided an important perspective, and Ms. Meier Wright said that the region's topography constrains the number of major roads. Objections by one city to allowing an interstate to pass through it can negatively impact the entire region's transportation infrastructure. Building on this theme of cooperation, Ms. Meier Wright discussed the success of the Baja Cali Bi-National Mega Region project. Because the two counties involved did not allow the national border to become a barrier and collaborated on common challenges, they were able to come up with strong policy recommendations and secure funding from Asia, Europe, and the North American Development Bank.

Ms. Christina Orsi of the University at Buffalo discussed an initiative in the State of New York that tied economic development funding to regional strategic plans. These initiatives were successful because they pulled in cross-sections of the economy and brought together industry, academia, government, and the nonprofit sector to collaborate. The initiative in the Buffalo area was co-chaired by the University at Buffalo's President and a local business leader. Ms. Orsi added that having a long-term focus and a data-driven approach were also important factors. She discussed how the group adopted a smart growth strategy after new data showed that Buffalo was becoming more sprawling despite a shrinking population. Ms. Meier Wright praised the scope and funding of the New York initiative, and added that organizations she had worked with made use of "best practices" trips, where stakeholders visited regions with similar challenges and learned how they addressed them. She said these trips to cities like Orlando, San Jose, Portland, Seattle, Vancouver, and Austin both helped the group bond and gave members new creative ideas and wide-ranging professional contacts.

The Role of Place-based Service Providers

Dr. Lloyd Jacobs, President Emeritus of the University of Toledo, noted the contrast between the long-term vision required to transform a regional economy and the short tenures of elected officials and even university presidents. Ms. Meier Wright stressed the

importance of placed-based service providers, like utilities and banks, that are unlikely to relocate and have a strong stake in the region's economic development, as anchors for initiatives. She added that academia and industry had less overall turnover than the public sector, especially when extending beyond the top executive levels to include thought leadership more generally. She noted that San Diego was able to thrive despite hosting just two Fortune 100 companies because of its strong startup ecosystem and a large number of organizations that have commitments to economic development beyond the office of any one individual. Dr. Terzic added that utilities have an especially strong interest in economic development because the nature of their industry means they cannot be wealthier than the region they serve. He discussed how utilities in Wisconsin have pooled their resources to form economic development arms, and the role utilities played in funding Pittsburgh's economic transformation from a steel town into a financial and medical center. Ms. Meier Wright agreed and added that San Diego strives to include representatives from different industries and sectors, as well from organizations dedicated to building up entrepreneurial communities, on its economic development boards. She said that Dr. Michael Porter, when working for the Council on its regional innovation initiative in the late 1990s, singled out collaboration as the key to San Diego's success, and added that the Council could play a role in fostering that collaboration in other locations.

Geographically Inclusive Growth

Ms. Wince-Smith praised the discussion's focus on geographically inclusive growth, as it was a major point of emphasis from the National Commissioners in their August 2019 meeting. She added that while programs like the National Science Foundation's S-Corps program have done a good job fostering inclusive growth, there remains a vast disparity in venture capital investment across the United States, with most firms investing only on the coasts. Ms. Wince-Smith also discussed a recent Wall Street Journal editorial highlighting the disparity in COVID-19 lockdown compliance between people who are able to work from home and financially comfortable and those who are not. Ms. Meier Wright described a visit to Johannesburg, South Africa, during which she witnessed extreme poverty just outside the city, and the challenges these areas faced in attracting investment. She said similar dynamics were at play in the United States, and gave the example of neighboring Imperial County, which was struggling to attract the investment that San Diego County received. Ms. Meier Wright discussed the importance of creating an environment and workforce that attracts firms, and how the Economic Development Agency helped Imperial County develop its workforce during the Baja Cali Bi-National Mega Region project. These investments in workforce training, combined with the area's weather and a state commitment to renewable energy, led to San Diego Gas & Electric investing in a renewable energy pipeline in Imperial County. She said this example highlighted both the opportunity of regional development and the patience necessary to execute it.

Reopening After COVID-19

Dr. Jacobs asked what the process of reopening after the COVID-19 pandemic would look like, and Ms. Meier Wright said that while she understood the public's anxiety and resentment, failure to comply with data-informed lockdown policies will lead to the healthcare system being overwhelmed. She said the only way to responsibly reopen will be to use data as a guide for reopening regions, and for when to shut them down again in the face of resurgences. Because the pandemic did not hit the whole country at the same time, it will not end at the same time everywhere either. Ms. Wince-Smith discussed the challenges of data integrity, noting debate over the validity of social distancing recommendations within the scientific community, and the emerging view that the disease may be one of the vascular system rather than a respiratory illness, which has implications for the use of invasive ventilators.

The Post-COVID-19 Normal

Ms. Orsi discussed pre-COVID-19 trends of young people moving to dense urban areas, and how the pandemic could lead to a migration out of denser cities toward less dense cities, especially as working from home becomes more common and viable. She noted that Buffalo had the physical infrastructure of a city twice as large due to population loss, which might make it attractive for people looking for more space. Ms. Meier Wright asked how the Council would shape its recommendations for the "new normal" and noted an opportunity to investigate which cities could thrive in a world where people seek lower density living and the ability to work remotely. Ms. Wince-Smith said the Council would build on emerging recommendations for the near term about reopening the economy safely and securely, and that it was essential to take advantage of the opportunity to make needed reforms. She said the crisis had highlighted the impediments in the nation's energy and broadband infrastructures, and how investment in universal broadband would have dramatic implications for the urban-rural relationship and associated class divide. Dr. Terzic concurred on the socioeconomic implications, noting that in wealthy Northern Virginia the virus was simply an inconvenience while it was devastating elsewhere, and how younger people were leaving densely populated areas like New York City as the combination of costs and crowding outweighed the benefits of living there. He predicted the country would being rethinking quality of life and that a new normal would emerge. Ms. Meier Wright added there could be implications for mass transit as people fear density, and that some industries might not come back from the crisis.

Leveraging San Diego's Veteran Population

Mr. Greg Pellegrino of Deloitte discussed San Diego's large veteran population, and how it impacts the region's competitiveness. He noted that in contrast to Michigan, where many college graduates leave the region, veterans who come to San Diego tend to stay, which provides a substantial asset for companies like Deloitte. Ms. Meier Wright said that many jobs benefit from the skills veterans bring, but that even officers leave the service without experience applying for civilian jobs, preparing resumes, and translating their skills into the private sector. She discussed an innovative program in San Diego that aims to help veterans develop these skills. Ms. Trimble noted that studies indicated that those transitioning out of the military differ socioeconomically from other workforce entrants because they receive retirement pay and robust medical support. She said that San Diego provides very attractive incubating infrastructure to veterans than induces them to stay. Ms. Meier Wright added that veterans have experience in "soft skills" like discipline and working in teams that are valuable in the corporate world.

Concluding Thoughts

Ms. Wince-Smith thanked the group for its discussion and said there would be one more session this week, followed by a hiatus. During this hiatus the Council will focus on synthesizing the recommendations emerging from the Working Group sessions and preparing for the second phase of Working Group discussions, which will begin the week of June 22.

Working Group 3 Calls May 21

Introduction

Ms. Kathy Trimble welcomed the group and introduced the featured speaker, Ms. Julie Meier Wright. She noted Ms. Meier Wright's long affiliation with the Council and her expertise in state and regional economic development through innovation. She also reminded the group that the weekly calls would go on hiatus until the week of June 22, when once-weekly calls will resume as part of Phase II of the Working Group sessions.

Featured Remarks

Ms. Meier Wright opened her remarks by expressing support for the Council's work, characterizing it as critically important and as having the potential to transcend partisan divisions with its focus on facts and data. She also warned that the United States faces increasingly stiff global competition, and that China and India have massive demographic advantages over the United States. She stressed the importance of ensuring policies keep up with surrounding world events, and that the United States needed to begin acting now to address many competitiveness challenges that require long-term action to address. She also discussed areas, like immigration, where unfavorable policies could and should be reformed quickly.

Ms. Meier Wright used the decline of Britain from its 19th Century status as the leading innovator, economic powerhouse, and political leader, as well as examples of historic empires and civilizations from Greece and Rome to France and Spain, to illustrate the dangers of complacency. She said that while the United States was the unquestioned hegemonic power of the second half of the 20th Century, it cannot take for granted that it will escape the fate of

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these other nations if it fails to address crucial issues. She added that China has been very clear in its plans to become the hegemon of the 21st century.

Referencing Dr. Ken Poole of the Center for Regional and Economic Competitiveness's presentations from the previous week, Ms. Meier Wright expressed a desire to build upon their themes and recommendations by focusing on turning them into actionable policies. She warned against wishful thinking by regions, and said that many state and local governments have wasted millions of dollars on development strategies with no chance for success. She identified the keys to successful development as an inclusive convening process with input from across sectors and stakeholders, strong and committed leadership, quality measurements and data, and a focus on policies that are "real, sustainable and fundable."

Ms. Meier Wright said that for regional development, "the place is the product," not political jurisdictions. She warned that if the product is flawed, a region will lose market share or fail altogether, and she emphasized that sound data is key to a successful development strategy. In particular, she recommended SWOT (strengths, weaknesses, opportunities, threats) analysis of a region's economic base and a frank comparison with the competition. To illustrate the importance of developing regional innovation clusters, she referenced the fact that just 1 percent of U.S. counties account for 30 percent of all economic growth.

Drawing on her service as California Secretary of Trade and her work as part of several different regional development organizations in California, Ms. Meier Wright discussed best practices in building regional innovation ecosystems. An overarching key is bringing together the right leaders and stakeholders and building ownership and sustainability into the development plan. She said that regions need to examine and leverage research institutions, the existing workforce, workforce training capabilities, local companies and supplier networks, and physical infrastructure to develop or expand an industry cluster. She also urged cooperation across jurisdictional boundaries, discussing her work on the Cali-Baja Bi-National Mega Region project. In this endeavor, San Diego and Imperial Counties in California collaborated with the government of Baja California in Mexico to address shared infrastructure challenges and attract investment that benefitted both sides of the border. Ms. Meier Wright said this example illustrated how political boundaries need not be obstacles for regional development.

Another element that Ms. Meier Wright identified as crucial is long-term commitment. She discussed San Diego's innovation ecosystem, which has evolved over 120 years continuously since the founding of the Scripps Oceanographic Institute in 1900. She also cited the example of North Carolina's Research Triangle Park, where it took decades of state support and investment from three large universities to attract the workforce and companies needed to develop an innovation cluster. While these efforts last far longer than any elected official's term in office, they can have dramatic long-term results, as evidenced by the Research Triangle Park's transformation of North Carolina from a tobacco and textile producer into an innovative technology hub. Building upon the concept of hubs, Ms. Meier Wright discussed how San Diego uses GIS mapping to visually illustrate the clustering of industries. She noted that the hub around the University of California, San Diego (UCSD) is compact enough to be walkable but contains one of the highest concentrations of research institutions in the world. In 2015, this cluster contributed $14 billion and 100,000 jobs to the regional economy.

Ms. Meier Wright also discussed general characteristics of the most successful innovation regions. They maintain welcoming attitudes and a commitment to fostering entrepreneurship of all kinds, and they facilitate seamless interaction among academia, research facilities, labor, industry and government. These regions also align their workforce development and economic development strategies, and remain on the cutting edge of new technology. She discussed the possibility that these ecosystems might be impacted

by COVID-19, but noted that similar predictions following the September 11 attacks did not materialize. She closed her presentation with another warning that the United States cannot be complacent. She said other nations covet what the United States has and are investing heavily to get there. Ms. Meier Wright urged stakeholders from across the country to come together and help regions that have been left behind find effective ways to innovate.

What and How to Measure Innovation

Dr. Ken Poole of the Center for Regional Economic Competitiveness discussed the capacity of different regions to develop innovation plans. He said that larger metropolitan areas had the necessary industry clusters and technology councils to form the organizational backbone for such efforts, but that many smaller regions had nascent or limited ecosystems. He discussed the proposal by the Brookings Institution and the Information Technology and Innovation Foundation to pick ten "second-tier" metropolitan areas and invest heavily in them, and how this proposal furthered the idea that innovation is inherently concentrated. He characterized Ms. Meier Wright's work as a "roadmap" for all the other regions that would not benefit from the second-tier hubs proposal, and asked how to ensure that these regions had the ecosystem in place to support economic development. Ms. Meier Wright said that the Council needs to help lead a national effort to change the conversation from one of ideology to one of ideas and data. Dr. Poole added that it is difficult to measure innovation directly, and that proxies like academic publications and patents don't always capture the true nature of innovation, which is impact on people's lives. Ms. Meier Wright said it was crucial to study a region's economic base and communicate that information to local policy makers, who often learn things about their region they did not know before. She said that her organization, Collaborative Economics, provides economic base analysis for regions that prepares the groundwork for in-depth investigations of industries where a region has a competitive edge. She added that many regions have at least some competitive advantages, but that without identifying them through data they risk going on "wild goose chases" after the wrong things.

Successes and Failures in De Novo Innovation Ecosystems

Dr. Poole agreed with the importance of building on existing strengths, while discussing exceptions where regions were able to build innovation ecosystems out of nothing. He discussed growing up in the Research Triangle area and seeing the dramatic transformation of the area into a technology hub, as well as Upstate South Carolina, where concerted state efforts to court BMW led to the development of an automotive manufacturing cluster. He said that commitment to the innovation process from a whole community can allow for the successful development of an innovation ecosystem from scratch, albeit at very high cost and risk. Ms. Meier Wright added two examples of similar attempts, one successful and one not successful. Rio Rancho, New Mexico spent enormous amounts of money and took on lots of debt to invest in attracting an Intel wafer fab facility, but even after thousands of employees flocked to the facility, the city was unable to generate the economic activity needed to repay its debts. Conversely, Alabama's state government invested heavily in attracting Mercedes-Benz to the state, and despite taking an enormous financial risk were able to establish an industry cluster, as Mercedes began investing more heavily and other car makers were attracted to the region.

COVID-19, Virtualization and Opportunities for Regions

Ms. Ann Gabriel of Elsevier asked if the COVID-19 crisis and its associated acceleration of the move to virtual work would provide opportunities for the democratization of innovation away from traditional technology clusters. Ms. Meier Wright said that this transition would be easier for companies that are already used to using technology and dealing with remote work, and that regions with good qualities of

life will benefit the most, as workers can now live in regions with lower costs of living and entertainment and cultural amenities while working in cutting edge industries. She discussed the example of Qualcomm establishing a remote workforce in Colorado because skilled employees preferred to live there, and how Intel based its investment decisions on the quality of life that regions would provide for employees.

Ms. Trimble noted that many midwestern cities are looking to attract high tech workers, but noted that with lower salaries these cities would need to identify other amenities to attract that talent. Ms. Meier Wright noted that many of these places have lower costs of living, and Ms. Ji Mi Choi of Arizona State University expressed the hope that future industry clusters would form around communities based on quality of life factors, rather than proximity to a research university or corporate headquarters. She identified a dual benefit from this potential development, as people and organizations invested in quality-of-life relevant assets like K-12 schools and cultural institutions and virtual work enabled the democratization of innovation and a wider distribution of its benefits. She added that Arizona had already experienced many of these benefits as its lower cost of living attracts workers from California. Ms. Meier Wright said that regions did not need to achieve the success of Silicon Valley or even San Diego to be successful, and said that she hoped younger business tycoons became invested in philanthropy. She discussed the high volume of potential philanthropists in Silicon Valley, and said that is was important for them to give back to the communities that enabled their success by contributing to educational and cultural institutions.

Different Ways to Benefit from Innovation

Dr. Poole noted that regions did not need to be conducting cutting edge research and development in order to leverage innovation to drive productivity. He said that while it is not feasible to recreate the success of research universities like Stanford or MIT, or to develop the research clusters of Boston and Silicon Valley, there are many opportunities to create value by bringing ideas developed in those regions to the commercial market. He discussed the medical device clusters in Phoenix and the Twin Cities, and how both of them played important regional and national roles in scaling certain kinds of innovative ideas and technologies for the market. Dr. Poole said that deliberately focusing on this scaling role could be a viable means of improving productivity and quality of life in many regions.

Building Innovation Capacity Across Industries and Regions

Ms. Meier Wright asked participants how to create economic opportunity in other industries, noting the significant disparity between the importance of frontline workers in the COVID-19 crisis and their compensation. Dr. Anthony Margida of TechGrit said that the crisis has led to not only the emergence of virtual tools, but a growing familiarity with them among the general public. He said that many second-tier regions could become self-sufficient based on the removal of geographic limitations, with small towns being able to anchor an innovation ecosystem in a broader region, contingent on a high quality of life and leveraging unique regional capabilities, institutions, and infrastructure. He added that these assets will not come together organically, and that there are tremendous opportunities in the intentional study of regional strengths and capabilities and using this research to inform regional ecosystem architectures. Ms. Meier Wright said that geographic boundaries are not disintegrating, but that they are fluid. She added that many metropolitan areas are thinking differently about their regional boundaries, and extending assistance and collaboration to neighboring regions. She discussed San Diego's working with Imperial County, long plagued by high unemployment, to identify workforce needs for biofuel farming. Using Economic Development Agency grant money, they were able to establish the infrastructure and workforce training necessary to establish biofuel pipelines in Imperial County to supply San Diego with clean energy.

Balancing National and Regional Priorities and Leveraging Regional Strengths

Dr. Branden Brough of Lawrence Berkeley National Laboratory said that while on a regional level every region should strive to be competitive, it is not realistic for every part of the country to build an elite innovation ecosystem. He asked where the balance should be between equal opportunity for innovation and targeted priority investments. Dr. Rao Unnava of the University of California, Davis echoed this sentiment, and asked if committing to at least one investment project in every state to start a cluster based on regional strengths would split this divide effectively. Ms. Meier Wright said that in addition to overcoming opposition to the idea of prioritizing investment sectors in some quarters, it was important to focus on targeting investment to struggling regions. She said, for example, that Imperial County needs investment in innovation more than San Diego does, and suggested a model where there is support at the national level for initiatives that are planned at the regional level.

Ms. Trimble said it was important to think about core competencies in a region, and use an overarching national policy to optimize regional development by ensuring a match between investment activity and region's indigenous or constructed strengths. Dr. Poole said that having cutting edge, state-of-the-art innovation throughout the country was vital to national strategy, but that a vibrant national economy depends on specialized regional clusters in different industries. He noted the importance of partnership, and the challenges caused by the erosion of the U.S. manufacturing base. Dr. Poole also suggested determining the focus of regions locally while adopting a national strategy that recognizes the importance of successful regional ecosystems. Ms. Meier Wright discussed a National Science Foundation initiative that gathers data on innovation while dividing the country into four broad regions. She said this initiative has encouraged innovation-rich areas to form partnerships with research universities in their wider "region" to address critical challenges like transportation infrastructure. She said the COVID-19 pandemic had shown the vulnerability of America's food supply chain, and asked if there was a way to shore it up by leveraging the agricultural capabilities of the Midwest.

Reviving or Retooling Historic Industries

The Honorable Branko Terzic of Berkeley Research Group discussed the ways in which regions can revive or retool historic industries to revitalize their economies. He noted that nearly every city has a historical economic base, and was often settled because of its strategic location for a particular industry, but that technological changes and failures to adapt obviated these advantages. However, he noted that it was possible to leverage existing capabilities for new ends, giving the example of the French company Hermes. Originally a buggy whip manufacturer, as buggy whips became obsolete the company, conceiving of itself a leather maker, not a buggy whip maker, turned to making expensive belts and purses and became a dominant player in the fashion world. Dr. Terzic said that engineering these turnarounds will require a multi-pronged approach, including private equity and venture capital. He added that harnessing technology is essential to continue prospering. Rochester lost its place in the film and copier industries despite being the home of Kodak and Xerox because those firms did not pursue digital video and photography technology. Ms. Meier Wright said rich collaboration among different levels of society was important for a region's long-term prosperity, as was understanding that the world economy is always changing and a region must constantly be adapting and building up capacity to thrive as industries change.

Concluding Thoughts: Equipping Regions to Develop Innovation Capacity

Dr. Poole referenced his suggestion from the previous week's discussions of leveraging the Economic Development Agency to invest in at least one innovation cluster in each metropolitan area, and to support the organizational infrastructure necessary to further develop those clusters. Ms. Meier Wright said there was a real opportunity for the Council to make an impact in second-tier counties, not by solving their problems for them, but by helping them acquire the tools necessary to solve those problems themselves. She added that this would require those regions to rethink their identity and boundaries and move forward with an aggressive development strategy. Ms. Trimble reminded the group that the Working Group is adding new members for Phase II, and encouraged participants to refer or recommend colleagues whose perspectives and expertise would help the Council explore new topics.

Working Group 3 Calls June 23

Introduction

The Honorable Deborah Wince-Smith and Mr. Chad Evans welcomed the group, and Mr. Evans discussed the agenda for the call, including a recap of Phase I of the Working Group Sessions, an overview of the June 16 virtual meeting of the National Commissioners, an introduction of the Working Group Co-Chairs, and an outline of the road ahead for Phase II of the Working Group calls. Ms. Wince-Smith discussed the group's mandate to look at systemic issues that impact American competitiveness, including trade policies, tax and regulatory policies, antitrust policies, and standards and norms. She detailed that Phase II of the Working Group sessions will be focused on generating detailed and actionable policy recommendations ahead of the release of the Commission's Year One Call to Action at the National Competitiveness Forum on December 17, 2020.

Recapping the Commissioners Meeting

Ms. Wince-Smith outlined the highlights of the Commissioners Meeting, including the presentation of a synthesis report that summarized the key themes and findings from the first eight weeks of Working Group discussions, and the featured remarks by Senators Todd Young (R-IN) and Charles Schumer (D-NY), the co-sponsors of the bipartisan Endless Frontier Act, which increases U.S. investment in

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Ms. Julie Lenzer
University of Maryland

Mr. Tad Lipsky
George Mason University

Ms. Rebecca Macieira-Kaufmann

Dr. Anthon Margida
TechGrit

Dr. Cheryl Martin
Harwich Partners

Dr. Isabelle Monlouis
Georgia State University

Ms. Christina Orsi
The University at Buffalo

Mr. Greg Pellegrino
Deloitte

Dr. Karl Smith
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Ms. Anne Tucker
Georgia State University

Mr. Olin Wethington
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The Honorable Deborah L. Wince-Smith

Mr. Chad Evans

Mr. Bill Bates

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scientific research and technological innovation. Ms. Wince-Smith underscored the importance of the Council's bipartisan engagement and advocacy efforts, and noted that both Senators endorsed the role of the Council and looked forward to working with the Commission on many fronts. She added that the Council produced a press release announcing the Nine Pillars- the key themes and findings from the first phase of Working Group discussion that were endorsed by the Commissioners and that will guide the work of the groups going forward. Ms. Wince-Smith encouraged members of the group to amplify the Commission's message by sharing the press release and other coverage of the Commission's work through their own social media avenues and networks.

Mr. Evans summarized the key takeaways from the Commissioners' feedback on the synthesis report. He conveyed the Commissioners' gratitude at the work the Working Groups have already done, and their desire to emphasize three major points. First, the Commissioners believe the Commission has a distinct role to play at a pivotal moment in U.S. history, and the Commission must publicize and share its work to amplify its message. Dr. Steven Ashby, Director of Pacific Northwest National Laboratory, observed that the Commission's Year One report will likely be the first publication on the future of the country in the post-COVID-19 world. Second, the Commissioners urged the groups to focus on the challenges of inequality of opportunity and of resiliency in the face of crises. The U.S. is plagued by unequal access to the tools and resources necessary to innovate, and the country's social and economic inequalities, especially for underrepresented groups, are an obstacle to innovation. It is imperative to diversify the pipeline of innovators and entrepreneurs. The COVID-19 pandemic also exposed major vulnerabilities in America's supply chains, economy, and preparedness for disasters. The country must respond swiftly and decisively to shore up these weaknesses. Third, the "rules of the game" have changed, and the policies that work for the United States in the 1990s no longer suffice in the 2020s. Dr. Michael Crow, Commission and Council Co-Chair and President of Arizona State University, urged "bold and transformational" recommendations. He likened America's policies vis-à-vis competitors to ice hockey: fierce, full-contact competition governed by strict rules.

The Nine Pillars and the Road Ahead

Mr. Evans went into more detail discussing the "Nine Pillars" that emerged from the first phase of Working Group discussions. All of these pillars concern topics that emerged organically across all of the Working Groups in Phase I of the Commission, and are "strategic, urgent, and pivotal." They are strategic in that they are fundamental to America's economic strength and security, as well as our national security and geopolitical strength. They are urgent in that failure to address them will create serious, and even dangerous, consequences for the U.S. and the world as a whole. They are pivotal in that they will play a determining role in the scale, scope, and rate of American innovation. Going forward, Mr. Evans asked group members to submit to the Co-Chairs and the Council team a list of three to five topics that members feel should be prioritized during the second phase of Working Group discussions. These lists will be used to shape the group's agenda ahead of the Year One Call to Action, to be presented in December at the National Competitiveness Forum. Mr. Evans reiterated that the goal is a series of big, high impact, transformational ideas with specific plans for implementation.

Additionally, Mr. Evans discussed the unique opportunities for the Commission in the current political moment. In addition to the Endless Frontier Act, many other pieces of legislation are in development that directly intersect with the Commission's mandate. These include the CHIPS Act, designed to increase production and investment in advanced microelectronics and semiconductors, as well as several infrastructure improvement bills. Amid growing Congressional interest in investment in competitiveness, the Council has had numerous opportunities to engage with policy makers, and several policy makers have reached out to the Council to discuss their work and opportunities for future engagement. The

Commissioners expressed a desire for the Commission to seize advantage of this momentum and share its findings and recommendations before the National Competitiveness Forum in December.

Co-Chair Opening Remarks

The group's Co-Chairs introduced themselves and discussed their interests and hopes for the second phase of Working Group calls. Dr. Peter Dorhout of Kansas State University discussed his role as Vice President for Research and his responsibilities in the field of economic development at the university. He expressed excitement at the work of the group, as well as the other Working Groups whose sessions he has observed as an Advisor, and praised the ideas outlined in the synthesis report as "fantastic." Dr. Dorhout also noted the significant overlap between the Endless Frontier Act's provisions and the synthesis report's recommendations.

Mr. Tad Lipsky of George Mason University's Antonin Scalia Law School described his background in antitrust law. He expressed excitement and getting to help turbocharge American innovation, and noted that the antitrust community has long held competition that produces and promotes innovation to be the best and most important form of competition. He described the evolution of antitrust policy from an American-only issue to a global issue in the post-Cold War era, and the threats to U.S. competitiveness stemming from foreign antitrust actions. In particular, Mr. Lipsky discussed the fines issued by EU governing bodies to American firms, aggressive regulatory measures such as the Digital Service Act, and the innovation-inhibiting policies pursued by the Chinese government's antitrust bodies. Mr. Lipsky also expressed interest in the role of intellectual property in competitiveness and its intersection with antitrust policy.

While the third Co-Chair, Ms. Vickie Lonker of Verizon, was unable to attend the meeting, Mr. Evans noted her longstanding interest in regulations and standards and their impact on innovation, particularly in the telecommunications industry. He added that the group had an interesting and well-rounded set of leaders to shape the next several months of discussions, and thanked the group's members for their work in engaging and recruiting colleagues to join the Commission.

New Working Group Member Introductions

Several of the newer members of the Working Group introduced themselves during the call. Ms. Julie Lenzer of the University of Maryland discussed her background as the school's Chief Innovation Officer and her prior work at the Office of Innovation and Entrepreneurship during the Obama Administration, where she created the Build to Scale program as part of a regional innovation strategies initiative. She said that her dual background in academia and the entrepreneurial world had informed her perspective, and emphasized the challenges universities face in getting innovations out of the lab. She also discussed her passion for increasing diversity and inclusivity, stressing the need to make use of all of our population's talents and energies. Mr. Evans noted that diversity was an important topic across all four Working Groups, and that during Phase II there would much more effort at cross-pollination of ideas. Ms. Lenzer also discussed her opportunity to attend the G20 forum in 2016 in China, and to learn about the challenges other nations face in competing in a global research and innovation economy.

Ms. Rebecca Macieira-Kaufmann discussed her background in industry, including her most recent position as the head of Citi's international banking operations, covering over 100 countries. She relayed the views of her acquaintances in the venture capital industry on what the country needs to remain a hub of innovation, and said they all emphasized STEM education, especially increasing the number of women in engineering, as well as an expansion of H1B visas to recruit the best talent from around the world. Ms. Wince-Smith discussed the Council's discussions with the President's Science Advisor and the head of the Office of Science and Technology Policy regarding recent policy changes around immigration, and the Council's outlining the impor-

tance of a robust supply of high-skilled immigrants. She also emphasized the need to enhance America's domestic talent pipeline alongside the recruitment of immigrant talent, especially among underrepresented minorities and women.

Ms. Elizabeth Gray of Willkie, Farr and Gallagher LLP described her background as an attorney, and in particular her experience in cybersecurity policy. She discussed her interest in the increasing role of digitization in the economy, as well as her interest in questions of diversity and inclusion. Mr. Evans noted that former Estonian President Toomas Hendrik Ilves spoke at the 2019 National Competitiveness Forum on best practices in the digitization of government services and the role of digital technology in good governance and innovation, and expressed interest in exploring the topic further.

Dr. Isabelle Monlouis of Georgia State University discussed her experiences in the corporate world with both Fortune 500 companies and innovation consulting firms, and her current role at Georgia State, where she works to develop university entrepreneurship and the local entrepreneurship ecosystem, as well as to bridge the gap between university curriculum and the skills needed for workforce development. Dr. Monlouis emphasized the importance of increasing diversity in the entrepreneurial ecosystem, warning that failing to harness the talents of underrepresented groups was not just morally wrong, but a loss of competitive advantage. She said the U.S. was at risk of ceding the "homefield advantage" of its diversity and large immigrant population by failing to address this issue.

Finally, Mr. Brad Brekke of the Brekke group related his experiences in corporate security and law. He discussed his role in developing the FBI's Private Sector office, which works with corporations around the country to address issues of economic and national security. He said he hoped to provide background on securing key technologies and resources from competitors from a governmental perspective.

Examples of Priority Recommendations

Mr. Olin Wethington of Wethington International LLC offered up his five priority areas for the Working Group to consider. First, the U.S. must increase its investment in R&D, especially in the realm of collaboration between government and the private sector in critical technologies that will drive future competitiveness. Second, the U.S. and its Allies must clearly define their relationship to China with respect to critical technologies. He urged the U.S. and its Allies to take a defensive stance regarding technology transfer, address supply chain security issues, and strengthen oversight of foreign investment in critical technologies. He added that the magnitude of China's threat merits special attention as a topic in its own right. Third, he called for the clarification and firm establishment of rules and international institutions and norms in a competitive global economy, particularly rules pertaining to the international flow of goods, capital, and ideas, as well as standards. Fourth, he advocated increased investment in infrastructure, noting that it is a "multiplier" of innovation and a foundation for competitiveness across the board. Mr. Wethington specifically called for the repair and advancement of legacy infrastructure and increasing the distribution of high-tech hubs of the future. Finally, he urged a focus on human capital, especially on universities and their role in training the next generation of innovators. Mr. Evans and Ms. Wince-Smith thanked Mr. Wethington for his preparedness and Mr. Evans said other participants would likely come up with similar lists.

Ms. Wince-Smith suggested adding investment in the National Laboratory system to Mr. Wethington's fifth point, and Mr. Tom Dailey of Dailey Strategic Advisors LLC echoed Mr. Wethington's emphasis on infrastructure as an enabling technology. In particular, he highlighted the importance of rural broadband and 5G deployment as enabling technologies in the telecommunications industry. Mr. Dailey further noted China's efforts in the 5G space through firms like Huawei and ZTE and the security and antitrust questions that arose from the involvement of the

Chinese government in these firms. Ms. Wince-Smith also cited Britain's plan to grant visas to Hong Kong residents as an important policy for attracting talent and innovative capacity, and Ms. Christina Orsi of the University at Buffalo urged greater leveraging of colleges and universities to build the pipeline of future university students by engaging in new and different ways with K-12 students.

Long-Term Optimal Policies vs. Short-Term Pragmatic Policies

Ms. Ji Mi Choi of Arizona State University discussed the importance of finding a balance between advancing long-term, optimal-state policy solutions with concrete plans for achieving them and reactive, short-term policy solutions to address real-time challenges. As an example, she highlighted recent policy changes that may jeopardize the H1B visa program, and questioned the feasibility of calling for new programs like an entrepreneurship visa in that environment. She advocated developing both best-case and more pragmatic recommendations. Mr. Evans said these kinds of trade-offs could be analyzed through a matrix that matches long-term goals for the Commission, the steps needed to reach those goals, and short-term issues where the Commission can be opportunistic. He said building this roadmap was something the Council could engage the Working Group Co-Chairs in. Dr. Dorhout referenced Dr. Crow's ice hockey analogy of competition, and discussed his experiences playing hockey during the early 1980s, shortly after the Miracle on Ice. He described how the U.S. hockey program greatly improved when it was exposed to competition from other nations who had different ideas and strategies for playing the game, which caused Americans to rethink their approach to the game and led to a dramatic improvement in performance. Dr. Dorhout also referenced the need to "skate to where the puck will be, not where it is"—for the commission to be anticipatory in its work. He likened the optimal future state to "where the puck will be" and warned that if the Commission only chases the puck where it is, it will not accomplish anything for all of its effort. He urged the group to take the best ideas and "coach" each other to play the game under new rules and strategies, and to continually envision the long-term optimal state even as the Commission reacts to events in real time. Mr. Evans discussed Dr. Crow's challenge to increase innovation capacity tenfold, issued during the inaugural Commissioners' meeting in August of 2019, and said that rather than merely increasing investment by a factor of ten, adopting these "new rules" and ideas could help the country reach that level.

Building Entrepreneurial Ecosystems and Mindsets

Dr. Anthony Margida of TechGrit discussed his work building entrepreneurial ecosystems in small communities in Kentucky and Ohio, places that were seen as "out of the way" by many in the entrepreneurial world. However, Dr. Margida said there was an "ocean" of entrepreneurs and innovators who were energized, and that widespread unemployment in the wake of the pandemic has caused many of those laid off to think about charting their own paths. He stressed the need to engage with and design programs for this group of latent entrepreneurs, and to become involved with them earlier in the process, before they have marketable innovations, to help build an entrepreneurial mindset. He also encouraged engaging with people who want to start "Main Street" businesses, social enterprises, and civic initiatives, as creating a broad-based culture of innovation leads to breakthrough innovations from unexpected sources. Dr. Margida said that many game-changing innovations come from people who are relative outsiders in a field approaching longstanding problems in fresh ways, and said that engaging more people in innovation could unlock some of these breakthroughs.

Ms. Wince-Smith connected Dr. Margida's ideas to the failure of many universities to engage with their surrounding communities. She argued that universities should work to develop the talent that is capa-

ble of matriculating at their institutions rather than simply bemoaning the lack of qualified students and researchers, and in particular noted the persistent poverty in New Haven, Connecticut, in spite of its hosting a world-class, richly endowed university in Yale.

Harnessing America's Diversity

Dr. Monlouis expressed optimism that America could still seize upon its "homefield advantage" in diversity, and said that America's large immigrant population meant there were many Americans who had strong connections to other countries. These immigrants' knowledge of markets and needs in their home countries, combined with their access to tools and resources in the United States, enables them to engineer innovative solutions to problems that significantly enhance productivity in developing countries. Many of these innovations can then be reverse engineered and adapted to meet the needs of underserved markets in the United States. As a concrete example, Dr. Monlouis discussed how the financial technology hub in Atlanta has produced innovations in digital payment systems that were first deployed in developing countries without well-developed banking systems, and then were adapted for the United States. She cited this phenomenon as an example of the innovation that can be reaped from embracing diversity and increasing access to resources for America's minority and immigrant populations. However, she emphasized that challenges remained to replicating these practices at scale.

Concluding Thoughts

Mr. Evans reminded the group of next week's meeting at the same time, and encouraged the group to send lists of priority topics to the Council team and Co-Chairs. Dr. Dorhout thanked the group for its contributions and ideas, and said that today's call was a great start to the conversation. Mr. Lipsky praised Mr. Wethington's articulation of priority areas, and added that increasing exposure to STEM fields at the earliest ages of schooling could have a huge impact in fostering an interest in innovation among students in the next generation and help bridge the gap in entrepreneurship facing underserved groups. Mr. Bill Bates discussed the Council's 2007 publication Transform and the updated version the Council is issuing for 2020. He noted that many of the original recommendations from 2007 remained relevant today. Ms. Wince-Smith thanked the new members of the group for their contributions and expressed approval of the "optimal future state" paradigm as a guide for the group's work.

Working Group 3 Calls June 30

Introduction

Mr. Bill Bates welcomed the group and said that the focus of the discussion would be building on the group's "homework assignment" of sharing their priorities for future discussions. Ms. Yasmin Hilpert summarized the responses that the Co-Chairs and Council team received in response to the assignment. She started by noting that many respondents identified priority areas that are in the purview of the other three Working Groups, and that these responses are listed at the beginning of the summary document, which she posted to the online portal. She identified the priority areas for Working Group 3 that most resonated with respondents as confronting the challenge posed to U.S. competitiveness by China, creating opportunities for universities and students to spin off intellectual property and startups, and addressing the "valley of death" funding issue for startups. Specifically, respondents wanted to discuss sanctions and penalties for IP theft and illicit technology acquisition, challenging China in the key industries mentioned as part of its ten-year strategy, and focusing on alliance-building and developing a cooperative approach to international relations, in which the U.S. leads the development of a global infrastructure predicated on strong economic alliances with allies that share our values. This would be done through a combination of bilateral and multilateral initiatives and agreements, including development banks. In academia, group members wanted to discuss the use of technology transfer in promotion and tenure decisions, and in startup funding to address the gap in investment between initial research and the securing of angel investors.

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Mr. Bates and Ms. Hilpert also briefly discussed yesterday's meeting of the University Leadership Forum, a group of university presidents and chancellors hosted by the Council, at which The Honorable Kelvin Droegemeier, Science Advisor to the President and Director of the White House Office of Science and Technology Policy, spoke. The topic of Dr. Droegemeier's remarks was securing the integrity of university research and addressing growing problems with non-disclosure of foreign payments and conflicts of interest and commitment by U.S.-based researchers, as well as China's attempts to illicitly acquire U.S. research and intellectual property. Mr. Bates mentioned that the slide deck from the presentation is available for public viewing online.

Co-Chair Remarks

Mr. Olin Wethington of Wethington International LLC said that he did not want to rehash his previous remarks on priority topics and areas from the previous call, but emphasized that formulating a response to China includes both defensive and offensive or affirmative measures. Sanctions and other actions designed to protect American IP and technology from theft or acquisition are important, but cannot override or diminish "positive" actions the United States takes to confront China, including building upon existing institutions, rules, standards-setting processes, and arrangements that have developed in the 75 years since World War II. He expressed hope that the group would flesh out an affirmative agenda that would seek to bring international norms and institutions in alignment with U.S. interests by working with allies who share our values.

Ms. Vickie Lonker of Verizon agreed with Mr. Wethington about the importance of a building-focused policy regarding China that incorporates U.S. allies as partners. She said such an initiative had a better chance at long-term success than a purely defensive and reactive position. She then discussed her desire to focus on improving connectivity and infrastructure, including not just broadband but other aspects of telecommunications. Ms. Lonker said that as 5G technology and low earth orbit satellites proliferate, telecommunications infrastructure and connectivity will have implications on the delivery of healthcare, education, and other services remotely, and that strong and widespread access to modern telecommunications infrastructure has impacts for America's ability to invest in our human capital. Finally, she asked if the group could or should play a role in promoting the expansion of the National Science Foundation in order to influence its agenda in a way that spurs innovation in the U.S., and if there was an opportunity to influence U.S. patent policy. Ms. Lonker said that the emergence of open-source technology raised new questions about how to avoid artificially closing down technology that could be kept open for the market and unleash innovation. Mr. Bates noted that Working Group 1 also discussed the importance of patents on its call earlier in the day.

Dr. Peter Dorhout of Kansas State University expressed support for the idea of an offensive strategy against China, and argued for expanding that framework to cover future economic and geopolitical rivals. He also observed that China spelled out its geopolitical plans years ago but the United States did not take action. Dr. Dorhout asked what strategies and goals the U.S. was willing to publicly and proactively commit to, and encouraged the group to envision what the global infrastructure necessary to achieve that vision would look like for the United States. He also stressed the need to create regional and national innovation hubs and take advantage of America's massive talent base, particularly through incentivizing technology transfer by universities and laboratories. Dr. Dorhout noted that 80 percent of the $600 billion spent on research and development in the U.S. each year is spent by the private sector, academia, and nonprofits, and that building incentives to encourage the transfer of technology from these institutions was essential. To that end, he also asked what incentives were necessary to encourage university faculty to partner with industry and the national laboratory system. Finally, Dr. Dorhout expressed interest in discussing the Economic Development Administration's Build to Scale program aimed at developing regional innovation hubs.

The Returns to Public Investment

Ms. Ji Mi Choi of Arizona State University argued that many institutions were already investing significantly in research commercialization and tech transfer, but that universities did not own student IP that was generated outside of their facilities. She asked if it would be beneficial to inventory university initiatives to spin off startups and encourage innovation in their communities. Ms. Choi also noted that when the federal government directly invests in funding startups, taxpayers do not receive individual returns on their investment the way private investors do, and that this disconnect chills public support for such projects. She asked if there was a way to better highlight the benefits that accrue to taxpayers from a more vibrant innovation ecosystem, or a way to create more tangible benefits for them. Ms. Rachel Jagoda Brunette of the Lemelson Foundation mentioned that the National Science Foundation's Broader Impacts reports could provide a model for requirements imposed on other programs that involve federal investment in accelerating businesses.

Dr. Kenneth Poole of the Center for Regional Economic Competitiveness said that programs involving direct investment of tax dollars into businesses, including the Economic Development Administration's Build to Scale program, are intended to generate social benefits, including providing opportunities for demographics and regions to be involved in the innovation ecosystem that otherwise would be excluded. He said many of these programs are aimed at generating a critical mass to sustain entrepreneurial activity in regions that don't have existing cultures of innovation. Dr. Poole also discussed the need to identify the major problems the group is trying to address and determining what role the federal government should play, and how state and local governments and other stakeholders should be involved. He asked if the priorities Ms. Hilpert collated from the group's homework assignment sufficiently covered all the relevant dimensions of the group's mandate to optimize the environment for the national innovation ecosystem. Mr. Bates said that answering that question was part of the group's goal on the call.

Mr. Wethington offered addressing the regulatory environment, including antitrust, IP and patents, and competition policy, as well as infrastructure and the multiplier effects from social investments, as other areas to include, if they were not already implied by the existing priorities. Dr. Gerald Blazey of Northern Illinois University expressed skepticism that the Build to Scale program was structured adequately to bring opportunity and innovation infrastructure to regions that lacked them, and suggested addressing regional innovation systems from a higher level than an individual program. Ms. Choi said she thought that the Build to Scale program fit under the heading of regional economic development more broadly, but that it also had aspects that fell under the broader topic of infrastructure investment. Dr. Ushma Kriplani of Argonne National Laboratory suggested focusing on "buckets" of policy recommendations grouped by topic, and she encouraged the group to base its policy recommendations around the outcomes it wants to achieve. She discussed the innovation district that Toronto built to foster collaboration between major universities, startups, and large companies, and what those districts would look like in the United States after ten years and what benefits they would generate.

Developing Focus Areas

Dr. Poole offered an initial list of "buckets" for the group to organize its discussions around: international competitiveness and rivalry with China, university leverage, the regulatory environment, economic inclusion and regional distribution, financing startups and R&D, and infrastructure. He suggested framing these topics with goal statements, and identifying key players who need to be involved in achieving those goals, as well as obstacles and gaps that must be overcome.

Ms. Ann Gabriel of Elsevier suggested building public trust in science as an important goal. She noted that the countries with the most effective responses to COVID-19 were those with strong public trust in scientific expertise, and that mistrust in government generally also reduces public support for federal investment, as people are not confident they are

benefiting from the government's spending. Dr. Kriplani suggested that infrastructure be embedded as a component of the other topic areas, rather than a distinct topic itself, and Ms. Lonker suggested having as few topics as possible and concentrating on areas where the group felt it could make the biggest difference. Mr. Wethington suggested adding an international corollary to the regulatory environment topic, to include international institutions, rules, and standards-setting bodies that are consistent with U.S. values and competitive interests. Ms. Anne Tucker of Georgia State University offered sustainability as a key topic, arguing that it is critical to long-term competitiveness, and Dr. Blazey added that sustainability should be embedded in all of the group's recommendations and discussions.

Visualizing End Goals

Ms. Choi noted that the Endless Frontiers Act calls for the establishment of ten innovation hubs throughout the country, and that innovation districts like the Research Triangle already exist. She cautioned against duplicating ideas and programs that are already the subject of public discussion and advocacy efforts. Dr. Kriplani suggested identifying ways for the group to provide a unique perspective to the public debate, and that one way to provide this angle would be envisioning what it would look like if the country achieved the goals laid out in the "goal statements" Dr. Poole proposed. Further, Dr. Kriplani suggested identifying what metrics would be used to measure progress towards each of those goals. Dr. Poole said that this exercise was better suited for individual reflection in the form of another "homework assignment" and that the international competitiveness framework needed to focus beyond just China, as other challengers were likely to emerge in the future and the country needed a flexible framework for all future challenges.

Concluding Thoughts

Ms. Lonker said she thought the Co-Chairs and the Council team could facilitate a second assignment for group members to envision both the end goals that would flow from a set of policy recommendations and the underlying capabilities needed to support those goals and realize those visions. The Co-Chairs could then use the initial round of responses as a starting point to further refine an agenda for the group going forward. Dr. Dorhout expressed support for the idea of "buckets" of recommendations, and said it was incumbent on each group member to identify what capabilities the country needs to meet the goals group members have and what metrics will be used to measure progress. He also suggested focusing on one topic each week. Mr. Wethington agreed that the group was ready to draft a framework for its remaining discussions, and to put various policies and priorities in the context of strategic goals that could be circulated to the group for discussion. Dr. Poole suggested framing each area with a problem or challenge statement and a goal statement that articulates how the Commission will solve that problem. Mr. Bates said that another option for discussing issues would be to have different subgroups meeting periodically to discuss issues in detail rather than whole-group weekly meetings every week. He also reminded the group that it will meet again on Tuesday, July 7th.

Working Group 3 Calls July 7

Introduction

The Honorable Deborah Wince-Smith and Mr. Chad Evans welcomed the group, and Mr. Evans introduced Dr. Peter Dorhout of Kansas State University, who led the discussion as a Co-Chair. Dr. Dorhout summarized the previous week's call, and shared the document he created with input from the other Co-Chairs outlining "bins" or "buckets" for the group to focus on in the coming months. He identified four broad topic areas, and within each area listed strengths, threats, and opportunities for countering those threats. Appended to each item was a list of policy recommendations that were developed during the group's conversations in Phase I of the Commission this Spring. Dr. Dorhout's document has been posted to the online portal for further discussion and viewing. The first bucket, Global Competitiveness and Existential Threats, deals with the challenges to U.S. dominance and competitiveness posed by China and other challengers, and the importance of working with our allies to develop a coherent policy to counter them. The second bucket, National Regulatory Environment, deals with tax, trade, and other regulatory policies that either foster or hinder innovation and competitiveness. The third, Regional and Local Innovation Ecosystems, focuses on developing innovation capacity and competitiveness throughout

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the country to ensure broad-based and inclusive prosperity. Finally, Systems Infrastructure includes all other topics, including broadband and telecommunications connectivity, transportation infrastructure and logistics, and other enabling infrastructure to link together the components of the national innovation ecosystem.

Co-Chair Remarks

Mr. Tad Lipsky of George Mason University's Antonin Scalia Law School elaborated on the issue of antitrust policy, especially in the context of international trade and foreign relations. While not advocating for a new international body to oversee antitrust disputes, Mr. Lipsky called for greater executive branch capacity to address antitrust enforcement issues, as existing trade agreements are not a useful vehicle for guaranteeing the Rule of Law in foreign antitrust policy, or for getting foreign countries to remove protectionist elements from their antitrust regimes. He suggested the development of a sui generis body for negotiating mutual antitrust agreements, similar to other bodies that have developed for coordinating the prosecution of white collar crime and the adoption of technological standards.

Mr. Olin Wethington of Wethington International LLC offered several suggestions for additional topics for the group to address. First, he called for greater incorporation of science and technology concerns in federal policy making, especially for economic policy. Mr. Wethington observed that the Office of Science and Technology Policy and the President's Science Advisor are not consistently integrated into the decisions of the National Economic Council, and that the federal government must take more of a portfolio approach to policy making, especially for decisions that have a science and technology dimension. Second, Mr. Wethington stressed the need to identify key technologies for future U.S. competitiveness and target investment in those technologies in conjunction with the private sector. While he believed this was necessary to compete with China, Mr. Wethington urged the U.S. to continue to prize market competition as the means for determining champion technologies and firms, even amid public-private partnership and strategic investment. Third, Mr. Wethington warned that the U.S. was losing opportunities to shape international institutions and global rules and standards around emerging technology, including digital communications, as well as areas like privacy standards and trade norms. He observed that the U.S. could maximize its leverage in these areas by coordinating with our allies, and warned that many international institutions are now headed by Chinese nationals in a trend that is counter to long-term U.S. interests. Finally, Mr. Wethington stressed the importance of an international coordinating regime governing the transfer of critical technologies, industrial espionage, and theft of intellectual property, all of which are used by China to gain an advantage over the United States in critical technologies.

Organization of Science and Technology Policy

The group discussed many ideas for improving the coordination and efficacy of U.S. science and technology policy, as well as its handling of international economic disputes. Ms. Wince-Smith noted that in Democratic administrations scientific advisors have been involved in economic policy making, but Council Senior Advisor Ms. Carol Ann Meares noted that this involvement stopped short of the role Mr. Wethington envisioned. Ms. Wince-Smith also asked which international organizations the U.S. should prioritize for deeper engagement, and suggested the Organization for Economic Cooperation and Development (OECD) and World Trade Organization (WTO). Mr. Evans asked if it was desirable or realistic to integrate the head of the Office of Science and Technology Policy (OSTP) or the President's Science Advisor into economic decision making, and Dr. Dorhout called for greater leveraging of U.S. laboratory infrastructure and capacity. He contrasted the lack of coordination in the U.S. with China's efforts to both build out their research capacity and coordinate their research agendas.

Dr. Gerald Blazey of Northern Illinois University called for the establishment of a Secretary of Science and Technology. He said that without a designated voice for science and technology in federal policy making, there will be continual oversights and inefficiencies in funding scientific research, and whenever the government does invest in solving a technological problem, the funding is spread out among a large number of mission-driven agencies. As these agencies are primarily concerned with using funding to further their own missions, it is very difficult to lead an all-of-government initiative aimed at solving cross-cutting problems. Dr. Blazey gave the example of exascale computing, where funding is split among the Department of Energy, IARPA, the National Science Foundation, and several classified agencies. While he expressed hope that the proposed Endless Frontiers Act would address this coordination problem, he encouraged the group to review its provisions and make a decision on endorsing it formally. Dr. Blazey also emphasized the need for an organization focused on R&D funding, as without an overarching strategy the government will not spend money efficiently on investment opportunities. Finally, he stressed the need to build a policy that focuses on all present and future competitors of the United States in the scientific and technological space, as China will not be the only challenger in the coming decades.

Ms. Wince-Smith shared takeaways from the first Working Group's meeting, including the need to develop supply chains for key technologies and the need to focus on scaling. She said that without scaling mechanisms in place, any investment in R&D in the U.S. would become seed corn for Chinese technological innovation. She also relayed the warning of former SEMATECH head Mr. Dan Armbrust that without a supply chain to ensure they are produced for the benefit of the U.S. market, advances in microprocessor technologies that supplant Moore's Law and CMOS Computing will not redound to the advantage of the U.S., but to our competitors. Ms. Wince-Smith also reported that there have been previous efforts to develop a Department of Science, but that they have always been met by fierce pushback from those who benefit from the status quo of diffuse federal funding sources. She added that the Endless Frontiers Act was also facing resistance from entrenched interests. Dr. Blazey said that while having decentralized funding sources was important for curiosity-driven scientific research, it was an obstacle for whole-of-government initiatives, and that the two approaches were not mutually exclusive.

Venture Capital, Foreign Investment, and Incentives

Ms. Wince-Smith suggested increasing both the funding and enforcement capabilities of the Committee on Foreign Investment in the United States (CFIUS). In particular, Ms. Wince-Smith called for authority for CFIUS to investigate the ownership stakes and funding sources for startups and venture capital funds. She noted that CFIUS mostly focuses on mergers and acquisitions, and as a result does not address the undisclosed Chinese investment into innovative U.S. startup firms in order to access their IP. Mr. Wethington said CFIUS's main obstacle in investigating startups was a lack of funding and personnel, but agreed it was an a valid and important task for CFIUS. Ms. Julie Lenzer of the University of Maryland said that putting new restrictions on funding sources for startups made it even more important to identify new funding sources for those companies, as many were already struggling to attract the interest of venture capital firms. Ms. Wince-Smith noted that hedge funds and private equity firms held trillions in uninvested assets, and Ms. Lenzer said it was important to incentivize their investment in U.S. startups. However, she brought up the example of the Opportunity Zones initiative as a lesson in the risks of such policies. She said that most investments under the Opportunity Zone program went into commercial real estate rather than their intended target of revitalizing businesses and entrepreneurship in disadvantaged communities. Dr. Blazey blamed the failure of the Opportunity Zone initiative on a lack of direction that resulted in investors choosing the lowest risk, highest reward channel, which was real estate.

Ms. Ji Mi Choi of Arizona State University reminded the group that in addition to universities already investing in helping students spin out intellectual property from their on-campus research under generous terms, there was a need to discuss securing taxpayer buy-in for federal investment in startups. She discussed the concept of returns to taxpayer shareholders, and the need to make the benefits clear and tangible to the public. Ms. Choi also encouraged the group to look at existing proposals for legislation addressing science and technology, and to develop a position on them rather than independently restating their ideas.

Tax Policy and Other Changes

Ms. Rebecca Macieira-Kaufmann suggested developing preferential tax treatment for long-term investment in key technologies in order to entice capital to flow there. By having a different tax structure for long-term capital gains, the government could reduce the bureaucracy and the risks involved with investments in disruptive innovation and elicit funding from hedge funds and private equity. Ms. Rachel Jagoda Brunette of the Lemelson Foundation mentioned the community capital movement, which adjusts accredited investor rules to make it easier to invest smaller amounts of money in areas underserved by investment, while also democratizing the benefits of investing. Dr. Ken Poole of the Center for Regional Economic Competitiveness observed that many of the changes the Commission wants to see involve the adoption of technology by existing companies, and proposed tax incentives for companies that obtain and deploy technology developed by startups. Mr. Evans suggested a tax break for companies that incubate startups, and Dr. Blazey said that any such initiatives would need to have guidelines and directions to ensure capital did not flow to the lowest-risk activity like in the Opportunity Zones program.

Ms. Wince-Smith asked what could be done to encourage venture capital firms to hold onto investments longer and be more patient, and Mr. Wethington said that he liked the idea of tax incentives for incubating startups. He added that tax policy adjustments were a good way to change incentives facing private capital to encourage investment of unused funds. Dr. Cheryl Martin of Harwich Partners said that the experience of "Green Banks" that invested in renewable energy technology showed that traditional banks were not structured to make investments in markets that have not developed yet, and Ms. Macieira-Kaufmann said that banks often have interest in facilitating partnerships between startups and large companies willing to invest in them, but that all involved parties lack the ability to scale their investment. Ms. Wince-Smith reminded the group that even establishing the R&E tax credit was controversial and provoked pushback

Finally, Ms. Wince-Smith suggested the development of a domestic infrastructure bank. She noted that while other nations, including U.S. competitors, had banks to facilitate risky but valuable infrastructure investments, the Export-Import Bank of the United States did not have the authority to invest

in domestic projects. Dr. Blazey also endorsed the idea of a quasi-independent investment bank that drew its funding from tax breaks for strategic long-term investments. Ms. Wince-Smith also suggested reforming bankruptcy laws to encourage greater investment in early stage technologies.

Finalizing the Buckets

Dr. Poole encouraged the group to think about finalizing the buckets for future discussion, including the identification of one or two problem statements that group will strive to solve with recommendations, as well as sub-topics to focus on within each bucket. He said the discussions today had largely focused on the first bucket, and wanted to ensure a clear roadmap for the others. Ms. Lenzer said it was important to make sure the U.S. ecosystem was strong, including access to talent and capital. Mr. Thomas Dailey of Dailey Strategic Advisors, LLC suggested identifying ten technologies or industries where the U.S. was falling behind, and "backing into" a public-private partnership to address each one. He added that the group had plenty of expertise to tap into in particular technologies.

Concluding Thoughts

Dr. Dorhout thanked the group for its conversation and suggestions, and said that he would work on both updating the list of "buckets" following input from the group and discussion with the other Co-Chairs, and on developing the agenda for next week's calls. Mr. Evans said that in addition to the usual summary, the Council would send out an amended version of Dr. Dorhout's document outlining the current buckets to expedite feedback. He said that the next couple days were the chance for members to provide final input into the topics covered. The group will meet again next Tuesday, July 14th.

Working Group 3 Calls July 14

Introduction

The Honorable Deborah Wince-Smith and Mr. Chad Evans welcomed the group, and Mr. Evans said that the session would be focused on building consensus about the "buckets" of issues that the group would discuss in the coming weeks. He summarized the previous week's discussion and the results of the weekly Co-Chair discussion call, in which four broad topic areas were established: global competitiveness and existential threats, the national regulatory environment, regional and local innovation systems, and systems infrastructure. Mr. Evans said he wanted to make sure the group's sentiments were accurately recorded, and turned the discussion over to the Co-Chairs. Ms. Vickie Lonker of Verizon said it would be good for the group to take a deep dive into the issues laid out, and simplify what the group

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was trying to achieve. She suggested using a SWOT (Strengths, Weaknesses, Opportunities, and Threats) analysis to approach each issue.

Buckets, Problem Statements, and Solutions

Mr. Evans discussed the Appendix stemming from the Commission's Phase I synthesis document, which included policy recommendations that had emerged from the group's discussions. He described the process the Co-Chairs went through of sorting the themes and ideas from those discussions into the four buckets, and categorizing them as strengths, threats, or opportunities. He also identified the need for problem statements to focus the group's attention and provide a guide to developing recommendations. Dr. Peter Dorhout of Kansas State University agreed that it was important to codify the buckets, and asked how they should be defined. He suggested that the ideas in the Appendix could be fleshed out as solutions to problems, and that the problem statements could emerge from a SWOT analysis of each bucket. Dr. Russell Carrington of Lawrence Berkeley National Laboratory asked how much time would be devoted to each bucket, and Mr. Evans said that beginning next week, the group would engage in deep dives on one bucket at a time, but that the goal was to provide an overview for all of them during this session. Ms. Ji Mi Choi asked if the ideas in the Appendix were the right basis on which to formulate recommendations, and how the group should rank them, as well as what diligence was necessary to validate them. She noted that some of the ideas from the Appendix were already in place at the federal or local level. Dr. Kenneth Poole of the Center for Regional Economic Competitiveness advocated focusing on the Appendix, as once the group was clear on the nature of a problem, it would be easier to identify recommendations for enhancing strengths, improving weaknesses, and leveraging opportunities.

Issue 1: Global Competitiveness and Existential Threats

Dr. Poole suggested that the problem facing the country in global competitiveness was the U.S.'s lack of coordinated industrial policy in the face of challenges from mercantilist competitors like China. Mr. Olin Wethington of Wethington International LLC agreed, and observed that the U.S. was beginning to consider moving from market-based solutions to more involved federal policy on this front. He also emphasized the national security character of the issues within the first bucket. Technologies like 5G and AI pose threats of national security disruption, and many of the sub-items from the Appendix that the Co-Chairs identified concern mitigating the national security threats posed by Chinese or other foreign leadership in these fields. Dr. Ushma Kriplani of Argonne National Laboratory observed that all of the four buckets ultimately related to national industrial policy, which in turn had geopolitical and security implications. She said that everything from emergency management to critical technology and supply chains influenced national security and was influenced by national security concerns. Ms. Ji Mi Choi of Arizona State University concurred, and said that this bucket could be characterized as an assessment of our competitors' strategies versus our own. She also suggested using SWOT analysis to identify necessary recommendations under each bucket, and to have the group divide and conquer on these topics. Mr. Evans noted that Working Group 4 was already beginning to subdivide, and that the Council could send out a poll to help sort participants into sub-groups.

Ms. Wince-Smith reminded the group that it had a unique focus on enabling conditions that accelerate or inhibit the generation of wealth and jobs. In this vein, she listed U.S. strengths as our legal system and the liquidity of our capital markets, and weaknesses as financing from China of entrepreneurs in key sectors, the short-term focus of investors and lack of long-term patient capital, and accounting and

financial systems that encouraged said short-term focus. Ms. Rebecca Macieira-Kaufmann suggested combining the various U.S. advantages in liquidity and legal policies under the umbrella of a free market economy, and Mr. Thomas Dailey of Dailey Strategic Advisors LLC warned that China was not the only threat. He particularly cited the EU's exporting rules and the General Data Protection Regulation as potential threats to U.S. business. Dr. Poole observed that Europe was taking the lead in areas like digitalization and privacy protections, while Mr. William Eggers of Deloitte shared research suggesting that some of the EU's AI regulations were actually harmful to its competitiveness.

Issue 2: National Regulatory Environment

Mr. Evans listed key sub-topics for the national regulatory environment as antitrust policy, intellectual property management, and the rule of law. Dr. Poole suggested a problem statement focused on the lack of adaptation by the U.S. regulatory system to new technology and international competition, hindering competitiveness. He added that the first bucket was concerned with looking outward at external forces threatening the U.S., while this bucket was focused on how the U.S. was hamstringing itself. Dr. Kriplani said that even the domestic regulatory landscape in particular country must be evaluated in the context of the international regulatory climate, and that while America may face threats where it lags in nimbleness and agility, it might lead in other areas. Dr. Kriplani suggested not focusing on areas where the U.S. is more competitive, like antitrust, and focusing more on areas like the adoption of energy standards, where the U.S. lags well behind the EU and China. Ms. Wince-Smith discussed the challenges facing energy regulation in the U.S., including balancing federal and state laws, consumer protection, safety, and health. She observed that utilities don't invest in innovation because of an outdated regulatory system, and that product liability issues lead to offshoring of production for whole classes of chemicals. However, she stressed the need for the U.S. to maintain critical safety regulations, contrasting our pharmaceutical safety standards with those of China. Ms. Anne Tucker of Georgia State University cautioned against wholesale rejection of liability lawsuits, as they helped to protect abuse and their deterrent effect lessened the need for formal regulation, and Dr. Anthony Margida of TechGrit agreed.

Dr. Gerald Blazey of Northern Illinois University said that regulatory burdens also weighed heavily on research universities, and that academics had to spend increasing amounts of their time on compliance. He warned that despite being a perennial issue, there had been no progress on this front within academia. Mr. Evans emphasized Mr. Dailey's earlier point about other threats to U.S. leadership besides China, and Mr. Eggers agreed that the U.S. often sat on the sidelines during the development of international technology regulatory standards. Mr. Dailey said that because AI, like 5G and broadband, acts as an enabler for a host of other innovations, the U.S. could not afford not to engage in setting standards, lest we find ourselves left behind by our competition. Dr. Blazey said the U.S. was also falling behind in setting standards for exoskeleton technology, and Mr. Evans emphasized that this group is the only one dedicated to the question of standards and regulations. Mr. Eggers said he was part of a World Economic Forum group focusing on agile regulation models, and offered to share relevant findings with the group.

Dr. Blazey asked how visa reform fit into the buckets framework, and Mr. Evans said that Working Groups 3 and 4 could both touch on the topic. Ms. Choi suggested that the immigration questions fit under the first bucket, and Ms. Wince-Smith said that the issue should be expanded to systemic immigration reform. She observed the contrast in policies between the U.S. and Canada, with Canada courting high-skilled immigration around the world, while the U.S. made it very difficult for people to immigrate. Dr. Dorhout noted that China was beginning to try and attract talent with its 1,000 Talents program, including returning expatriates and attracting new immigrants. Mr. Wethington stressed that the group

needed to emphasize the continued importance of the private sector as a driver of innovation. While he advocated more of a role for the federal government in balancing, facilitating, and offering incentives to the private sector, Mr. Wethington characterized the market orientation of the U.S. economy as crucial to its competitiveness.

Issue 3: Regional and Local Innovation Systems

Dr. Poole suggested a problem statement for the regional and local innovation systems bucket as the concentration of innovation capacity and venture capital in certain areas and among certain groups of innovators, limiting growth, exacerbating geographic, gender, and racial inequality, and contributing to increased social welfare costs as regions struggle. Mr. Evans characterized the bucket at concerning the equitable spread of innovation, and Dr. Poole said it was important to be intentional about ensuring opportunity extends beyond Silicon Valley, New York, and Boston. Ms. Choi asked how to strike a balance between being a market-led economy and applying an active federal strategy to close prosperity gaps, and Dr. Poole said the emphasis should be on equality of opportunity, not of outcome. He noted that many places have a natural advantage simply based on where they were, who lived there, and who and what they were connected to. By expanding opportunity, the U.S. could create more efficiency and reduce the social costs of economic stagnation and lack of opportunity.

Ms. Rachel Jagoda Brunette of the Lemelson Foundation said that some communities resist efforts at economic development that they fear would change their local culture. She emphasized the need to create demand for the expansion of innovation and opportunity. Dr. Poole said that with fifty states and thousands of localities, it was important to recognize the role of sub-national governments in crafting local policies, and the importance of federalism.

Ms. Wince-Smith noted that this topic was a primary focus for Working Group 4, and urged the group to focus on tax policy, regulations, and standards. She warned that the U.S. was being left behind because of a lack of a coordinated strategy to develop standards for new technologies, and the high costs of regulatory compliance. She also discussed the importance of private property rights over key resources like minerals, attributing the success of the U.S. oil and gas industry to private ownership of resource rights, which incentivizes innovation. Dr. Poole suggested that minimizing the cost of regulation be a focus of the second bucket, while Mr. Wethington said that not all of the sub-topics in the group's purview were equally important. He recommended elevating standards setting, capital issues, and tax policies above other topics, and suggested the Co-Chairs play a role in establishing priorities for the group. Mr. Dailey argued there was a trade-off between not constraining the development of new technology with premature standards development and allowing other countries to potentially dominate the standards-setting process. Dr. Dorhout noted that the policy recommendations in the Appendix were developed before the creation of Working Group 4, and suggested that the group focus primarily on issues that did not overlap with Working Group 4's mandate.

Issue 4: Systems Infrastructure

Dr. Poole suggested a problem statement for the systems infrastructure bucket as well: that deteriorating U.S. infrastructure quality was becoming an impediment to U.S. competitiveness and inhibiting growth. He also advocated developing parameters to measure the success of recommendations for each bucket. Ms. Wince-Smith said that U.S. commercial air traffic control lagged behind the standards of the military and of commercial aviation in other countries, and that this posed a serious challenge to transportation that harmed competitiveness. She also advocated the establishment of a national infra-

structure bank, and identifying the impediments to implementing universal broadband and 5G. Dr. Karl Smith of the Tax Foundation said that construction costs for infrastructure projects were much higher in the U.S. than in other developed countries, and that the precise cause was not known. He suggested the group investigate this as a productivity inhibitor. Mr. Wethington warned that the country desperately needed a national infrastructure policy that address the overhauling of legacy infrastructure, and argued there was a need for political commitment to infrastructure issues. Mr. Eggers suggested including 5G and 6G infrastructure, as well as low-earth orbit satellites and space technology as important infrastructure pieces.

Concluding Thoughts and the Road Ahead

Mr. Evans said that from the group's discussions it was clear that the Council team and Co-Chairs needed to adjust the buckets to emphasize key issues more, including long-term capital investments and standards, and avoid duplication of Working Group 4's work. He said the Council and Co-Chairs would work on refining the buckets and sending an updated version for feedback, and if the group reached a consensus, send out a poll to identify personnel for subgroups. He said these tasks would be accomplished ahead of next week's call, and Mr. Wethington and Ms. Lonker both expressed support for this plan. Mr. Evans also reminded the group that the Council's Competitiveness Watch dialogue as part of its Technology Leadership and Strategy Initiative is on Thursday, and that group members are welcome to attend. The featured speaker will be The Honorable Michael J. Kratsios, Chief Technology Officer of the United States and Deputy Assistant to the President, White House Office of Science and Technology Policy. He has also been nominated to serve as Under Secretary of Defense for Research and Engineering, and will discuss the administration's AI efforts, COVID-19 response, and other priorities. The next meeting of the Working Group will be on Tuesday, July 21st.

Working Group 3 Calls July 21

Introduction

The Honorable Deborah Wince-Smith and Mr. Chad Evans welcomed the group. Mr. Evans said the purpose of the call would be to go over the priority issue areas for the group with renewed emphasis on topics, like capital formation, that were left out of the previous SWOT (Strengths, Weaknesses, Opportunities, Threats) document outlining problem statements in key issue areas and recommendations for addressing them. In addition, Mr. Evans expressed the need to prioritize the issues and develop a road map for tackling each of them. He said he would send a poll to group members asking them to identify which topic areas they would like to contribute more on as members of subgroups. Subgroup members would engage in additional background preparation and help lead discussions when the whole group considers their chosen issues. Finally, Mr. Evans welcomed a new member of the Working Group, Dr. Michael Paulus of Oak Ridge National Laboratory.

Issue One: Global Competitiveness and Existential Threats

The first issue area Mr. Evans shared with the group concerned America's global competitiveness and existential threats to that competitiveness. As problem statements, the Co-Chairs identified developing

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a clear understanding of national targeted technologies, national stockpiles of key items and manufacturing tools related to those technologies, and strong international standards and regulations to have fair global competition and prevent intellectual property theft. Ms. Wince-Smith said that because this issue was an overarching one that touched on the challenges identified in the other three issues, the SWOT document should include strengths and weaknesses related to these challenges. She listed deep liquid capital markets and robust venture capital as additions to the strengths column, and the uneven spread of venture capital across the country as an important weakness. Ms. Wince-Smith also identified infrastructural decline as a major weakness impacting America's competitiveness.

Issue Two: National Regulatory Environment

On the issue of the national regulatory environment, Mr. Evans identified the problem statement as how to unburden American businesses and address an antiquated bureaucracy that is not adapting to the new realities of global competition. Dr. Kenneth Poole of the Center for Regional Economic Competitiveness asked if the U.S. legal system was part of this priority area. He said that often it is not regulation itself, but the inability for the courts to reach a timely decision when ruling on regulations, that inhibits investment decisions. Firms face uncertainty over whether they can proceed with actions or investments and end up abandoning them. This is especially true with pipelines and other infrastructure projects undergoing environmental review. Dr. Poole added that the National Governors Association was conducting a policy academy at the state level on this topic in conjunction with the Pew Charitable Trusts. Ms. Wince-Smith said that the growing cost burden of regulatory compliance for small- and medium-sized business was a weakness, as well the proliferation of regulations. Additionally, she cited the treble damages rule for product liability as a major obstacle to domestic production of key materials and technologies.

Ms. Julie Lenzer of the University of Maryland noted that regulations are designed for old technologies and business models and often inhibit innovative businesses. In particular, she cited Uber, which has faced pressure from regulatory models that are not built to facilitate "sharing economy" businesses. Ms. Lenzer said that regulations should not be put in place to protect antiquated industries. Ms. Rebecca Macieira-Kaufmann agreed, and cited California's recent law preventing Uber employees from working as independent contractors, and laws on short-term leasing of property that have hindered companies like AirBnB. She joined Ms. Lenzer in emphasizing that the current regulatory system was outdated and contrary to the wishes of the workers in new industries, like Uber drivers who prefer to freelance over full-time employment. Mr. Thomas Dailey of Dailey Strategic Ventures LLC said that regulatory consistency across agencies was a major issue, especially for emerging technologies like 5G. Mr. Evans remarked that just as the U.S. needs to prepare for the jobs and workforce of the future, it must also focus on developing the regulatory environment of the future that is conducive to the unleashing of innovation and growth.

Issue Three: Systems Infrastructure

The third priority area, systems infrastructure, identifies as a problem statement that the deteriorating quality of U.S. infrastructure, along with higher costs for infrastructure renovations compared to other developed countries, is inhibiting growth and competitiveness. The Honorable Olin Wethington of Wethington International LLC expressed support for a national infrastructure bank to finance infrastructure projects. He observed that states already have infrastructure banks, and encouraged the group to include an infrastructure bank as a recommendation rather than an opportunity on the SWOT document, in order to better flesh out pros and cons. Ms. Wince-Smith said that access to energy and power was a strength, but that the splintering of America's energy system and the unwillingness of utilities to invest in improvements because of an inability to recoup investments through higher rates were weak-

nesses. She further identified weaknesses in America's water infrastructure as a weakness. Mr. Dailey stressed the need for greater resiliency in America's supply chains. He said the country needed to being preparing for the next disaster ahead of time, and Dr. Poole added that supply chain resiliency impacts food security, healthcare security, and national security among other things. Ms. Lenzer asked how to lessen America's dependence on China for its medical supply chains, and Dr. Poole said that this would require changing the incentives faced by procurement officers, who are pushed to find the greatest cost efficiencies at the expense of resiliency or redundancy. Only by changing the demand incentives companies face can the U.S. improve its supply chain resiliency.

Ms. Ann Gabriel of Elsevier said that infrastructure issues were impacting scholarly communication, and Ms. Macieira-Kaufmann underscored the role of housing and zoning regulations in infrastructure and competitiveness. She discussed the resistance among the "Haves" in the Bay Area, a hub for innovation, towards building more new housing, exacerbating the housing shortage, increasing costs of living, and preventing more people from accessing the region's prosperity. Ms. Wince-Smith noted that the Council's 2016 publication No Recovery, a joint effort with Gallup, found that 3 percent annual GDP growth was necessary for continued progress in America's standard of living, but that housing, education, and healthcare, which comprise 36 percent of the economy, have seen virtually no productivity growth in recent decades.

Issue Four: Capital and Financing Innovation

The final issue the group discussed concerned capital, including where it is deployed, who receives it, and how it should be defined. Several participants argued for a broader definition of capital. Dr. Sunil Mithas of the University of South Florida argued that human capital and the workforce should be incorporated, and said that America's economy benefits tremendously from its ability to attract high-skilled immigration from all over the world. He emphasized that improving policies to attract and retain human capital do not require the expenditure of new funds, and are ripe for quick implementation. Dr. Russell Carrington of Lawrence Berkeley National Laboratory argued that infrastructure and facilities, including labs and equipment, should be seen as a form of capital, as they enable innovation to take place. Mr. Evans agreed with the importance of these components, and noted that Working Group 4 is heavily focused on human capital.

Another important issue for participants was the distribution of capital, with a focus on diversity and inclusion. Ms. Lenzer observed that women and minorities do not receive most venture capital funding, and that even programs designed to set aside investment funding for minority- and women-owned businesses often fail to serve these populations. If a female-founded business attracts enough investors so that women hold less than 51 percent of shares, the business is no longer eligible for these federal investments, even though these businesses represent the female-founded startups with some of the highest chances at success. Ms. Macieira-Kaufmann said that a major challenge for increasing the diversity of the startup world was the importance of networking in venture capitalists' funding decisions. Because the vast majority of venture capital investors, investment bankers, and private equity investors are male, they tend to invest in people from within relatively narrow, homogeneous social networks. Ms. Macieira-Kaufmann said more initiatives like Him for Her, which connects male venture capital investors to female startup founders, and more representation of women and minorities on boards and in other spaces in the investment world will be key to increasing access to venture capital funding for underserved entrepreneurs. Ms. Rachel Jagoda Brunette of the Lemelson Foundation agreed, and suggested working to increase the diversity of venture capital investors in order to increase the diversity of investment recipients. Ms. Lenzer added that networking effects, and their attendant effects on diversity, even extend to industry participation in public-private partnerships. Ms. Ji Mi Choi of Arizona State University said

that many of the problems of venture capital concentration came from the discrepancy between the short-term, individual benefits to investors and the long-term, overall benefits to society from particular investment decisions. She emphasized the need to distinguish between using policy to regulate investments and leveraging government funding to address the shortfall in the private market. Finally, she said that the wide variations in whether and how states provide unemployment benefits to those who quit their jobs to start a business presents both a weakness and an opportunity to reduce uncertainty and provide backing for entrepreneurs to take risks.

Participants also discussed the challenges of incentivizing long-term investment. While Ms. Macieira-Kaufmann noted that the typical investment period for venture capital is ten years, Ms. Wince-Smith said that venture capital firms often no longer wait the full ten years before trying to force a merger or acquiring the startup. She added that debt financing often forces companies to become highly leveraged in private equity buyouts where they become loaded up with debt. She suggested developing incentives for venture capital investors to hold their investments for longer in order to qualify for capital gains, and said that if current conditions prevailed in earlier decades, tech giants like Intel would never have attracted sufficient funding to start. Ms. Macieira-Kaufmann suggested framing the issue differently to get it to resonate, such as by shifting the focus to how patient capital is deployed rather than contrasting patient capital with venture capital investments. She also suggested developing a public-private partnership concept for funding these kinds of investments. Ms. Lenzer said that the IP-intensive, long-term research that is done at universities and labs is often more reliant and better suited for federal funding than for venture capital funding in spite of its frequent commercial potential. Ms. Wince-Smith warned that there were major implications if the U.S. was unable to provide financing for ideas developed at home, as companies in the "valley of death" are often acquired, along with their IP, by foreign investors. In addition to reiterating the need for a national infrastructure bank, she mentioned the Union Labor Life Insurance Company as an investor that is willing to invest in long-term projects and does not churn its funding, while still earning high returns.

Missing Pieces

Dr. Poole observed that the regional innovation issue area had been replaced by the capital issue area, and Mr. Evans confirmed this was deliberate due to the heavy focus of Working Group 4 on local and regional innovation ecosystems. Ms. Wince-Smith urged the group to focus more on standards and America's place in global trading systems. Mr. Wethington asked if standards had become part of the global competitiveness topic, but Mr. Evans said standards and trade would need to be highlighted more in the next iteration of the SWOT document. Dr. Mithas said that a revival of standards-based awards, such as the Baldrige Awards for product and busi-

ness quality, would create new standards for companies to aspire to and improve the competitiveness of U.S. firms by driving better-quality products.

Dr. Poole suggested including regional innovation and human capital and equity issues as a cross-cutting component of all four topics, and Ms. Wince-Smith also cited the national debt as a major weakness for U.S. competitiveness. Mr. Wethington discussed the importance of tax policy in incentivizing the persistence of capital, but suggested cataloging and surveying existing ideas and literature first to catch the group up on the latest thinking on the subject and provide ideas for existing recommendations that have yet to be adopted.

Concluding Remarks and the Road Ahead

Mr. Evans said that the Council team would refine the SWOT document over the next day and solicit feedback on the re-worked problem statements, following which he would send out a poll for participants to indicate the issues where they would like to engage more deeply. He said this would help the Council team and Co-Chairs develop a roadmap, including choosing which topic to begin discussing in depth over the next two to three weeks, and would signal how much interest there was from participants in each topic area. Mr. Wethington advocated announcing the schedule ahead of time for all of the topic areas, as some topics would require more advance preparation and background research from Working Group members. He also suggested surveying members to determine their availability to conducting research into particular topics. Ms. Wince-Smith said the Commission needed to include a charge for the U.S. to re-tune its leadership role in the world, as this was essential to the Council's goal of helping American companies be more competitive globally. She specifically cited the need for more U.S. involvement in international organizations and standards-setting bodies. The next meeting of the group will be on Tuesday, July 27th.

Working Group 3 Calls July 28

Introduction

The Honorable Deborah Wince-Smith and Mr. Chad Evans welcomed the group. Mr. Evans said that this session would be focused on establishing a road map for the remaining calls, and detailing the process of recommendation generation and background material preparation for each "swim lane" in the group. Mr. Evans also provided an overview of the status of the other three Working Groups. Working Group 1, which met earlier today, began discussing the topic of the structure and components of the U.S. innovation system, and in particular the need to establish consortia for innovation on platform technologies including advanced materials, microelectronics, and telecommunications. Next week, the group will discuss the National Laboratory system, including its infrastructure challenges and ways to improve its integration with the rest of the innovation ecosystem, along with ways to more fully leverage our nation's laboratory capabilities for developing and scaling disruptive technologies. Working Group 2, which met yesterday, discussed Dr. Albert Pisano of the University of California, San Diego's proposal for a network of innovation centers to accelerate the development of new technologies that are essential

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to sustainable production and consumption. This proposal is part of the group's broader look at innovation as a means of enhancing the U.S. production enterprise and leveraging energy abundance to transform the manufacturing space. Working Group 4 opened its discussion last Friday on regional and geographic innovation and inclusion, and this Friday will discuss the displaced workforce and Main Street entrepreneurship. Next Friday, it will discuss cultivating the innovation talent pipeline. Throughout the group's discussions, Working Group 4 will address questions of diversity and inclusion, in particular how to evaluate recommendations for their impact on the inclusion of underrepresented groups.

Choosing Conversation Topics

Mr. Evans laid out a plan for the group's discussions going forward. Four "swim lanes" have been established covering Global Competitiveness and Existential Threats, the National Regulatory Environment, Systems Infrastructure, and Financing and Fueling Innovation. He shared the results of the poll of Working Group members on preferred topics, and identified Co-Chairs who have volunteered to serve as guides. Dr. Peter Dorhout of Kansas State University will serve as the guide on the first topic, there is not yet a guide for the second topic, Ms. Vickie Lonker of Verizon will guide the third topic, and The Honorable Olin Wethington of Wethington International LLC will lead discussions of the fourth topic. Each week, the group would have an initial conversation on one of these priority areas, and then begin deep dives in the same order once each topic had been introduced. This gap between sessions dedicated to each swim lane gives group members who indicated interest in that particular lane time to develop comments, critiques, thoughts, and suggested policy recommendations that will form the basis of deeper discussions among the whole group on those subjects. During the time between focused discussions, the Council team can provide support, including gathering nascent recommendations that have emerged from previous group discussions. Mr. Evans said it was time to choose an order for discussing each swim lane and begin developing the ideas that have already emerged for each topic further. Dr. Dorhout asked if the subgroup tasked with developing ideas for next week's topic of conversation should gather offline to coordinate opening remarks, and Mr. Evans said the Council would send out contact information for the group, delineated by subgroup assignment. Ms. Lonker agreed with giving members of the subgroups time to digest the issues and share position statements, which the Council could then collate around various issues. Dr. Dorhout offered to lead a discussion on the first topic of Global Competitiveness and Existential Threats next week to begin the conversations.

What Recommendations Look Like

Mr. Wethington suggested that members of particular subgroups prepare one-page statements of recommendations ahead of calls focused on their topic, and also suggested the establishment of a template for recommendations. Mr. Evans said that the Council could recirculate ideas that have already emerged for each swim lane, and share past examples of effective recommendations from previous Council initiatives. Ms. Wince-Smith suggested that each statement of recommendations include the recommendation, why it is important, how it will be implemented, and what its expected impact will be. Ms. Carol Ann Meares, Senior Advisor to the Council on Competitiveness, suggested including a specification of which entities or agencies will be responsible for implementing the recommendation.

Ensuring Adequate Coverage of Topics

Ms. Wince-Smith noted that the topic of the National Regulatory Environment contained extremely important issues, and that she had reached out to the Honorable Walter Copan, Director of the National Institute of Standards and Technology, for experts in the private sector and former government officials on standards. She also discussed the need for this subgroup to discuss how regulations can either incentivize or hinder innovation, and how to strike a balance between innovation and safety, including the differing needs of differing industries. Ms. Wince-Smith

added that government procurement, especially the government's purchasing power, can provide strong first-mover advantages for emerging technologies, and warned that China was securing exemptions from WTO regulations on government procurement with their indigenous innovation programs, which they used to shut competitors out of their markets. Mr. Wethington suggested having members of subgroups commit to covering particular topics with their one-page recommendation statements, in order to map out gaps in coverage. He said that his topic of Financing and Fueling Innovation consisted of five discrete subtopics, and it was important to know who would be developing recommendations for each of them. Mr. Evans agreed and said the Council's contact database could assist with this. He added that group members had the option of organizing their recommendations and remarks via conversations on the online portal, and that mapping out coverage could help the Council figure out where more expertise was needed for the Working Group.

Dr. Dorhout noted that with the overlap in mandate between the swim lanes chosen by Working Group 1 and Working Group 3, the Council could share information between subgroups with similar missions so that one could cover topics not being addressed by the other. Mr. Evans said that the Council could provide a list of potential recommendations relevant to each subgroup, and send a reminder ahead of a focused call to subgroup members to provide the Co-Chairs with their recommendation statements, which could in turn be used to help the Co-Chairs provide framing remarks.

Concluding Thoughts and the Road Ahead

Ms. Wince-Smith noted there was a major antitrust hearing for several tech giants tomorrow that was relevant to the group's mandate, and Mr. Evans said the Council would send a link to the hearing along with the weekly call summary. He also reminded the group he would send out contact information for the different subgroups shortly, and in particular for the first subgroup on Global Competitiveness and Existential Threats. He then thanked the group for its thoughts and contributions. The next meeting of the group will be on Tuesday, August 4th.

Working Group 3 Calls August 4

Introduction

The Honorable Deborah Wince-Smith and Mr. Chad Evans welcomed the group. Mr. Evans said the day's discussion would focus on a deep dive into international "rules of the road" and the threat posed by competition from China and other competitors. He also provided an update of the state of the other Working Groups. Working Group 1, which met earlier today, discussed the structure and components of the U.S. innovation system, especially the national laboratory system and how to better leverage it in service of competitiveness goals, presented by Dr. Paul Hommert, former director of Sandia National Laboratory and a Distinguished Fellow with the Council on Competitiveness. Dr. Albert Pisano of the University of California, San Diego also shared his concept for a national network of innovation centers focused on platform technologies with the group, which he initially developed as a vehicle for innovations in sustainable production and consumption with Working Group 2. Working Group 2, which met yesterday, discussed best practices and efficiencies in sustainable production, including a discussion of the future of the hydrogen economy and the use of permitting to encourage sustainable manufacturing.

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Working Group 4, which meets on Fridays, spent last week discussing the displaced workforce and Main Street entrepreneurs, and will spend this Friday discussing the innovation talent pipeline and workforce issues. Dr. Isabelle Monlouis of Georgia State University noted that the group discussed involving the National Association for Community College Entrepreneurship (NACCE), and Ms. Ji Mi Choi of Arizona State University offered to connect the Council with NACCE's President and CEO. Ms. Wince-Smith noted that this Working Group is responsible for framing the discussion for the entire Commission, and has a very important task.

Developing Recommendations

Co-Chair Dr. Peter Dorhout of Kansas State University discussed the document the Council team sent out providing a rubric for developing recommendations and containing examples from previous Council initiatives. He noted that the group has a document consisting of a SWOT analysis, a problem statement, and a list of ideas to be distilled into key recommendations for each of the group's four "swim lanes." He went over the components of a recommendation, including a goal the recommendation hopes to achieve, the relevance of the goal, what the recommendation itself is, who is responsible for implementing the recommendation, how it should be implemented, and what the expected impact will be. Dr. Dorhout reminded the group in the context of the day's discussion topic around the challenge from China that any recommendations developed for a specific competitor could be broadly applied to other current or future competitors. Mr. Evans said it was important for the group to begin discussing concrete recommendations, and to put ideas down on paper to share with the group, allowing for iteration and collaboration during and between calls. He added that the Council is in discussions with the Deputy Director of the FBI regarding a possible briefing on issues surrounding China's challenge to the U.S. on a variety of issues, and that the Council is exploring new possible avenues for engagement with universities and the National Laboratory system.

Ms. Choi suggested specifying which recommendations contained dependencies in their implementation. She observed that often entities need Congressional or other high-level approval before they can engage on a topic, and that enabling an agency to act is not the same as requiring the agency to act or encouraging it to take ownership of an initiative. Dr. Dorhout agreed, noting as an example that the National Science Foundation cannot enact any recommendations involving the committal of funds unless it has its budget approved by appropriators. Mr. Evans added that while the example recommendations in the document the Council sent to members were all federal-level recommendations, members of the group should not feel obligated to focus their recommendations there if they believe they are more suited for academic, state/local government, or private sector audiences.

An Executive Antitrust Body

The group extensively discussed the recommendation idea, developed by Mr. Tad Lipsky of the Antonin Scalia Law School at George Mason University, a Senior Fellow at the Council on Competitiveness, for a high-level executive office to address threats to U.S. innovation. Mr. Lipsky said this concept has been pursued by numerous groups and individuals over the years, and that federal antitrust agencies are sympathetic to its aims, but are bound by bureaucratic constraints from addressing all but the most egregious problems. Further, numerous Free Trade Agreements, such as those with Chile, Peru, and the USMCA have provisions concerned with abuse of antitrust policy to threaten innovation. Mr. Lipsky said the real issue is a lack of focus. Presidents have intervened in major conflicts in the past on an ad hoc basis, such as President Clinton's successful efforts to prevent the EU from stopping the merger of Boeing and McDonald Douglas, and President Bush's unsuccessful attempt to enable the merger of GE and Honeywell. President Obama also intervened to stop Chinese attempts to bully a patent assertion entity that was licensing technology to China, including threatening to arrest its CEO.

Mr. Lipsky said that threats to innovation from antitrust come in two forms: protectionism disguised as antitrust action and lack of due process for U.S. firms accused of antitrust violations by foreign competitors, especially the EU and China. Protectionist policies include blocking mergers and acquisitions by U.S. companies on spurious grounds, often to protect a "champion" firm from competition, such as EU attempts to block Boeing's merger with McDonald Douglas to protect Airbus. Due process violations include threats of grievous consequences from Chinese anti-monopoly authorities for U.S. firms accused of antitrust violations, including warning them not to hire lawyers, and the EU's prohibition of the submission of arguments or evidence on behalf of accused firms and the lack of a neutral third party to adjudicate cases.

In order to combat these anti-innovation policies, Mr. Lipsky proposed creating an office within the Executive Office of the President, that would handle these disputes and provide expertise and continuity of policies, in a similar fashion to the U.S. Trade Representative for trade disputes. This idea is similar to the recommendation of a convening of experts by the Chamber of Commerce in 2017. The Honorable Olin Wethington of Wethington International, LLC suggested making the head of this office a permanent member of the National Security Council and the National Economic Council, and advocated for representation of science and technology expertise on these councils even beyond antitrust policy. This office and advisor would put forth policies to promote American innovation and competitiveness. Ms. Wince-Smith noted that science and technology advisors had been included in the NSC and NEC sporadically in past administrations, but not on a permanent basis like in Mr. Wethington's proposal. Mr. Evans said that a recommendation was emerging around a Deputy Assistant to the President alongside a small standing group with expertise and continuity to stay attuned to antitrust issues. The expected impact would be to reduce antitrust abuses by America's competitors, including protectionism under the pretext of antitrust enforcement and gross violations of due process in antitrust hearings.

Punitive Measures to Protect Innovation

Ms. Wince-Smith said the recommendation needed to have a stronger punitive element in order to alter competitors' behavior. She suggested calculating the economic harm done to U.S. firms prosecuted under abusive antitrust policies and using this as a basis for damages and sanctions imposed on the prosecuting country. She added that these measures could be adopted for intellectual property disputes as well, as by the time a case makes its way to the International Trade Commission, the affected firm has gone out of business. Mr. Lipsky said this approach has been tried in the past, most notably with respect to Japan's unfair antitrust practices against Kodak where the US imposed sanctions on Fuji, but that the judgment did not help Kodak break into the Japanese market. He added that trade agencies don't acquire expertise that is relevant to assessing and resolving these trade disputes, and that while trade agencies should have a seat at the table in antitrust discussions, they have not proven especially effective in the past in facilitating long-term improvement. Dr. Dorhout asked if Mr. Wethington, Mr. Lipsky, and Ms. Wince-Smith would spearhead a group to develop a more detailed version of this recommendation. Mr. Wethington said that the President already has the authority to take these kinds of actions, and that the real question concerns where the staff needed to develop and present the U.S.'s case would be housed. Ms. Wince-Smith reiterated the need to develop a way to calculate the damage done to U.S. firms by anti-competitive behavior in order to ensure that the U.S. response has teeth.

Partnerships with Allies

Dr. Dorhout asked if there were opportunities for collaboration with America's allies to push back on unfair antitrust practices and other challenges from competitors like China. In particular, he suggested Australia, Canada, and the United Kingdom. Ms. Julie Lenzer of the University of Maryland discussed an article she shared on the online portal that noted the shared interests of the U.S., Canada, and Mexico on international trade, IP, and related issues, and Mr.

Thomas Dailey, formerly of Verizon, suggested the Five Eyes (U.S., Canada, United Kingdom, Australia, and New Zealand) along with Mexico, as they had common interests in this regard. Mr. Dailey added that Japan also shares common interests with the U.S. regarding China, and cautioned against making the alliance too large, as it could become unwieldy. Ms. Lenzer discussed the ease with which the U.S. has allied with the UK, Australia, and Germany on other threats from China, but said she did not know if those countries were aligned with the United States on antitrust. She suggested unilaterally taking a stand first and then seeking support from other countries. Ms. Wince-Smith suggested other countries with whom the U.S. has strong bilateral trade agreements, as well as emerging nations like Brazil and India.

Mr. Lipsky said his experience was that multilateral approaches seldom led to concrete progress, and that bilateral agreements had at most convinced countries like Canada and South Korea to commit to avoiding the worst antitrust abuses on paper. Ms. Wince-Smith discussed her conversations with the head of the Brazilian Patent and Trademark Office, and his concern with the pressure China is placing on Brazil to adopt Huawei 5G infrastructure. He said the Minister of the Economy is reluctant to use Huawei, which could be an opportunity for the U.S., and Ms. Wince-Smith added that Brazil is working with the U.K.'s Office of Prosperity, analogous to the U.S. Agency for International Development (USAID) to develop a high standard of IP protection on par with the U.S. and Britain. She said strong IP standards were important for attracting foreign direct investment and partnerships and for ensuring robust economic growth. Dr. Dorhout asked if Ms. Choi, Mr. Dailey, and Ms. Lenzer would be willing to develop a more detailed recommendation outlining a strategy for alliances and partnerships to enforce U.S. norms and standards, and they agreed.

Concluding Thoughts and the Road Ahead

Mr. Evans thanked Dr. Dorhout for leading the day's discussion, and thanked the group for its very rich and concrete conversation. He said he would be happy to re-share the poll of group members on their preferred swim lanes, and asked members of the different swim lanes to develop recommendations similar to the one presented by Mr. Lipsky based on the ideas that have emerged in their swim lane as reflected on the SWOT document. Mr. Evans encouraged the group to spend time offline sharing and iterating on these ideas and recommendations, using the Council rubric to guide their structure. He noted that each Co-Chair is leading one of the swim lanes, and that the Council team can provide support to facilitate these discussions. Mr. Evans said the goal was for these interstitial sessions to be used for developing recommendations so that whole-group discussions could be focused on specific recommendations like today's. He added that he would get back to the group once a discussion topic has been selected for next week's session in order to give members of the relevant swim lane time to prepare. The next meeting of the group will be Tuesday, August 11th.

Working Group 3 Calls August 11

Introduction

The Honorable Deborah-Wince Smith and Mr. Chad Evans welcomed the group. Mr. Evans discussed the agenda for the day's call, including a preview of the upcoming strategic writing and reflection period and introducing the featured speaker, The Honorable Olin Wethington of Wethington International, LLC. Mr. Evans also discussed the progress and current agenda of the other three Working Groups. Working Group 1, which meets on Tuesdays, discussed the upcoming strategic reflection period and worked on redefining and refocusing its swim lanes ahead of this hiatus. Working Group 2, which meets on Mondays, continued its discussion around a national network of innovation centers for technologies critical for sustainable production and consumption. Working Group 4, which meets on Fridays, spent last week discussing the innovation talent pipeline and workforce development, and this week will return to questions of regional innovation and geographic inclusion.

Strategic Writing Period and Featured Remarks

During the next two weeks, the weekly Working Group calls will be replaced by a two-week strategic writing and reflection period. Ms. Wince-Smith said many group members expressed a desire for "white

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space" to think about the topics the groups have already discussed and begin putting down on paper concrete policy proposals. She encouraged the group to use this time to add from their individual perspectives ideas they felt were missing from the discussion or that they would otherwise like to contribute. Mr. Evans said that during the next two weeks, members should either begin writing recommendations independently or putting down their thoughts for the rest of their "swim lane" to iterate on and co-develop. While members can engage in this process on their own, the Co-Chairs will act as guides for particular swim lanes, and may assign individuals to write particular recommendations and/or convene swim lane-specific call sessions to work on developing recommendations. The Council can provide logistical support for weekly sessions, and Mr. Evans stressed that members are free to engage in the way that works best for them, as the most important thing is to generate recommendation ideas. When the group returns from the reflection period, the Council team and Co-Chairs will pull together the ideas that have emerged and suggest a path forward for the next month or two of discussions as the Council prepares its Year One deliverables for release in December.

Mr. Evans went over a set of materials he said would be delivered to group members later today. First, the Council will provide a contact spreadsheet of group members broken out by swim lane to facilitate coordination of recommendation generation during the reflection period. He requested that members who wish to join a swim lane or change swim lanes let the Council team know so it can prepare an updated database. The Council team will also re-send the rubric it developed for writing recommendations, listing essential elements of a recommendation and providing examples from past Council initiatives. Finally, the Council collated a set of nascent recommendations that emerged during the first phase of Working Group conversations and that were presented to the National Commissioners back in June. Mr. Evans said the Council would send out these ideas to provide fodder for members' writing, research, and collaborative efforts in their swim lanes. In the coming days, the Council will create a Google Doc or other shared document that will enable members of the different swim lanes to collaborate virtually on policy proposals.

Next, Mr. Evans introduced Mr. Wethington's featured remarks, which were focused on policy recommendations in the arena of international "rules of the road" and U.S. engagement with allies to advance a global policy regime that is consistent with U.S. competitiveness. Mr. Wethington introduced 12 recommendation ideas, which he said completed coverage of the regulatory environment swim lane, the group having already discussed domestic institutions and antitrust policy.

Recommendation Ideas: WTO Reform

The first set of recommendations Mr. Wethington proposed centered around the World Trade Organization (WTO). While the organization's influence has waned over the past two decades and its credibility and legitimacy have been undermined, the WTO, along with the General Agreement on Tariffs and Trade, has been a linchpin of the success of the postwar U.S.-led international order and American prosperity and competitiveness. Because of the importance of the WTO to U.S. interests, Mr. Wethington advocated formally endorsing the role a reformed WTO as an essential element of U.S. competitiveness. Regarding reforms, Mr. Wethington urged an overhaul of the WTO's decision-making structure to make it more efficient, as well as an adjustment of its dispute settlement regime. He said the structure of the WTO appellate body, the role of its judges, and the scope of its decisions need to be rethought. Besides structural reform, Mr. Wethington called for revitalizing the WTO's agenda concerning issues that have been under discussion for years without resolution. These include e-commerce, digital trade, and rules for technologies of the future, as well as holdover issues like industrial subsidies, state aid, investment protection, labor and environmental rules, and the categorization of "developing countries." He noted that China in particular benefits in

terms of standards compliance from its current status as a "developing country" one Mr. Wethington argued was no longer appropriate given its economic rise.

Recommendation Ideas: Digital Trade and New Technology Standards

Mr. Wethington offered two recommendation ideas on digital trade and standards for new technologies. He noted that the U.S. has made significant progress on digital trade policy with the U.S.-Mexico-Canada free trade agreement (USMCA), the U.S.-Japan free trade agreement, and the U.S.-Singapore and U.S.-South Korea free trade agreements. However, Mr. Wethington argued it was time to extend these agreements into the WTO context. He cited a litany of important topics, including digital customs duties, electronic signature validity, protection of source code and algorithms, and protection of personal information. Mr. Wethington noted the need to strike a balance between openness and protection of privacy and national security, and said that while the State Department recently released a Clean Networks Initiative that addressed valid national security questions, the scope and implementation methods of the plan are unclear. Relatedly, Mr. Wethington urged the development of sector-specific standards for other emerging technologies, including AI and advanced microelectronics, and the institutionalization of these standards internationally. Ms. Wince-Smith suggested including gene editing and genetic engineering, and Mr. Evans suggested including new forms of energy as subjects requiring new standards.

Recommendation Ideas: Defensive Actions

The next three recommendations Mr. Wethington suggested concerned defensive actions by the U.S. in the face of a growing competitive threat from rivals, especially China. First, he called for the establishment of an international regime for regulating and controlling the transfer of critical technology, established by the U.S. and its like-minded allies. He also urged harmonization between the U.S. and its allies on foreign investment review protocol. While he praised the new Committee on Foreign Investment in the United State (CFIUS) regime established by the Foreign Investment Risk Review Modernization Act (FIRRMA), Mr. Wethington noted a lack of coordination between these practices and those of our allies. Mr. Wethington also advocated incentives to re-shore the production of critical technologies to deal with the national security implications of overseas production, and stressed the need to coordinate on this issue with our allies as well. Ms. Wince-Smith suggested as part of this recommendation a call for a global end to tariffs as a trade policy.

Recommendation Ideas: Export Financing, International Procurement, and Digital Taxes

Two of Mr. Wethington's recommendations dealt with questions of export financing, procurement, and digital taxation. China's Belt and Road Initiative poses a geopolitical threat through its control of infrastructure and other overseas assets in other countries, and China also engages in heavy subsidization to promote the export of technological equipment. While the G20 has raised this issue and the OECD and World Bank have been active in developing new standards, there is not yet a formal international consensus on combatting these practices. Mr. Wethington noted that the Export-Import Bank was recently given authority to match Chinese financing terms and conditions, and he advocated in particular providing support for the 10-12 emerging technologies the U.S. government regards as "critical" in the authorizing language. He also noted that this recommendation impacts the competitiveness of our allies. On a matter than involves many U.S. allies, Mr. Wethington called for a new consensus on the Digital Services Tax, which has been used by EU member states to target U.S. technology companies and boost their own national champions. He called for a resolution of this conflict in a way that protects U.S. firms from unfair targeting, and noted that current EU practice in this regard is counter to existing WTO standards.

Recommendation Ideas: U.S. Engagement in Standard Setting and International Bodies

Finally, Mr. Wethington offered two recommendation ideas for deeper U.S. engagement in international scientific, technological, and standards-setting bodies, with a more coordinated federal response. He advocated against the approach the U.S. taken with the World Health Organization, in which we threatened to withdraw due to displeasure with its behavior, and promoted instead a posture of engagement and reform by leveraging our considerable financial and scientific resources. He noted that China has assumed leadership roles in four of the fifteen UN scientific organizations, but that the successful blocking of a Chinese-backed candidate to head the World Intellectual Property Organization (WIPO) showed that the U.S. retains the ability to influence personnel decisions at these organizations. Mr. Wethington said the U.S. should prioritize securing influence in scientific and technological organizations, as well as the WHO, the International Energy Agency (IEA), and Interpol. Mr. Wethington also noted China's coordinated effort to influence standards-setting for emerging technologies, and urged the U.S. to counter via more coordinated agenda-setting in its own efforts to influence standards. This would involve retaining the traditional role for industry in shaping the U.S. position while increasing the involvement of agencies like the National Institute of Standards and Technology (NIST) and greater engagement in capacity- and consensus-building abroad. Mr. Wethington particularly warned against leaving a personnel vacuum in any international standards-setting body.

Relationships Across Recommendation Ideas

Ms. Anne Tucker of Georgia State University asked which two recommendations Mr. Wethington felt were most foundational, and connected to the others. Mr. Wethington said that the two most important recommendations were developing rules around emerging technology and reforming the WTO. New technology rules are essential to setting norms around the Internet of Things, 5G, and other crucial technologies to U.S. competitiveness, along with digital trade. Mr. Wethington noted there have been successes in this regard in the last few years that must be built on. Reforming the WTO is crucial because of what is necessary to overhaul it: effective statecraft and coalition-building that would allow the U.S. to retain a numbers and influence advantage over China, and leveraging of reciprocity as a component of U.S. trade policy. Mr. Wethington said it was essential for the U.S. to bolster its capacity in both these areas, because doing so was essential for continued global leadership and to ensure a fair international trading system and set of rules, especially concerning China.

Ms. Rebecca Macieira-Kaufmann asked how standards around emerging technologies and digital trade impacted the competitiveness of the U.S. and its allies. Mr. Wethington said that the digital trade space could serve as a model for building norms around other sectors where domestic policies have an impact on cross-border competitiveness. He gave examples of pertinent issues including cross-border flows of data, internet censorship, and the ability of American service providers to operate in other countries. He said that while the USMCA and U.S.-Japan free trade agreement both established principles on these issues, there remained a need for a general-purpose framework for balancing digital openness with national security and privacy protection. In particular, he noted that the national security exceptions to openness were going to continue to grow as challenges to American competitiveness increase.

Challenges in Investment Review

Mr. Greg Pellegrino of Deloitte discussed his experience working with the Department of Homeland Security fifteen years ago on mergers and acquisitions, and his observation then that the government lacked personnel with the requisite skills needed to identify complex ownership and financing structures. He expressed concern about the ability of CFIUS

and other investment review bodies to keep up with the increasingly complex financing and investment mechanisms involved in deals, and suggested that skill evolution be added to harmonization with allies as a goal for investment review. Mr. Wethington agreed on the importance of skill development, and said that CFIUS does not face a funding problem so much as a capacity problem when it comes to implementing FIRRMA. He identified the need for Treasury to bring in the intelligence community, and the role of transparency requirements in making merger and acquisition decisions. He said it was very hard to get transparency about the ultimate parties at interest in many transactions, and that the U.S. has increasingly used insufficient or fraudulent disclosure as a reason to block investments and deny acquisitions.

Concluding Thoughts and the Road Ahead

Mr. Evans recapped the expectations for the strategic writing period and reminded the group about the list of promised materials. He noted that while most of the conversation in the group's weekly discussions had been on the Global Competitiveness and Existential Threats swim lane, the other swim lanes around the National Regulatory Environment, Systems Infrastructure, and Financing and Fueling Innovation needed policy recommendations as well. Ms. Wince-Smith thanked Mr. Wethington for his thorough presentation, and two of the Co-Chairs, Dr. Peter Dorhout of Kansas State University and Ms. Vickie Lonker of Verizon, said they would reach out to their respective swim lanes in the coming days. The next meeting of the group will be on Tuesday, September 1st.

Working Group 3 Calls September 8

Introduction

The Honorable Deborah Wince-Smith and Mr. Chad Evans welcomed the group. Mr. Evans said the day's focus would be on touching base with the group following the end of the strategic writing and reflection period, and getting macro-level feedback from the group. In addition, the meeting will serve as an opportunity for the Council team to share reflection and opportunities for deeper discussion by the Working Groups. In the following weeks, the group will run through the recommendations generated during the strategic writing period in more detail.

Co-Chair Remarks

Dr. Peter Dorhout said that while illness had prevented him from convening the Swim Lane around Global Competitiveness and Existential Threats, he felt that The Honorable Olin Wethington of Wethington International LLC had done an excellent job developing an initial set of recommendations, and that he anticipated further discussions on this topic going forward. Mr. Wethington said that his Swim Lane on Fueling and Financing Innovation had productive conversations and generated recommendations during the writing period, and added that there were three tax policy suggestions that the

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group had not formally put down in writing yet. His group recommended enlarging the tax exclusion for research and development expenses for small and medium-sized enterprises, making the terms of the basic R&D tax credit more generous, and putting down a formal Commission position that the corporate tax rate should remain low and competitive with other developed countries, especially given potential climate swings following the election. Mr. Wethington also said the group discussed but did not elaborate on the concept of a national infrastructure bank. He said the idea was not new and had bipartisan support, but that legislation has been hamstrung by disagreements over governance structure.

Areas Mr. Wethington's group discussed only in passing included re-shoring and retaining manufacturing and the issue of technology transfer to foreign competitors. On the former, Mr. Wethington said lowering taxes would be difficult politically, but the Defense Production Act and restrictions around foreign transfer of intellectual property could also aid in reshoring. Dr. Kenneth Poole of the Center for Regional Economic Competitiveness suggested making use of robotics and other technology to expedite re-shoring and near-shoring. On the issue of foreign investment, Mr. Wethington said the group felt it lacked familiarity with the issue, and that the primary challenge facing the Committee on Foreign Investment in the United States (CFIUS) was one of personnel and expertise, not funding. Mr. Wethington concluded by emphasizing the areas where the group had significant discussion, including a national investment fund, infrastructure, taxes, and a innovation investment data clearinghouse.

Areas for Deeper Discussion

Mr. Evans identified six areas that the Council team felt warranted deeper discussion after reviewing the recommendations generated during the strategic writing period and the recommendation ideas that emerged from Phase 1. On the question of national leadership, he cited the need for a series of recommendations strategically articulating where innovation resides. He noted that Working Group 1 had been having lots of conversations around the need for a more strategic approach. Second, on the question of federal investment in research and development, the group should establish how much the government should spend and what technologies it should invest in. With federal spending as a share of GDP well below its historic 1960s high, it is imperative to develop specific goals and numbers to meet to ensure increased productivity and prosperity at a time when the U.S. faces at least as great of a strategic challenge as it did during the Space Race era. Third, the group should discuss technology transfer from universities and laboratories, with a particular emphasis on securing the perspective of universities and national labs. Regarding the future of work, while Working Group 4 is focused on the topic more broadly, there needs to be more specific discussion of rapid changes in the nature of work. The pandemic has led to the acceleration of workplace trends that were projected to take place over years but have instead come to fruition within six months. Fifth, the group needs to have greater discussion of the challenges posed by China, especially regarding theft of intellectual property and developing guidelines for joint research ventures with Chinese scientists. Finally, the Commission needs to develop more recommendations addressing resilience, which has become a key subject following the fallout from the global pandemic. While there were many ideas around resilience in Phase 1 of the Working Group conversations, they were not capitalized on, and resilience must be a key part of the Call to Action in December.

Ms. Wince-Smith added that participants should not feel constrained by the recommendation template provided by the Council. She said that throughout its history the Council has been characterized by its thought leadership and drive to understand the world and America's needs. The Council pioneered work on resiliency years before it became a topic of widespread discussion, and Ms. Wince-Smith urged the group to put forth ideas that will be challenging to implement in the near term but need to be part of the public discourse. In particular, she discussed the need to establish a systems integrator role for federal innovation policy, as the Office of Science and

Technology Policy and the Departments of Commerce, Justice, and Treasury do not play a role in many of the issues that are the purview of this group due to stove-piping and lack of communication and coordination. Ms. Wince-Smith stressed the need to have a coordinated response to actions like China's predatory infrastructure financing in developing countries, and she emphasized the need to change the status quo. While more investment will be helpful, that additional funding cannot flow into the same fragmented system it does at present.

Additional Considerations and Questions

Mr. Greg Pellegrino of Deloitte said that his Swim Lane on Systems Infrastructure had robust discussions about the implications of virtual work, and encourage the group to continue pushing in that direction, as his Swim Lane felt it hadn't turned the corner in identifying the long-term implications of adjustments in talent, the role of the workplace, employee well-being, cybersecurity, and other issues. He said that if the group did not continue exploring this topic, it risked being behind the times in the recommendations it offered. Mr. Thomas Dailey, formerly of Verizon, echoed this sentiment, and also noted the implications for tax bases of large-scale migration due to remote work. If there is significant migration out of cities, the cost structures and revenue structures facing governments will change.

Dr. Ushma Kriplani of Argonne National Laboratory said the discussions had been excellent, and that she was convening a group of national lab personnel from the Commission to share the ideas generated by their respective Working Groups. She added that the national labs excel in particular in technology maturation, and asked if there was a way to have the labs as a collective drive the national conversation on these topics. She noted that technology maturation had implications across the different working groups, especially for infrastructure. Mr. Evans said that Working Group 1 was discussing large national research efforts, and that the Commission was putting together a group focused on a national action plan for advanced microelectronics with significant input from laboratory personnel. He said he could envision a similar project for infrastructure and technology maturation. Ms. Wince-Smith agreed and noted that the national labs were already developing the infrastructure needed to underpin next-generation technologies.

Mr. Wethington offered a seventh area for deeper discussion, the subject of "technology statecraft." He said that the U.S. cannot think of competitiveness policy in a purely domestic context, and must engage and assert itself around international institutions and rules in conjunction with like-minded allies. As the world becomes more fragmented geopolitically, the U.S. will not succeed unless it becomes better at forging alliances with those who share our values. In particular, the U.S. must put effort joint development of international norms, institutions, and standards with out allies, and this is a function not just of commitment of resources, but of effective diplomacy.

Concluding Thoughts and the Road Ahead

Dr. Gerald Blazey of Northern Illinois University asked how the remaining topics to explore matched against the Swim Lanes, and Mr. Evans said that the Council would work on determining that, but that in the meantime the Council was open to any thoughts on these gaps, including outside experts the Council should connect with. He added that next week's call would focus on a deeper dive into the Fueling and Financing Innovation Swim Lane, including a deeper look at the recommendations generated by that group. Mr. Evans also added that participants should feel free to continue working in whatever modalities are best for them, and that it was fine to take extra time to refine thoughts and recommendation ideas. In addition, the group will discuss the path forward ahead of the December release of the Commission's Year One findings. The next two to three weeks will be spent exploring the Swim Lanes in greater detail, but soon the Commission will need to make a decision around prioritizing recommendations for December. The next meeting of the group will be on Tuesday, September 15th.

Working Group 3 Calls September 15

Introduction

The Honorable Deborah Wince-Smith and Mr. Chad Evans welcomed the group. Mr. Evans said the day's discussion would focus on a deep dive into the recommendations developed during the strategic writing period by the Fueling and Financing Innovation Swim Lane, chaired by The Honorable Olin Wethington of Wethington International LLC. Mr. Wethington said that members who developed recommendations would share their proposals, followed by a commentary and question period. Mr. Evans thanked the Co-Chairs and the other members of the Working Group, especially the members of the Fueling and Financing Innovation Swim Lane, and said he looked forward to hearing the ideas they proposed. Mr. Wethington opened the discussion by thanking the members for their work in generating recommendations, and grouped his Swim Lane's recommendations into five categories: tax policy, an innovation investment fund, regional investment in innovation, matching startups to established firms, and shared resources and facilities at the National Laboratories.

Tax Policy Recommendations

Mr. Jim Carlisle of Bank of America discussed the recommendations on tax policy he developed along with Ms. Ji Mi Choi of Arizona State University, Ms. Julie Lenzer of the University of Maryland, and Ms. Rebecca Macieira-Kaufmann. Mr. Carlisle said that there is already a generous capital gains incentive for investment in startups of 100 percent exclusion for investments that are held longer than five years.

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However, this only applies to investment in C-Corporations, while most start-ups incorporate initially as pass-throughs. Further, canvassing of the investor community led his group to believe take up rate is low because of a lack of knowledge of the provision's existence. As such, the group's first recommendation was to allow for investment in pass-through startups to qualify for this investment credit. Second, there is an existing R&D tax credit that is fairly robust, but it does not benefit most startups because they do not have taxable income against which to apply the credit. Recent changes to the provision have allowed start-ups to claim the credit against payroll tax liability, but the group also called for the amount and time period for the credit to be expanded. Finally, while the Tax Cuts and Jobs Act of 2017 reduced the corporate tax rate from an uncompetitive 35 percent to a 21 percent rate in line with the average for OECD countries, there is some political momentum to adjust the corporate rate again. The group recommended officially endorsing competitive corporate rates as a guidepost during any further debate about the corporate tax rate.

Ms. Lenzer said the group's discussions were prompted by the failure of the Opportunity Zones bill, which turned into investment in real estate rather than startups. She said that she had not heard of the tax credit for investing in C-Corporations despite being an angel investor herself, and that greater knowledge of investment opportunities would spur greater take-up on those opportunities. She added that sharing already existing incentives would provide a powerful incentive to invest much of the idle wealth sitting in hedge or equity funds that could go into startups. Ms. Lenzer noted that one reason the Opportunity Zones project failed was that people are uncomfortable investing in sectors outside their own due to lack of familiarity, and that it was also important to create mentor networks of investors to help build this familiarity and expertise, especially for women and minorities, to increase the number of startup investments in underserved communities and to unleash inclusive prosperity.

Mr. Wethington asked about recent policy discussion regarding providing tax credit for companies that re-shore overseas production. Mr. Carlisle said that while this and the idea of taxing overseas production have been circulated, there are reasons for the current layout of supply chains, and that anything that it makes economic sense to manufacture domestically generally is. He added that a tax credit wouldn't make much impact on companies' production locations. Mr. Evans expressed general agreement with this view but noted the security concerns regarding production of critical supplies like medicines and personal protective equipment, as well as technology with national security implications like advanced microelectronics. Ms. Wince-Smith said that the U.S. lost production of solar panels to China because banks found it too risky to invest debt capital in infrastructure investments, and asked if there were incentives that would return banks to these kinds of investment projects, which are far larger scale than investment in startups. Mr. Carlisle said that while this was outside his area of expertise, he would solicit information from experts on the matter, and added that banks are investing in

solar and wind projects, as well as municipal finance market for infrastructure. Mr. Wethington said that often environmental policies, regulatory policies, and other issues besides taxes are the primary drivers of production location.

An American Innovation Investment Fund

Dr. Gerald Blazey of Northern Illinois University shared his idea for a national Innovation Investment Fund, which he initially co-developed while working with the American Physical Society when looking for ways to alleviate the funding disruption to the research community caused by the use of Continuing Resolutions by Congress to pass budgets. This fund would ensure widely-distributed (demographically and geographically) public-private capital to move targeted science and technology investments to market. The fund would be a public-private partnership to de-risk investment, and targeted to respond to the planned economies the U.S. is competing with. The investment would be long-term and would spend interest accrued annually on its endowment.

Mr. Wethington asked where the initial capitalization would come from, and Dr. Blazey suggested offering a reduced tax rate on the repatriation of overseas income for companies that contributed that income to the fund. Mr. Carlisle noted that the 2017 tax bill introduced a one-time tax on all offshore earnings as if they were repatriated, meaning any further repatriation would not be taxed and obviating that incentive. Dr. Blazey said that the funding mechanism could then be the subject of another recommendation. Mr. Wethington asked what the priorities for investment would be, and how they would be determined, such as through a charter, a board or commission, or collaboration of government and private sector stakeholders. Dr. Blazey suggested using the Endless Frontiers Act as a template, including investing in some of the key technologies outlined by that legislation, such as AI, quantum information systems, and advanced manufacturing. He also expressed concern that the National Science Foundation would be stretched by the Endless Frontiers Act and lose sight of its basic mission. Further, Dr. Blazey said the fund would only work well if it was quasi-independent and directed primarily by private-sector actors, with high-level representation from mission-oriented agencies like DOD, DOE, and NNSA.

Mr. Wethington suggested taking the same model and having a set of smaller sector-specific funds associated with mission-oriented agencies, and funded via the annual appropriations process. Dr. Blazey said that agencies would resist this move as an attempt to supplant them. Ms. Wince-Smith said that the fund idea was similar to the sovereign wealth funds managed by other countries, like Australia's Future Fund.

Laboratory-Directed Research and Development

Emerging from Dr. Blazey's recommendation idea was an expansion of laboratory-directed research and development (LDRD) funding. This funding, which can comprise up to 6 percent of national laboratory budgets, can be invested in long-term, high-risk ventures at the discretion of the labs. These investments have seeded the vast majority of major national laboratory breakthroughs. Mr. Wethington suggested enlarging the share of lab budgets that could be used for this research, and Ms. Wince-Smith agreed, while noting some members of Congress are reluctant to allow even the LDRD that currently takes place. Dr. Michael Paulus of Oak Ridge National Laboratory said that LDRD produces "ten times" as many inventions that lead to spinout companies as any other funding source, and that this is because LDRD does not have prescriptive oversight, allowing lab investors to follow their passions and opportunity. He added that today funding opportunities have been greatly narrowed, limiting maneuverability, but that increased investment in LDRD could improve the "bang for the buck" on the national labs. Dr. Peter Dorhout of Kansas State University also expressed support for this idea, drawing on his time benefitting from LDRD funding while working with Los Alamos National Laboratory. He said that

LDRD funding leads to investment in core equipment and facilities, and the seeding of corporate relationships, that make successful development and spin out of technology possible. Mr. Evans noted that this idea connected with Working Group 1's discussions of a central governing body to provide leadership and coordination for innovation and competitiveness policy.

Regional Dispersion of Innovation Investment

Dr. Kenneth Poole of the Center for Regional Economic Competitiveness described his ideas for building regional technology hubs, particularly as a vehicle for building innovation capacity. Drawing on Ms. Lenzer's remarks about investors who have capital but lack familiarity with different markets, he noted that these investors generally invest in existing money centers when they do venture into startup investing, and that building local knowledge and capacity for these kinds of investments would enable the creation of startups outside existing innovation hubs. It would also enable those firms that do emerge in other areas to stay there rather than relocating to be near a funder in an existing hub. Dr. Poole added that the capital firms outside existing hubs need is generally pre-venture capital stage, and with angel investors becoming less patient and acting more like venture capitalists, there is a need to develop other funding sources. He discussed the effectiveness of the State Small Business Credit Initiative, where each federal dollar invested in companies leveraged seven to ten dollars of private capital, and suggested a revival of a similar program to help states address local economic needs and build the expertise needed to keep innovative firms from relocating. By keeping the program at the state level, seeded investments would be targeted to local economic needs and would attract nonprofit and private sector stakeholders with an interest in the success of the area. As an existing example of a similar program, Dr. Poole cited the Connecticut Innovations initiative, which has since become independent and drives investment as a nonprofit.

Mr. Evans said this idea mapped well with the Regional Innovation Swim Lane in Working Group 4, which is working to develop a regional toolkit for areas looking to enhance their innovation capacity. Ms. Lenzer said there was a lot of untapped potential in much of the country, and noted that many recipients of Small Business Credit Initiative funds were dropped when the program was discontinued in spite of continued attempts by the Department of Commerce to keep working with them. She added there was philanthropic interest in these kinds of investments as well, such as with Steve Case's Rise of the Rest program. Dr. Poole said his ideas also connected with Dr. Blazey's national investment fund initiative, and could be the regional component of a national program. Mr. Evans said that ownership of this initiative that spans regions connects with the questions discussed by Working Group 1 as they discussed a National Innovation Council that would have similar status to the National Security Council or National Economic Council and could oversee and champion competitiveness policy. Ms. Lenzer also suggested the National Advisory Council on Innovation and Entrepreneurship as a potential model.

Matching Startups and Established Firms

Dr. Anthony Margida of TechGrit discussed his proposal for a virtual technology commercialization marketplace, that would improve upon the shortcomings of the Small Business Innovation Research (SBIR) program. Dr. Margida noted that many tech-based startups, especially those spun out of universities, have compelling market identifications ad technology solutions, but do not have the capital, sales channels, customer relationships, equipment, or other know-how to scale successfully. This program would pair them with corporations that have these assets but need innovations. Dr. Margida outlined a five-step process for matching startups with large firms. First, the government entities, like DOD, NSF, and the National Institutes of Health, that fund SBIR grants, would identify verticals in which they want to solicit proposals for innovations. Startups would then submit proposals for market product fits that line up with those verticals, and the funding agencies would

review the proposals while determining the awards, including cash and access to lab facilities and other resources, for recipients. Next, corporations would pre-commit a custom package of assets, including cash, access to equipment and facilities, access customer networks, or other benefits, in order to receive approval to participate in the program. Once both startups and corporations have been approved by the funding agencies, they are free to meet and negotiate partnerships, at which point they receive the awards determined by the funding agency. Mr. Wethington asked if corporations would be required to take an equity stake in order to participate, and Dr. Margida said corporations would be given the choice to define their "skin in the game," including potential equity stakes or exclusive licenses. Ms. Lenzer said corporations would not be interested in taking equity stakes unless they did so through dedicated venture arms.

Concluding Thoughts and the Road Ahead

Mr. Evans said that next week's call would be focused on further exploration and discussion of Dr. Margida's proposal, as well as an examination of Dr. Paulus's recommendations regarding shared use of laboratory resources and facilities. He thanked everyone who contributed to the recommendations during the strategic writing period, and said that the Working Group calls would continue for the next couple of weeks. Next week's call will also include a discussion of the longer-term road map for the Commission as it approaches the release of Year One findings in December at the National Competitiveness Forum. The next meeting of the group will be on Tuesday, September 22nd.

Working Group 3 Calls September 22

Introduction

Mr. Chad Evans welcomed the group, and said the day's conversations would focus on finishing up a discussion of the recommendations from the Fueling and Financing Innovation Swim Lane, as well as a discussion of the recommendations from the Systems Infrastructure Swim Lane. He also provided an overview of the coming months as the Council moves towards its Year One Call to Action in December. Beginning next week, the weekly Working Group calls will become biweekly, and meet for half an hour instead of the full hour. During October and November the Council will prioritize recommendations and draft the Call to Action, with the Working Group calls serving as sessions to update members on the progress of the draft and feedback received from the National Commissioners, Advisors, and Outreach and Engagement Committee. These calls will also provide an opportunity for Working Group members to share their own feedback and input. During this time, the Council will provide logistical support to any Swim Lanes that wish to continue meeting in a self-directed manner.

A Digital Marketplace for Technology

Dr. Anthony Margida of TechGrit described his proposal for a virtual marketplace connecting entrepreneurs with established companies to expedite the scaling of innovative technologies and products. He conceptualized this idea as a new approach to the existing Small Business Innovation Research (SBIR) program, which he said had fallen short of expecta-

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tions. Under this framework, granting organizations participating in SBIR, such as NIH, the EPA, or the Department of Defense, define specific verticals of technology where they want to see innovation, including thoughts about particular markets these innovations would serve. These granting agencies would then invite startups to make proposals to enter the marketplace, and startups would get accepted into the program based on their outlining of a market and technology or product that serves that market that has at least demonstrated proof of concept. Corporations would also apply to be sponsoring partners, and would commit to put "skin in the game" including funding, access to customer bases, equipment, large-capital investments, and organizational know-how. Once both sponsoring institutions and startups have been selected, both enter the marketplace, where they are free to negotiate partnership deals with each other. Once deals have been agreed, the partnership receives a pre-determined award from the granting agency, consisting of cash and alignment with a National Laboratory or other federal research resources to accelerate growth and commercialization. Dr. Margida said that this model would provide startups that have identified a compelling market need and developed a prototype product to meet it with corporations that have the money, channels to market, manufacturing capabilities, know-how, and access to high-capital equipment the startups lack. Requiring pre-screening ensures that every idea that receives funding has been validated by a corporation with insight on commercialization and that has committed to getting the startup to commercialization.

The Honorable Olin Wethington of Wethington International LLC asked if this program would be implemented by an umbrella organization, or if granting agencies would include requests for funds in the appropriations process. He also asked what the budgetary commitment of the program would be. Dr. Margida said he envisioned the initiative as an overhaul of the SBIR program, using its $3 billion annual budget as a benchmark that could potentially be expanded on. Dr. Peter Dorhout of Kansas State University asked if the program was a government angel investor fund, and if so, what the financial and tax incentives were for the corporations involved. Dr. Margida said corporations would be free to negotiate the compensation packages they desired with startups, which could include licensing rights or ownership of technology, acquisition, or an equity stake in the startup. Ms. Julie Lenzer of the University of Maryland suggested having the Small Business Administration play a coordinating role for the program, as it already oversees SBIR operations across participating agencies. Council Senior Advisor Ms. Carol Ann Meares said that as SBIR was designed to give startups a chance to participate in mission-driven government research projects, this initiative was better off being run as a separate program. Dr. Kenneth Poole of the Center for Regional Economic Competitiveness predicted there would be concerns that companies would construct shell "startups" in order to receive awards of public risk capital, and asked what safeguards would be put in place to verify the startups. Ms. Vickie Lonker of Verizon said that large firms generally try to keep their investments in startups secret in order to preserve competitive advantage, and asked how firms could shield their activity from competitors. Dr. Margida said that some public record would be inevitable as public money was involved, but Ms. Meares said that federal grant programs have the ability to classify information if needed.

Sharing National Laboratory Resources

Dr. Michael Paulus of Oak Ridge National Laboratory discussed his recommendation idea for making greater use of National Laboratory resources as shared innovation infrastructure. He discussed the Department of Energy's suite of Scientific User Facilities, as well as those owned by other agencies like the Department of Defense, which are nearly 40 world-class facilities filled with scientific experts where researchers from academia and industry can work on research projects. These facilities contain equipment and resources unaffordable even to top universities and large corporations, and applicants are selected to work there based on the merits of the research, with the condition that it is made public

afterward. Dr. Paulus said that these facilities already engage with academia, but could do much more to engage with industry, especially small businesses. He emphasized that these facilities were a unique asset of the U.S. innovation system, and should be leveraged in order to drive innovation and differentiate the U.S. from its competitors.

Mr. Wethington asked if expanding facilities' ability to connect with and work with industry and academia could be done through existing agency authority, and Dr. Paulus said it could be done through appropriations. Mr. Evans connected this idea to the concept of shared national innovation infrastructure, which could turbocharge America's innovation capacity by providing further resources to academia and the private sector. He used the example of high performance computing, discussing the potential for shared resources to allow NIH, the Department of Agriculture, and other agencies to leverage high performance computing to develop transformative innovations. Dr. Ushma Kriplani of Argonne National Laboratory endorsed Dr. Paulus's recommendations, and added that it was essential to get the scientific side of agencies on board with increased funding for user facilities first. She said there were many roadblocks to scaling up involvement with user facilities, and that some were relatively easy to remove while others would require Congressional action. Mr. Evans noted the overlap between Dr. Paulus's ideas with recommendations developed in Working Group 1 for greater utilization of national lab resources, and suggested connecting the two.

Building Systems Infrastructure

Ms. Lonker shared the Systems Infrastructure Swim Lane's recommendations for using public-private partnerships to build the digital infrastructure needed for the future of work, education, transportation, and other services, centering around the establishment of an entity that would define market-based, government-funded infrastructure deployment programs in industries characterized by high fixed costs. She described how the pandemic had exposed America's infrastructural weaknesses as well as societal inequalities, and the need for investment to address both. At a time when America faces threats to its technological preeminence, there is no targeted standard for internet connectivity- encompassing more than just broadband- and that demographic trends towards urbanization were beginning to reverse as a result of the pandemic, increasing strain on existing digital infrastructure as people increasingly work and learn remotely. The migration of tax bases from urban to rural areas will also provide a boon to less densely populated regions while eroding the capacity of urban governments to be self-sustaining. The internet is now at the core of today's economy, and demands on the telecommunications spectrum and infrastructure continue to increase, necessitating widespread investment as the internet becomes similar to telephone service, the electric grid, and the interstate highway system.

The entity responsible for overseeing these investments would be modeled after the FCC, the Federal Energy Regulatory Commission, and the Department of Transportation. These agencies all provide examples of investment solutions in infrastructure with high fixed costs, such as carrier of last resort obligations, the Universal Services Fund, rural electrification programs, and interstate highways. Ms. Lonker added that investment in infrastructure throughout the country would also make possible regional innovation centers like Silicon Valley, as talent around the country is able to take advantage of key enabling digital infrastructure. She stressed that this entity would be technology-agnostic, and identified a large number of primary and secondary stakeholders, including the transportation industry, as the telecommunications and transportation industries have historically followed similar paths. Building a resilient network of telecommunications infrastructure would also extend opportunity to marginalized groups and enable resilient national defense capabilities.

Dr. Gerald Blazey of Northern Illinois University said that just as the telecommunications industry has mirrored the transportation industry, the transportation industry will increasingly rely on digital technology. He suggested that the Commissioners consider measures to address the interlinkage between these

two kinds of infrastructure. Mr. Evans noted that the FAA and rural utilities services were heavily involved in highway construction, and that wireless infrastructure has profound impacts on hralth and other government services. He also noted overlap between these recommendations and those in Working Group 4 focused on developing regional innovation hubs. Ms. Rebecca Macieira-Kaufmann also identified parallels with ongoing legislation on smart manufacturing infrastructure. Dr. Kriplani said that this entity would need to be administered a level that supersedes agency turf battles, as digital connectivity is the enabling infrastructure for other platform technologies on which to build the U.S. innovation enterprise. Mr. Evans recalled Council University Vice-Chair and National Commissioner Dr. Michael Crow, President of Arizona State University, remarking at the January Launch Conference that hundreds of millions of people were currently left out of the innovation economy, and noted that he had shared Working Group 4's guidelines for building diversity and inclusion into recommendations. Dr. Kriplani added that access to baseline infrastructure for marginalized communities is every bit as important as increased career opportunities.

Mr. Thomas Dailey, formerly of Verizon, said he felt the FCC was too narrowly focused on broadband as a means of digital connectivity, and urged innovation in how the country thinks about deployment of architecture. Mr. Wethington noted this project would require Congressional approval, and asked what the smoothest path was toward that approval. Ms. Lonker said the Swim Lane did not get that far, but said establishing a funding source would be a major challenge. Mr. Evans suggested a National Infrastructure Bank as a potential funding source for these projects, and Dr. Kriplani suggested housing this entity as a subset of an existing office in an agency like the Office of Science and Technology Policy. Dr. Poole suggested having National Institute of Standards and Technology (NIST) or an expanded National Science Foundation. Dr. Blazey expressed support for housing it in NIST, while Dr. Kriplani suggested housing at a level that supersedes individual cabinet agencies to prevent them from siloing.

Concluding Thoughts and the Road Ahead

Mr. Evans encouraged the group to look at the Diversity and Inclusion guidelines developed by Working Group 4, and said that the Council would work to identify best practices from the private sector to augment these recommendations. He reminded the group that the Council would send out a detailed note explaining the schedule going forward, as well as new invites for the October and November slate of calls. The next meeting of the group will be on Tuesday, September 29th.

Working Group 3 Calls September 29

Introduction

The Honorable Deborah Wince-Smith and Mr. Chad Evans welcomed the group, and Mr. Evans reminded participants that calls were now every other week instead of weekly and half an hour instead of a full hour. He said that the goal of the next several calls was to get a sense from participants as to what recommendations the Council should prioritize in preparing its Year One Call to Action to be released in December at the National Competitiveness Forum, as well as which recommendations should be saved for Year Two. Mr. Evans said the Council would send out both a matrix and a survey to help prioritize and map out the intended impact of the recommendations in the coming days.

Co-Chair Remarks

Dr. Peter Dorhout of Kansas State University said that the Working Group had developed several sound ideas, and advocated deeper discussion in three areas. First, he emphasized the importance of discussing how better to integrate not only the National Laboratories, but all federally-supported research enterprises, into the innovation ecosystem. He said the United States can make significant investments and compete with China by making greater use of our laboratory resources, and noted that Dr. Michael Paulus of Oak Ridge National Laboratory and Dr. Ushma Kriplani of Argonne National Laboratory had shared their thoughts on this subject with the group. Dr. Dorhout also called for greater discussion of public understanding and expectations around technolo-

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gies, especially the societal impacts that would follow from a loss of public confidence in communications devices or other critical infrastructure. Finally, Dr. Dorhout urged more focus on bolstering America's role in the World Trade Organization and combining and broadening the recommendations in this space developed by The Honorable Olin Wethington of Wethington International LLC. Mr. Evans said the concept of integrating the national labs into the innovation ecosystem paralleled discussions by Working Group 1 on the need for systems change across multiple dimensions, including the national labs. He added that conveying a sense of urgency was also crucial, as were creating new institutions and public-private partnerships to fill gaps in the system and identifying funding sources for these endeavors.

Mr. Wethington identified four areas where he felt discussion should focus in the coming weeks. First, the substantial elevation of federal leadership on competitiveness and innovation issues. Mr. Wethington called for a more holistic and integrated decision process taking into account both economic and national security considerations, and said there were many models to consider for a new and more robust incorporation of technology within the economic and national security decision processes. Second, he called for more "technology statecraft," or the deliberate enhancement of America's capacity to create and write rules for the future to shape and direct international institutions that have a bearing on our global competitiveness. Third, Mr. Wethington discussed resources and incentives. He called for a significant increase in funding for the key technologies that will drive large components of the economy, and advocated the use of both fiscal policy and tax incentives to promote strategic technologies and their transition to the marketplace. Finally, Mr. Wethington emphasized the need to reduce disparities in the distribution and development of technologies, including both geographic and demographic disparities. These disparities include both infrastructure—which a national infrastructure bank could play an important role in addressing—and disparities in the location of technology hubs.

Infrastructure Funding

Mr. Evans noted that Working Group 1 had discussed the idea of a sovereign wealth fund to finance major infrastructure projects, and would be consonant with a more robust federal role in systemic investment in innovation. Ms. Ji Mi Choi of Arizona State University noted this had parallels to the American Innovation Investment Fund proposed by Dr. Gerald Blazey of Northern Illinois University. Ms. Wince-Smith said that the Export-Import Bank and the Overseas Private Investment Corporation provided models for institutions that could fund major infrastructure projects, this time domestically rather than internationally. Dr. Blazey suggested that there could be two different sovereign wealth funds: one for infrastructure and one for research. Ms. Wince-Smith mentioned Australia's Future Fund as an example of a sovereign wealth fund to emulate, and also noted that hedge funds contained large amounts of idle capital that could be used to fund infrastructure projects.

Framing for December and Year Two

Ms. Choi asked how much polishing the recommendations needed before they were ready for presentation, and Mr. Evans said that at the macro level the Council was pleased with the content generated, but that it could use some expertise and creativity in strengthening the core ideas that have emerged. Dr. Dorhout suggested putting greater emphasis on the existential threat posed by China's attempts to become a global economic leader at U.S. expense, and Mr. Evans said the opening of the Call to Action would set the state for where the U.S. stands in terms of competitiveness, and how it must go forward. Dr. Blazey cautioned against focusing exclusively on China, noting that America's biggest competitors would continue to change and the country must develop a framework and rationale flexible enough to accommodate any challenge. Ms. Wince-Smith said this would also be a larger focus for Year Two of the Commission, along with greater discussion of standards and regulatory policy. She also emphasized the need to strengthen policies and remedies for theft of American IP by China and other competitors, and to counter cyberattacks meant to steal American intellectual property and damage our critical infrastructure. Mr. Wethington suggested prioritizing items for the Year One Call to Action by looking through the lenses of immediate threats to America's competitiveness and prosperity, as well as those with bipartisan appeal amid a new administration.

Concluding Thoughts and the Road Ahead

Mr. Evans said the Council would come back to the group in the coming days with tools for evaluating and prioritizing recommendations, and that next week's Co-Chair call would help set up the schedule for the next call in two weeks. The next meeting of the group will take place on Tuesday, October 13th.

Working Group 3 Calls October 20

Introduction

The Honorable Deborah Wince-Smith and Mr. Chad Evans welcomed the group. Mr. Evans shared that Oak Ridge National Laboratory, whose director, Dr. Thomas Zacharia, is a Co-Chair of the National Commission, hosted earlier this afternoon a town hall on leveraging tools at the nation's national laboratories for regional development.

The December Report and Year Two

Mr. Evans said he shared with the Co-Chairs a document outlining the areas where the Working Group has developed a set of high-potential recommendations for inclusion in the Year One Report, "Competing in the Next Economy," as well as areas where the Council team has identified gaps. These gaps include both ideas that are ripe for Year One development but will require strategic or tactical input from specific Working Group members in the coming weeks to develop and nascent ideas that should be a focus for Year Two. Additionally, Mr. Evans noted the document would revisit several ideas generated during the first phase of Working Group calls this Spring that the Council felt it was important for the Working Group to weigh in on before December. This document will be sent to all of the Working Group members for feedback and input later today.

Ms. Wince-Smith discussed the December report, set to be released at the National Competitiveness Forum on December 17th, as well as subjects to prioritize in Year Two. The report in December will be organized thematically, rather than by Working Group, in its presentation of recommendations. The Council team will also have a session with all of the Working Group Co-Chairs to go over the report and ensure

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the Commission is capturing big, bold, transformational ideas. She noted that with the new challenges arising to America's global leadership, incremental reforms were not enough. Rather, like we did at the end of World War II, the United States must make large investments in developing and sustaining institutions that will preserve our competitiveness and global leadership while facilitating the continued spread of our values. The country is at a major existential turning point, and our investments and policies must be focused on the next twenty to thirty years, not the short term.

For Year Two, Ms. Wince-Smith outlined several crucial areas of focus. China has been routinely violating OECD and WTO rules governing financing and investment in foreign countries, particularly regarding debt-financed infrastructure in the developing world. China has also been in violation of the Basel Accords, signed after the September 11th attacks to prevent individuals and organizations from surreptitiously moving money through the global banking system. In these and other areas where China is violating global norms for geopolitical gain, the U.S. and its allies must counter them through international alliances and "technology statecraft" around the creation and enforcement of standards and norms. Additionally, she noted that the Council is working to put together a task force on addressing the digital divide that excludes both rural areas and inner cities from the innovation economy and that will focus on developing a plan for universal, affordable broadband access.

Co-Chair Thoughts

The Working Group Co-Chairs shared their reaction to the document Mr. Evans developed. Ms. Vickie Lonker of Verizon said it was important to highlight where there were major opportunities to further develop recommendations for the Year One report, as well as to identify which issues would best be addressed in Year Two. Dr. Peter Dorhout of Kansas State University noted that the gaps in discussion the Council team had identified were in broad, strategic fields, such as capital funding, the Valley of Death in technology investment, and aligning banks and the tax system to facilitate more effective investment in innovation. He also noted gaps around investment in underserved communities and in creating an educated workforce for the 21st century. Dr. Dorhout cautioned that the Commission must focus on the long-term strategic plan for competitiveness, rather than just the short-term race to lead in a particular technology. He also noted the idea of establishing clearinghouses, exchanges, or databases of information was not fully developed from the group's recommendations. He said the group should be cautious in developing such a recommendation, as similar initiatives often fail due to challenges maintaining, updating, and publicizing those databases.

The Honorable Olin Wethington of Wethington International LLC emphasized the importance of aligning the Commission's work with the political context of a presidential election and incoming administration. He noted there was also significant legislative activity around many of the topics on the Commission's

agenda, and that the Council should highlight recommendations that have bipartisan appeal and connect with pending legislation. He also encouraged the Council to promote bold, transformative ideas, as administrations are most receptive to these policies during their first six months to a year in office.

Areas of Strength

Mr. Evans briefly outlined areas where the Council team felt the group had developed strong recommendation candidates, as well as opportunities for cross-pollination with ideas being developed in other Working Groups. In the international space, there were strong recommendations around technology statecraft, as well as rules and regulations for scientific collaboration and engagement. He noted that Working Group 1 was working on a recommendation for national leadership and centralized ownership of the nation's innovation agenda, and that these recommendations could be combined under the umbrella of an entity with budget authority, strategic oversight, and the ability to gather and forecast information. Another strong recommendation emerged in capital and financing around capital gains tax preferences for long-term investments. Recommendations around optimizing our innovation infrastructure, especially our nation's federally-funded research and development facilities, ties in with recommendations being discussed in Working Groups 1 and 2 around new mission spaces and authority for the National Laboratory system. Mr. Evans noted that former Sandia National Laboratory Director Dr. Paul Hommert and Los Alamos National Laboratory Deputy Director for Science, Technology, and Engineering Dr. John Sarrao from Working Group 1 were putting together a group to better develop national lab-focused recommendations. He encouraged interested members to connect with them in the coming weeks.

A fourth area of strength in the recommendations the group developed is in filling the Valley of Death, with a proposal for an American Innovation Investment Fund that would seek to fill gaps in funding for scaling disruptive technologies. In this space, there were also strong recommendations around investing in people, a key part of the nation's innovation infrastructure. Human capital development also ties in with the recommendations developed by Working Group 4 on workforce development programs for industries of the future. Several groups have developed recommendations dealing with universal broadband access and connectivity, but Mr. Evans noted that this group's were the most concrete and actionable, and would serve as a nexus for other Working Groups' members who were interested in cross-pollination and development of ideas. Finally, the group has developed strong recommendations around diversity, equity, and inclusion, including reforming the process for awarding SBIR program grants and using other existing tools to expand access to entrepreneurial funding and mentorship.

Areas to Address in Greater Depth

Mr. Evans noted that some areas in need of more discussion would need to wait until 2021, as they were broad enough that substantial research was needed. These include a set of related issues around standards setting in the international arena, as well as reform of intellectual property protection. Dr. Dorhout noted that state actors routinely ignore rules and regulations around IP management, and asked if more regulations would help address this or simply create more hurdles for inventors. Mr. Evans also noted that the group would engage in greater discussions in Year Two on diversity and inclusion, as well as geographic diversity and regional innovation, where there would be many opportunities for cross-pollination with Working Group 4. He encouraged participants to let the Council team know about any gaps identified in the document where they would be able to help develop recommendations ahead of December.

Concluding Thoughts and the Road Ahead

Mr. Evans reminded the group that he would send the document outlining the strengths and gaps in the group's recommendations shortly, and asked members to provide their feedback and input over the coming days. Ms. Wince-Smith reminded the group that it was imperative the Commission provides a powerful agenda for the incoming administration with its Year One Call to Action. The next meeting of the group will be Tuesday, October 27th.

Working Group 4: Unleashing Capabilities for Work and Entrepreneurship

Working Group 4 Summary

Working Group 4 began its discussions during Phase II of the National Commission's first year, which ran from June 26-October 16, 2020. This group was formed to explore more fully topics initially raised, discussed and developed in Working Group 2. Working Group 4's conversations focused around bolstering diversity, equity and inclusion; supporting regional economic development and geographic inclusivity; addressing worker displacement caused by broader economic trends and the impact of the COVID-19 pandemic; and fostering entrepreneurship and improving entrepreneurial education. Highlights and themes from the Group's discussions:

- The Group discussed ways to promote greater diversity and inclusion for historically underrepresented groups in the innovation space, and throughout academia, industry and the STEM fields. A particular focus was to articulate a way; a methodology to help all of the National Commission's Working Groups consider the implications of diversity, equity and inclusion in their discussions. The Group felt efforts to promote inclusion needed to be deliberate and thorough, rather than an afterthought. The Group discussed ways to increase the diversity of innovation pipelines through greater exposure to innovation and entrepreneurship in the educational system for members of marginalized groups, and efforts to ensure that members of marginalized groups in the innovation pipeline are given the same opportunities to participate and showcase their skills. A consensus emerged around creating a framework and set of questions policy makers could consult to ensure they were not excluding or marginalizing members of underrepresented groups in designing public policy or establishing institutional norms and practices.

  Working Group members expressed support for the development of a "toolkit" that would enable states, regions and localities to build innovation ecosystems that take advantage of local resources and assets, and ensure their populations are poised to be able to share in innovation-led economic growth. These toolkits would be based on best practices from successful regional development initiatives. They would include both general principles and more specific items, such as the development of infrastructure needed to facilitate innovation-intensive activity or partnerships with nearby regions, as well as across state or even national boundaries.

- The Working Group discussed ways to help workers displaced by a variety of changes sweeping across the workforce landscape—whether from tech-driven disruption or from the impact of the Covid-19 pandemic. These included both retraining workers for new jobs with more flexible, stackable credentials, and helping workers connect their existing skill sets to new opportunities and jobs in the innovation economy. Of particular importance to the Group was the development of new ways of educating displaced

workers, many of whom lack the time and resources to return to school full-time, and new ways for workers to demonstrate particular skills or competencies outside of the conventional model. In particular, developing and providing evidence of the flexible "soft skills" like communication, creativity, and teamwork will be increasingly important for workers of the future, and displaced workers looking for new jobs in particular.

- Relatedly, the Group discussed ways for regions that have seen their traditional sources of employment evaporate to rebound and rebuild, including training workers for "re-shored" jobs in the service industry that take advantage of existing skills and infrastructure. The Group also discussed the desire of many workers in the innovation economy to "give back" to their hometowns and communities by bringing them into the innovation economy, and ways to take advantage of the growth in virtual work to enable those workers to move back and help build innovation ecosystems in these regions.
- Central to efforts to bolster demographic and geographic inclusion, and to help regions develop innovation ecosystems, are efforts to upgrade digital infrastructure, especially broadband technology. Broadband access is essential for remote work, especially in innovation-intensive fields, and for students to engage with innovation and develop digital literacy, especially with the rise of online learning during the pandemic. Rural areas and low-income urban areas are especially underserved by broadband technology, and existing incentives are not strong enough for providers to build the necessary infrastructure in these areas. Partnerships and programs to achieve universal high-speed and broadband access were a major topic of discussion for the Working Group.
- The Group discussed the need for earlier and greater exposure to innovation-intensive fields and entrepreneurship in a students' educational pathway. Many students' decisions about whether to pursue STEM careers or become entrepreneurs are made early, and students from underrepresented groups in particular often lack early exposure to these issues and opportunities. As such, the Group felt there would be a particular benefit to the nation's long-term innovation capacity and competitiveness by focusing on earlier and greater exposure with these students. Additionally, the Group discussed ways to provide better support for the development of innovations that are physical products, which frequently require more support and incubation than services and software. And the Group led a series of conversations around how to optimize "Main Street" businesses essential to a robust innovation economy, as they play a large role in quality of life and the decision of innovation-intensive businesses and innovation industry workers to locate in particular regions.

- The Group discussed creating a pilot program for developing a regional innovation hub that would involve stakeholders from industry, academia, labor and the national laboratories working to foster a skilled, entrepreneurial workforce and encourage entrepreneurs to come to and stay in the region. The role of national laboratory facilities and scientists in incubating startups through providing equipment, test beds, and mentorship was a focus of discussions.

To view video and read full transcripts of each Working Group session, log in to the National Commission Community Online Portal. Video and transcripts are available within Working Group Rooms.

Working Group 4 Calls June 26

Introductory Remarks

The Honorable Deborah Wince-Smith and Mr. Chad Evans welcomed the group. Mr. Evans outlined the agenda for the call, including a summary of the first phase of Working Group discussions, a summary of the National Commissioners' meeting on June 16th, introductory remarks from the Co-Chairs, and introductions of the Working Group members, followed by general discussion on topics for the group to prioritize in the coming three months. Ms. Wince-Smith said she was pleased with the expertise, experience, and wisdom represented in the group, and discussed the need to address the future of work, the imperative of unleashing opportunities for inclusive entrepreneurship across the country, and the problem of regional disparities in economic development and opportunity. She also stressed the need for direct and rapid inclusion of women, minorities (particularly African Americans), and other underrepresented groups that have been excluded from entrepreneurial opportunities and opportunities to join the higher-skilled workforce.

The National Commissioners Meeting and Feedback

Mr. Evans recapped the National Commissioners meeting on June 16th. He noted the high attendance, with over 50 Commissioners and over 90 people in total participating. He reported that the Commissioners affirmed and supported the Commission's findings in Phase I of the Working Group discussions, and added three major themes for the Working Groups to consider going forward. First, the Commissioners agreed that the United States is at a pivotal moment for our country and economy, and the Commission has the opportunity to play a major role and an obligation to lead during this critical time.

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Dr. Steven Ashby, Director of the Pacific Northwest National Laboratory, observed that the Year One Call to Action to be released in December will likely be the first document addressing the U.S. economy and American competitiveness in the post-COVID-19 landscape. Second, the Commissioners charged the Working Groups to devote attention to two major topics. The United States is not as competitive as it could be because it has failed to address social and economic inequalities that inhibit social progress. This acts as an obstacle to competitiveness by keeping a significant share of the U.S. population "off the playing field" and hindering them from reaching their full potential. Conversely, cultivating this potential would represent an enormous competitive advantage for the United States. The United States has also paid a heavy price in human lives and economic damage from the COVID-19 pandemic, which has revealed a lack of resiliency in America's economy and society and in particular shown the fragility of our supply chains. The Commission must lead in the effort to immediately address this. Third, the rules of engagement have changed when competing with other countries. The policies that worked in the 20th Century are obsolete, and the 1990s should be thought of as the Dark Ages. Incremental changes will not be sufficient to ensure the United States remains on the cutting edge of competitiveness in the 21st century.

Finally, the Comissioners emphasized that human capital is as important or more important than financial capital, but this has not been reflected in how the country has invested in its workforce and its citizens. The Commission must think of the necessary capabilities so that the average citizen is employable, engaged, and productive. Currently 1/3 of the population is at risk of being left behind by the new economy, with another 1/3 on the precipice of risk. The country cannot thrive if 2/3 of the population does not benefit as it should from innovation.

The Nine Pillars and the Synthesis Report

Mr. Evans also discussed in further detail the synthesis report, which outlined Nine Pillars for the Commission to consider as the Working Groups develop policy recommendations in Phase II. These pillars consist of topics and themes that emerged across all of the Working Groups, and were identified as "urgent," "strategic," and "pivotal." "Urgent" means that failure to act on the issue poses serious threats to the U.S. economy, national security, and competitiveness. "Strategic" means that the subject is fundamental to U.S. national security and economic prosperity. "Pivotal" means that the topic is likely to have a determining role in the scope of America's innovation capacity going forward.

Remarks from the Co-Chairs

Dr. Carol Dahl of the Lemelson Foundation described her roles as a Commissioner and participant in two Working Groups- Working Group 2 and Working Group 4. She echoed Mr. Evans' remarks about the enthusiasm of the Commissioners towards the Phase I findings, and emphasized the importance

of resiliency and developing a vibrant economic base that applies to all Americans. She also said the group had the opportunity amid the current crisis to reframe what innovation means for the 21st century. Dr. Dahl expressed excitement for the focus on human capital, which she said was key to resolving inequity along geographic, demographic, and gender lines. She also stressed the need to extend policy interventions down into the K-12 educational system. Finally, Dr. Dahl endorsed rethinking the meaning of entrepreneurship as it relates to innovation. In addition to technology that determines which economies lead and which ones follow, she emphasized the role entrepreneurs play in keeping communities livable and workers employed.

Ms. Julie Meier Wright of Collaborative Economics agreed with Dr. Dahl's remarks and discussed her work going through the 57 questions posed in the group's charter across five broad topics. She said this organizational framework provided the opportunity to combine and classify recommendations going forward, and noted the growing desire to bring parts of supply chains back to the United States, in particular to left-behind areas of the country. She discussed her background as the Secretary of Trade and Commerce for California, in running a regional economic development effort, and her years in the private sector, as well as her time as a Senior Fellow at the Council. Ms. Meier Wright said that the pandemic provided an opportunity to take a second look at regions around the country with the potential to be innovation hubs, albeit with different criteria for success than those of Silicon Valley. She said addressing regional disparities in innovation capacity will be key to combating inequity, and welcomed feedback from the group on how to distill the questions from the Working Group charter into actionable recommendations.

Dr. Lee Cheatham of Pacific Northwest National Laboratory also recounted his experience at the Commissioners Meeting, where he participated as an Advisor. He characterized the Council's presentation of its findings as well thought out and internally consistent. He then talked about his background in the private sector, academia, and with National Laboratories, and his focus on economic growth and competitiveness. He said the Commission faced a unique opportunity, not just to be the first group to publish recommendations for the post-COVID economy, but to pioneer bold, transformative changes to America's economy and society- a once in a decade opportunity. Dr. Cheatham characterized the future of work and the future of entrepreneurship as distinct but closely related, and suggested the group would find success by focusing on areas of overlap that could address challenges in both areas. He also stressed the need to learn from the pandemic, which he predicted would lead to permanent and substantive changes in the way we work and the role of entrepreneurs, and the need to recognize the implications of accelerating digitalization on the nature of work. Finally, he warned that the United States cannot count on being the world's sole leader in innovation anymore, and must prepare adequately for a world of shared global leadership. He said that incorporating these angles into the questions posed by the charter will give the group insights into what recommendations will best fit the country's future needs.

Dr. Lloyd Jacobs, President Emeritus of the University of Toledo, discussed his work as a Distinguished Fellow at the Council and his time as both an academic surgeon and a university president. He described his worries about the unprecedented challenges facing the United States, but also praised the synthesis report from Phase I for properly framing things. Dr. Jacobs noted that the industry hit hardest by the pandemic and associated recession, the hospitality and leisure industry, employs a large number of young people and members of underrepresented groups. He warned that the group could not focus solely on high-tech industries in its consideration of innovation. Mr. Evans expressed appreciation for Dr. Jacobs previous work in describing the transformation of Toledo from a glass-making center to a solar industry hub, providing an example of generating innovation in a struggling region.

Ms. Erica Volini of Deloitte discussed her work leading Deloitte's global human capital practice. She expressed admiration for the Business Roundtable's decision to redefine the purpose of a corporation from merely benefiting shareholders to serving the needs of all stakeholders, including shareholders, workers and the community in which the corporation operates. Ms. Volini characterized the time as ripe for harnessing a triumvirate of corporations, universities, and governments to work together on behalf of communities given the desire for a new role for corporations. She described her experience growing up with entrepreneur parents, and the fear that many people experience when contemplating running a business and risking loss, and urged a redefinition of entrepreneurship from a high-risk business venture to a mindset that is essential to every worker. Ms. Volini spoke of the need to give all people the capability to be entrepreneurs regardless of background or industry. She noted the desire of younger generations to give back to their communities and hometowns, and discussed her idea, inspired by her husband's desire to build up his hometown in Eastern Kentucky, of using entrepreneurs, companies, and universities to train workers in left-behind regions in shared services and technology skills. She suggested this could be part of a move to re-shore jobs that were lost overseas in recent decades. Finally, she expressed excitement at the opportunity to learn from people in industry, academia, and government and witness the synergies generated by discussion among people from diverse backgrounds.

Introductions of Group Members

Other members of the Working Group also introduced themselves. Ms. Charlotte Alexander of Georgia State University discussed her background in labor and employment law, as well as her work directing an analtics labs that uses data science to change how the law works. She expressed interest in the tech-based transformation of professions as well as the schools that train professionals.

Dr. Jerry Haar of Florida International University discussed his work on globalization, competitiveness, and related issues. He identified the urban-rural divide, and the drain of human capital from rural areas due to migration to cities, as a major challenge to inclusive prosperity. He noted that recent events had caused both people and companies to consider relocating to less densely populated areas, and spoke of the potential for this trend to boost productivity in rural areas. He expressed interest in determining the role of state and local economic development administrations and universities in developing human capital in rural areas, and described the opportunities for companies to partner with these groups in ventures that would represent shared values and win-win situations rather than philanthropy or social responsibility initiatives.

Ms. Amy Lientz of Idaho National Laboratory spoke about the role National Laboratories could play in the group's work, as they are often sites of innovations that have not hit the commercial market. She said the group could draw on the experiences of entrepreneurs working with the labs to identify obstacles to scaling, including providing healthcare and benefits to affiliated entrepreneurs and risk aversion by labs. She also discussed the role the labs could play in informing discussion of diversity and inclusion policies through analysis of both successful and unsuccessful initiatives they have pioneered.

Dr. Carlotta Arthur of the Luce Foundation discussed her role as director of the largest program for Women in STEM in the Country, as well as her backgrounds in engineering and psychology, particularly the health implications of psychological stress. She said that while the Commission's work on diversity is critical, it is not enough to put more players on the field. The rules of the game in which they operate must change or else the country will continue to struggle with inclusion because of systemic issues.

Mr. Thom Ruhe of NC Idea discussed his work as an entrepreneur and his involvement in various foundations focused on economic development and improv-

ing human capital throughout the U.S. and the world. He stressed the importance of inclusion and noted that at his organization, at least 50 percent of time, treasure, and talent is spent on boosting entrepreneurship by women and minorities and in rural areas. He called for a reframing of entrepreneurship as a life skill, rather than a trade or technical skill, and as a set of beliefs and assumptions that drive behavior in any organization, regardless of age or size. He compared the importance of literacy to economic mobility with the similar need today for the ability to quickly unlearn and relearn skills to find value creation.

Finally, Ms. Jenny Sorensen of Sorensen Strategies described her work as a consultant for the Lemelson Foundation and her previous work at the Gates Foundation helping Melinda Gates' advocacy efforts around women and children's health. She expressed agreement with the ideas of the other group members, and noted it aligned with what Lemelson has been advocating and working on for years.

The Role of Inclusion

Dr. Dahl noted that while all four Working Groups had been tasked with improving diversity and inclusion in America's economy and innovation space, this group in particular was tasked with focusing on the subject. She described the group's mandate as focusing both on preparing the next generation of workforce talent and creating the next generation of entrepreneurs. By contrast, other groups are focused on developing the tools and structures entrepreneurs need to thrive and create businesses. However, she noted that it is harder for people from underrepresented groups to access the funding, mentorship, and other assets they need to fully participate in an innovation economy, and stressed the importance of conveying this to the other groups. Mr. Evans noted that other groups had also been discussing this issue, and reminded participants about Dr. Arthur's sharing via the online portal of a toolkit that can help policy makers consider the inclusivity of their proposals. Dr. Dahl added that if downstream systems do not change, including the K-12 educational environment, higher-level inclusionary efforts won't matter because of the bottleneck created by the lack of access at lower levels.

Short-Term and Long-Term Priorities

Dr. Dahl differentiated between the short-term and long-term objectives and potential policy recommendations for the group to consider. In the short term, returning the unemployed to work will be essential, but in the long term, systems change to adjust to the changing nature of work and increase inclusion in entrepreneurship and innovation will be essential. She also contrasted the group's need to focus on ensuring U.S. competitiveness in leading-edge, disruptive technological innovation with its mandate to ensure innovation permeates all of the economy and society and improves communities and Ameri-

cans' quality of life. She added that inclusion should be woven throughout the group's discussions on both sets of topics. Ms. Volini agreed with this framing, and encouraged the group to start putting policy recommendations up for discussion and using polling to determine which policies to pursue and further develop.

The Road Ahead

Mr. Evans reminded the group that with weekly one-hour meetings and a deadline of December 17th to release the National Commission's Year One Call to Action, it was imperative for the group to coalesce around a few key issues and drill down on them to generate actionable recommendations. He also noted the opportunity presented by the 2020 Presidential Election and the chance to provide input on policy priorities for the new administration. Dr. Cheatham suggested that the group share examples on the online portal of policies that the Commission could promote for implementation, along with an explanation of how said policies fit the Commission's future vision and what gaps remain between the present and the realization of that future vision. He argued that this would help the group focus on both near-term and long-term objectives.

Concluding Thoughts

Ms. Volini suggested that the group coalesce around a definition of the word "innovation" and encouraged participants to post their views about how they define the term on the online portal. Ms. Wince-Smith discussed the Council's previous definition of innovation as "I to the Fifth Power", the intersection of ideas, imagination, insight, invention, and impact. She suggested adding inclusivity to that list as well. Ms. Meier Wright said she was in the process of binning all of the 57 questions from the Working Group charter according by category in order to help develop a roadmap for the group's future discussions. Mr. Evans reminded the group to share its lists of priority topics and reminded participants that the next meeting will take place in two weeks due to the July 4th holiday.

Working Group 4 Calls July 10

Introduction

The Honorable Deborah Wince-Smith and Mr. Chad Evans welcomed the group, and gave the opportunity for three of the newer members of the group to introduce themselves. Ms. Van Ton-Quinlivan of Futuro Health discussed her background as the Vice Chancellor of the California Community College Systems' workforce commission and her current role as the CEO of a joint initiative between the Service Employees International Union and Kaiser Permanente called Futuro Health that seeks to address the shortage of allied healthcare workers as America's population expands and ages, an initiative that has taken on new urgency in the pandemic. Mr. Ernie Dianastasis described his background in the IT services industry and his current efforts with the startup The Precisionists, Inc., which aims to place 10,000 people with developmental disabilities like autism in jobs by 2025, and to change workplace cultures to create successful outcomes for people with disabilities. Mr. Thom Ruhe of NC IDEA discussed his work in economic development and his current role in spearheading economic development initiatives in North Carolina, particularly in rural areas.

Mr. Evans reminded the group that the upcoming presidential election means that during the transition period from November to January, the new administration will be receptive to bold policy proposals to implement during its first months in office, and the Commission should establish priorities that will be of particular importance to the new administration and that address the current political and economic climate. He then turned to the Co-Chairs of the group to lead the day's discussion.

WORKING GROUP PARTICIPANTS

Ms. Charlotte Alexander
Georgia State University

Dr. Carlotta Arthur
Luce Foundation

Mr. Leslie Boney
North Carolina State University

Dr. Lee Cheatham
Pacific Northwest National Laboratory

Dr. Carol Dahl
Lemelson Foundation

Mr. Ernie Dianastasis
The Precisionists, Inc.

Dr. Jerry Haar
Florida International University

Dr. Lloyd Jacobs
University of Toledo (Emeritus)

Ms. Amy Lientz
Idaho National Laboratory

Ms. Julie Meier Wright
Collaborative Economics

Mr. Thom Ruhe
NC IDEA

Ms. Van Ton-Quinlivin
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Outlining Six Topic Areas

Dr. Carol Dahl of the Lemelson foundation discussed the six broad topic areas the Co-Chairs had identified for further discussions. She broke these six areas into three larger categories of Workforce, Entrepreneurship, and Inclusion, with each category having two subcategories. The Workforce category includes both the short-term challenge of displaced workers during the pandemic and rapidly changing skill-sets and declining industries, as well as the long-term challenge of preparing the talent pool for the workforce of the future in an inclusive fashion. The Entrepreneurship category includes addressing the unique needs of innovation-based entrepreneurs, who drive the majority of job creation and economic productivity, and "Main Street" entrepreneurs, who make up the majority of businesses and are essential to making communities vibrant and livable. The Inclusion category subdivides into racial and gender inclusion in the innovation pipeline and geographic inclusion and the urban-rural divide. Dr. Dahl said that changing the educational system to develop aspirational equity at an early age was essential to increasing the number of women and minority entrepreneurs, while addressing geographic inclusion required different pathways.

Dr. Dahl also mapped the policy ideas that emerged from the Phase I Synthesis Report onto the six categories she outlined. To assist innovation-based entrepreneurs, these included requiring students experience invention, innovation, and computer science at the K-12 level, and the development of a cross-agency working group to identify and champion best practices in innovation-based entrepreneurship. Others included a fast track program for student loan forgiveness and the expansion of the Small Business Innovation Research (SBIR) and Build to Scale programs, with a particular emphasis on Minority- and Women-Owned Business Enterprises (MWBEs), and incentives to mentor an inclusive entrepreneurial workforce. To address lifestyle entrepreneurship, the Synthesis Report recommends increasing the Small Business Administration's budget by 25 percent, and recommends the creation of inclusive programming for all related federal initiatives to boost racial and gender diversity. For geographic diversity, the report recommends creating innovation hubs in "second-tier" metropolitan areas, expanding the Build to Scale program for developing regional innovation hubs, and providing deep financial, technical, and administrative support to early seed startups in geographic areas outside of traditional entrepreneurial hotbeds.

The Displaced Workforce

Ms. Wince-Smith warned that the United States needed to improve its trade adjustment assistance policies, as entire communities can deteriorate when their principal industry declines. She compared the lackluster U.S. response to de-industrialization with the example of Wales, where the government was proactive in retraining coal miners and in developing clusters of biotechnology and software development. Mr. Leslie Boney of North Carolina State University

added that if the Commission does not address the economic collapse in December, it will come across as tone-deaf. Dr. Jerry Haar of Florida International University discussed his research on trade adjustment assistance programs, and said that the vast majority of eligible individuals are unaware of existing programs and do not participate. He added that displaced workers form a large voting bloc, and addressing their concerns will be of paramount importance to policy makers. He suggested finding and disseminating best practices in workforce retraining and trade adjustment to interested parties, especially at the state and local level. Ms. Julie Meier Wright of Collaborative Economics said that addressing the issue of displaced workers tied into all of the other topic areas, and needed to be a primary focus if the Commission hoped to influence the incoming administration, which would be taking office during likely double-digit unemployment.

Focusing on Inclusion

Ms. Meier Wright said that fostering geographic inclusion was essential to the health of the economy and the country, and suggested identifying ways to reach smaller metropolitan areas and rural areas and connect them to the innovation economy. She also underscored the importance of universal broadband access to allowing people in those areas to participate fully in the digital economy through remote work. Ms. Ton-Quinlivan said that the pandemic was likely to have permanent impacts on healthcare delivery, with a much larger role for telehealth going forward, even to the point of collecting health data from patients remotely and transmitting it to medical professionals, which would require a dramatic change in the skill set of health professions. It would also require universal broadband access to both provide healthcare services to rural areas and to enable people living in rural areas to train for healthcare careers, illustrating the cross-cutting role broadband access plays in both geographic inclusion and workforce retraining.

Ms. Wince-Smith warned that the United States needed to ensure entrepreneurial hubs expanded beyond the two coasts, and noted that venture capital was heavily concentrated in these areas. She pointed out that many other regions contain assets like universities that could be hubs of talent and innovation, and that every region will have unique assets and strengths to build on. Dr. Dahl added that the question of "equity of aspiration" applied to rural areas, not just underrepresented demographic groups. She discussed the excitement and enthusiasm in rural Oregon for programs aimed at boosting entrepreneurship, and said that the group should not presume rural areas cannot develop certain kinds of innovation infrastructure. She suggested working on bringing in missing components of innovation ecosystems to these areas rather than trying to make do without them. Ms. Meier Wright said that politicians focus their attention on the larger voting blocs dwelling in populous urban areas, even though rural areas have greater needs, and highlighted the need to get policy makers to focus on these left behind regions. She also emphasized that different economies will have different benchmarks for success, and that the economic activity and balance that is ideal will differ from area to area. To that end, she suggested creating tools and frameworks to enable different regions to assess their assets, obstacles, and opportunities and empower themselves.

Mr. Dianastasis advocated the addition of disability as a dimension of inclusion. He noted that 40 million Americans have a disability of some sort, and that this group of Americans faces high underemployment and unemployment. While this untapped labor pool has tremendous upside with the right accommodation and training, it will be a drag on the economy and innovation ecosystem if we do not work to create successful outcomes for them. Dr. Carlotta Arthur of the Luce Foundation noted that since a disproportionate number of people with disabilities are members of minority groups, there could be intersections between policies aimed at promoting inclusion of disabilities and those aimed at addressing racial and ethnic diversity. Ms. Yasmin Hilpert stressed

the need to focus on inclusion by age cohort, as the growing population of older Americans faced unique challenges and needs with regard to workforce development and continuing education than younger people, and Dr. Haar agreed on the need for a strategy in this area. He noted that people over 50 are one of the fastest growing demographics in America.

Matching Members to Topics

Mr. Evans suggested matching group members to topics of particular interest or in line with their expertise in order to prepare more detailed conversations about each topic area. Ms. Charlotte Alexander of Georgia State University expressed interest in the connection between displaced worker policy and innovation-based workforce development and the growing number of freelance, contract, and other non-traditional employees. Dr. Dahl expressed interest in developing innovation talent, innovation-based entrepreneurship, and both demographic and geographic inclusion. Ms. Ton-Quinlivan and Mr. Haar expressed a desire to focus on displaced workers, and Ms. Ton-Quinlivan agreed with Ms. Alexander on the need to focus on contingent workers, as she predicted such work arrangements would grow in the aftermath of the pandemic. Ms. Lientz said she wanted to work on geographic inclusion and the innovation pipeline of the future. She noted her experience in workforce development initiatives in rural areas and expressed a desire to identify best practices and barriers to improve existing programs in addition to expanding them.

Intersections Between Areas

There was considerable discussion among the group members as to how to address demographic and geographic inclusion. A general consensus emerged that both needed to be folded in to the other four topics, but that geographic inclusion in particular required standalone consideration as well. Dr. Arthur said she felt race and gender cut across priorities, as did Mr. Boney, who said each of the other topics had a demographic aspect. He asked how to increase diversity in innovation talent and among innovation-based entrepreneurs, and how to overcome the disproportionate impacts of worker displacement on racial minorities. Ms. Meier Wright noted that changes to virtual environments from the pandemic would have unique impacts on rural areas and on women, and connected these impacts back to the challenge of broadband access. Ms. Wince-Smith observed that different sectors of the workforce and different areas of the country faced different challenges around the inclusion of women, with government faring better than industry in promoting women to leadership positions.

Mr. Ruhe said that both demographic and geographic inclusion applied to the other four topic areas, but in different ways. He noted in particular that geographic inclusion brought up challenges like broadband access and other infrastructure that merited standalone consideration as well. He discussed his foundation's work in rural North Carolina and the need to tailor economic development efforts towards re-skilling and workforce development due to the lack of private equity networks, intellectual property-generating entities, and other components of the innovation-based economy of the Research Triangle.

Dr. Lee Cheatham of Pacific Northwest National Laboratory observed that the Commission had clear and compelling high-level goals, and that the Working Groups were beginning to develop detailed policy ideas, and asked how the group could best develop a plan for connecting these. Ms. Wince-Smith said that identifying specific actionable policy recommendations first would allow the Commission to develop a road map from those policies to its larger goals. She described how the innovation ecosystem in San Diego developed from component pieces, including a wireless industry that developed because of the needs of the U.S. Navy, which had a large presence in the area. She also discussed emerging plans in the Knoxville area to create an innovation hub, centered around the University of Tennessee and Oak Ridge National Laboratory.

The Educational System

Ms. Lientz said that the conventional focus on K-12 education should be thought of as "K-Career" education, and emphasized the important role community colleges played in retraining workers and in continuing education opportunities. Dr. Dahl said that the most important priority was to train innovators and the talent their businesses will need, and that this would require changing the country's approach to K-12 education, ensuring greater support for career training in higher education, and using the community college system among other assets to bolster continuing education opportunities. Dr. Arthur emphasized the importance of K-12 education in fostering an entrepreneurial workforce.

Conclusion and the Road Ahead

Ms. Hilpert suggested developing a poll to allow group members to signal their preference of topics to specialize in and provide feedback on the order the group should consider each topic in. Dr. Dahl suggested starting with the displaced workforce, and Dr. Haar cited New Mexico as a case study for the intersection of geographic inclusion, demographic inclusion, and displaced workers, noting the unique economic landscape in New Mexico as well as its large Latino population. Ms. Alexander advocated presenting inclusion as part of the overall economic development framework, rather than as a separate subject. Ms. Meier Wright suggested having a featured speaker for a future Working Group session from Los Alamos National Laboratory to discuss the geographic, demographic, and workforce development challenges in New Mexico. The next meeting of the group will be on July 17th.

Working Group 4 Calls July 17

Introduction

The Honorable Deborah Wince-Smith and Mr. Chad Evans welcomed the group. Mr. Evans said that the previous week's discussion and Co-Chair meeting had been productive, and presented the group with three overarching recommendation areas, from the six discussed previously- developing the entrepreneurial pipeline and innovation-based entrepreneurship, displaced workers and Main Street businesses, and geographic and regional inclusion. He said that this consolidation did not mean all the topics previously discussed were not still up for consideration. He added that one of the six categories, racial and gender inclusion, was going to be embedded in each of the three discussion categories, as it is a cross-cutting issue that cannot be extricated as a standalone item.

Co-Chair Remarks

Dr. Carol Dahl of the Lemelson Foundation echoed Mr. Evans' remarks about the importance of folding questions of inclusion into the other discussions, and added that this group could set expectations for the other three Working Groups in terms of incorporating inclusivity as an inherent part of their work. Mr. Leslie Boney of North Carolina State University expressed his support for the consolidation into three topics, and reminded the group that the first report from the Commission will be released in the aftermath of a contentious election, with an ongoing pandemic and high unemployment. He said the categories chosen for the group's focused discussions will be especially relevant during this transitional time. He added that the group could not merely pay lip service to diversity and inclusion. Ms. Julie Meier Wright of

WORKING GROUP PARTICIPANTS

Ms. Charlotte Alexander
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Dr. Carlotta Arthur
Luce Foundation

Mr. Leslie Boney
North Carolina State University

Dr. Carol Dahl
Lemelson Foundation

Mr. Ernest Dianastasis
The Precisionists, Inc.

Ms. Ellen Donaldson
Mr. J.R. Edwards

Lockheed Martin
Dr. Lloyd Jacobs

University of Toledo (Emeritus)

Mr. Bill Johansen
Lawrence Berkeley National Laboratory

Ms. Amy Lientz
Idaho National Laboratory

Ms. Julie Meier Wright
Collaborative Economics

Mr. John Melville
Collaborative Economics

Mr. Thomas Ruhe
NC IDEA

Ms. Van Ton-Quinlivan
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Collaborative Economics, a Senior Fellow with the Council on Competitiveness, said she saw inclusion on both geographic and demographic lines and displaced workforce issues as an overarching priority. She added that geographic inclusion was especially important for spreading the innovation economy beyond high-tech hubs on the coasts.

Expanding the Group

Mr. Evans asked the group members to think about individuals in their networks with expertise that would deepen the group's knowledge and experience on the topics it focuses on. In particular, he asked participants for help in recruiting experts in entrepreneurship and startups, and experts on the topics of diversity and inclusion. Dr. Lloyd Jacobs, former president of the University of Toledo and a Distinguished Fellow with the Council on Competitiveness, encouraged the group to be explicit in its focus on diversity, and Ms. Meier Wright emphasized the need to increase the group's diversity in terms of both background and age. Ms. Wince-Smith agreed, noting in particular the need for more young entrepreneurs in the group.

Participant Priorities

Mr. Evans asked participants to share their priorities for focused discussion, and to share any topics they felt the group had not yet adequately addressed. He added that he hoped participants would be willing to commit to extra preparation, background research, and leadership of discussions in the issues they had chosen. Ms. Ellen Donaldson expressed interest in the subjects of innovation talent and racial and gender inclusion. She said that there were already substantial disparities in educational opportunities prior to the pandemic and associated school closures, and that these disparities had increased, with students from underrepresented groups and in high poverty areas were being increasingly left behind. Mr. Evans drew parallels between this emphasis and Commission and Council Vice-Chair Dr. Michael Crow, President of Arizona State University, who expressed the necessity of ensuring the 100 to 200 million Americans currently left out of the innovation economy have the opportunity to participate in the economy of the future.

Dr. Carlotta Arthur of the Luce Foundation expressed support for highlighting racial and gender diversity as cross-cutting factors. She noted that a disproportionate share of those displaced by the pandemic were women and people of color, as well as lower-income workers. She further underscored the need to include diversity as "baked in" to other topics, rather than as an afterthought, and said she would be happy to share best practices in this area along with her expertise in diversity, inclusion, and the social determinants of health. Mr. Evans observed that the Council has thought about incorporating resilience into all other topics in the same way as Dr. Arthur urged for diversity. Mr. Thomas Ruhe of NC IDEA expressed interest in racial, gender, and geographic diversity, as well as Main Street entrepreneurship. He encouraged the group to avoid terms for Main Street

entrepreneurship with pejorative connotations, such as lifestyle entrepreneurship, and noted that Main Street businesses were likely to be the first foray into entrepreneurship and economic inclusion for many displaced or left behind workers. Ms. Charlotte Alexander of Georgia State University expressed interest in both displaced workers and geographic and demographic inclusivity, and said she wanted to explore how the innovation framework applies to the labor force more broadly. She emphasized the importance of regaining the losses sustained during the pandemic and rebuilding all forms of labor in a positive way, and the need to discuss entrepreneurship within firms or organizations, as well as in standalone endeavors. Ms. Alexander also stressed the disparate impact that long-term school closures would have on women, especially single mothers, and their workforce participation.

Ms. Van Ton-Quinlivan of Futuro Health expressed interest in displaced workers, noting that the nature of work is shifting, and that employees move companies far more frequently than in the past. As a result, employers do not provide the same on-the-job training and benefits as they previously did, and people are left to finance their own re-skilling. She emphasized the need to develop new social structures to enhance the portability and ease of financing worker education and training. Ms. Amy Lientz of Idaho National Laboratory expressed interest in both cultivating innovation talent and geographic inclusivity, discussing her own background working on challenges facing rural areas and the Native and Latino communities in Idaho. She added that there were many case studies of efforts to cultivate innovation talent through programs like SBIR and the I-Corps, but that these efforts were not leading to broader inclusion of entrepreneurial training in schools or greater innovation. She stressed the need to identify barriers to the success of these programs, and of looking to best practices from other rural states, including Wyoming and Montana. Ms. Lientz also echoed the importance of Main Street businesses, as they are where most entrepreneurs start, and provide an opportunity to introduce them to the world of high-tech innovation. Ms. Wince-Smith noted there were similar geographic challenges in Arizona, where tribal areas lagged far behind metropolitan Phoenix in opportunity. Mr. Evans added that Dr. Jerry Haar of Florida International University had both already begun working on background material for the discussion of displaced workers and was in the process of hiring a research assistant to help the group explore the topic in depth.

Mr. J.R. Edwards of Lockheed Martin discussed his background at the nexus of the future of work and Lockheed's technology strategy. He said the Commission was an excellent opportunity to assert leadership on a topic that is becoming increasingly relevant to Fortune 100 firms, and that he would save further comments for later. Mr. John Melville of Collaborative Economics discussed his work in launching industry partnerships and reconnecting business with the education and training systems, and expressed interest in all the dimensions of inclusion, both demographic and geographic. He stressed the need to move beyond the loosely organized

nature of such programs, and emphasized the assets and workers that were not being leveraged maximally or developed to their full potential. He highlighted the need to invest holistically rather than pouring money into different silos, and said that the current wave of re-shoring and reorganization brought on by the pandemic was a tremendous opportunity that the nation needed to use to its advantage. Mr. Evans noted that this focus was similar to Ms. Erica Volini of Deloitte's work on redeployment of the labor force.

Dr. Dahl said she was excited by the combined priority of the innovation workforce and cultivating entrepreneurial talent in the educational system. She expressed interest in geographic diversity, but noted that some communities faced greater challenges than others in access in the innovation economy. She also stressed the contribution of inequality of aspiration and inequality of awareness to the lack of diversity in the entrepreneurial pipeline, and said it was crucial to promote awareness of opportunities to children from underrepresented groups. Dr. Dahl cited in particular the work done by researchers at Harvard on equality of opportunity, which found that there is tremendous inequality of opportunity even by zip code, let alone region. Mr. Ernest Dianastasis of The Precisionists, Inc. expressed interest in innovation-based entrepreneurship and the talent pipeline, as he said that without more growth and more jobs, the other goals of the group were not achievable. Dr. Jacobs expressed interest in Main Street entrepreneurship and displaced workers, especially in the hospitality, leisure, and travel industries. He said these sectors were devastated by the pandemic and employed a large number of younger workers, often those financing their educations, as well as members of underrepresented groups. The job losses in this sector have a large impact on diversity and act as the entry point into the workforce- and entrepreneurship- for many of the least secure workers.

A Path Forward

Mr. Evans observed there was an emerging consensus around priority areas for further discussion and encouraged the group to come to an agreement on a topic for next week. Once topics for deeper conversations are chosen, the Council team can begin assembling the background material and primers needed for the deep dives that will generate recommendations. While he suggested spending two to four weeks at a time on each topic, Mr. Evans reminded the group that the conversations did not need to proceed in a linear fashion. Ms. Meier Wright suggested starting with topics that overlapped with the mandate of other groups, as the group could then send its findings around to inform the discussion of the other Working Groups. Dr. Dahl recommended an interspersed model, with rotating topics on a weekly basis, as this would allow members of the subgroups to prepare more thoroughly for discussions between each session, allowing for more focused conversations. Mr. Evans noted that rotating every week might produce a whipsaw effect for the Council team, and suggested rotating topics every two weeks. He added that mixing topics in this fashion would avoid the subgroups breaking down into silos.

Harnessing Geographic Movement

Ms. Meier Wright observed that many left-behind regions of the country are unsure of how to start bolstering their innovation capacity, and that these regions often have different definitions of success than high-tech hubs like Silicon Valley, even prior to the massive displacement caused by the pandemic. Mr. Melville added that many of these communities could benefit from re-deploying their assets, as they have valuable industries, but lack the people and talent to expand them and reach their full growth potential. The massive dislocation caused by the pandemic has created a large pool of workers who could be redeployed to help mid-sized metropolitan areas, as well as rural areas, reach this potential. Ms. Meier Wright recalled Ms. Volini's discussion of the growing trend of successful entrepreneurs and professionals returning to their hometowns to help expand economic opportunity and increase innovation there, and added that many people were leaving California, providing an opportunity to redeploy their entrepreneurial expertise. Ms. Alexander echoed these sentiments, noting that many people were leaving urban areas due to the pandemic and taking advantage of the ability to work remotely. She added that this would increase both the demand and need for improved rural broadband and telecommunications infrastructure. Mr. Boney agreed that robust broadband could be very impactful in overcoming barriers of place, but emphasized the need to train local talent for remote work jobs in these areas as well. He also stressed the need to help dislocated workers found more Main Street businesses. Ms. Alexander added that it was important to ensure that any movement to smaller metropolitan areas not be concentrated in enclaves, and that policy makers work deliberately to foster connections that benefit existing communities in these regions. Ms. Wince-Smith recommended the group seek out members with experience on workforce development boards, and Ms. Ton-Quinlivan noted that the National Governors Association had begun conversations on workforce development that could lay the groundwork for the group's discussions, with appropriate adjustments to reflect the ongoing pandemic.

Concluding Remarks

Mr. Evans asked if Ms. Meier Wright and Mr. Boney would be willing to lead a discussion for the next few weeks on regional innovation and geographic inclusion, with the additional goal of developing a second topic to begin exploring immediately afterward. Participants expressed general agreement with this plan, and Mr. Evans said the Council team could start developing pre-reading materials. The next meeting of the group will be on Friday, July 24th.

Working Group 4 Calls July 24

Introduction

The Honorable Deborah Wince-Smith and Mr. Chad Evans welcomed the group. Ms. Wince-Smith said she was excited to begin moving from the "Why" of the future work and entrepreneurship to the "How." Mr. Evans began the discussion by sharing with the group the status of the other three Working Groups. Working Group 1 has broken into sub-issues of U.S. innovation strategies for global leadership, competitive assessment of the U.S. position in key technologies, investment in research and innovation, and U.S. innovation systems and structures, the last of which will be the group's first deep dive topic. Working Group 2 has broken into two sub-issues on the topic of the circular economy: best practices and efficiencies and innovations. Working Group 3 has split into four sub-issues, focused on global competitiveness and existential threats, the national regulatory environment, systems infrastructure, and financing innovation.

Mr. Evans said that the other three groups will follow a process of introductions of each topic area, followed by a rotation of sustained discussions on each issue. During the time between the introductory session and the sustained discussions, subgroup members will work to develop background materials, questions for discussion, and the seeds of recommendations to be discussed by the whole group when it is time to discuss their topic. Mr. Evans said that this group would follow the same process as the other three, and that after today's discussion on

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regional innovation systems, the group would spend the next two weeks introducing the topics of displaced workers and Main Street entrepreneurship, and cultivating the innovation talent pipeline, respectively. Throughout these conversations, Mr. Evans emphasized the need to embed cross-cutting issue of diversity and inclusion. Each of the subgroups will be guided by one or more Co-Chairs, and Mr. Evans asked for permission from the group members to share their contact information and subgroup membership to enable the Council team and Co-Chairs to better coordinate the activities of the subgroups. During weekly calls, one of the Co-Chairs will work to summarize the day's discussion, and pull together key themes that emerged from the conversations.

New Member Introduction

Several new members of the Working Group introduced themselves. Mr. Donald Thompson of Walk West discussed his background as the CEO of a digital marketing company in Raleigh, NC, and his work as a consultant on diversity and inclusion policy. He reminded the group that innovation does not always consist of brand-new ideas, but also applying and scaling ideas that have proven successful in new contexts. He said a failure to incorporate existing best practices often dooms efforts at transformative innovation. Dr. Sundari Baru discussed her background as an economist working on the topics of workforce development and career ladders and lattices. In particular, she shared her passion for improving access to career counseling in underserved communities, and her interest in re-skilling and upskilling efforts. Dr. Moody Altamimi of Oak Ridge National Laboratory discussed her role as Director of Research Excellence, and her background in software engineering and information technology. Ms. Sunne McPeak of the California Emerging Technology Fund shared her experiences in state government, elected office, and as part of a business-led regional policy organization.

Co-Chair Featured Remarks: Regional Innovation Initiatives

Two of the group's Co-Chairs, Mr. Leslie Boney of North Carolina State University and Ms. Julie Meier Wright of Collaborative Economics, a Distinguished Fellow of the Council on Competitiveness, delivered opening remarks on developing regional innovation systems. Ms. Meier Wright discussed her background in the subject, including leading some of the earliest efforts to study regional innovation systems, first in California and later nationally, as part of the Council's work on regional innovation systems in the 1990s. She discussed lessons from these experiences that are relevant to all regional innovation efforts, in particular that "the place is the product" and that regions must develop a deep understanding of their economy, where innovation is taking place and why, and how to build on their strengths and assets.

Ms. Meier Wright delved into the work that San Diego County did in developing the Cali-Baja megaregion, in conjunction with neighboring Imperial County and northern Baja California, Mexico. She said that regions should be defined by economic connections rather than political boundaries, and that this approach helped spur effective connection across the megaregion, as San Diego County fostered connections with Imperial County and Baja California and helped develop these struggling regions. By combining the research capabilities of the University of California, San Diego with the land and sunshine in Imperial County and Baja California, the effort was able to turn the region into a hub for the production of solar panels, synthetic fuels, and alternative energy. Ms. Meier Wright said that looking to link outlying areas with innovation hubs by leveraging the unique resources of each was a successful model for expanding innovation and prosperity in rural and distressed urban communities.

Ms. Meier Wright noted that innovation was not spread evenly across the country, with just 31 counties in 16 states accounting for 33 percent of U.S. GDP and 25 percent of jobs while containing just

22 percent of the population. These counties produce $1.3 trillion more in annual GDP than their share of the workforce would suggest. She emphasized the many elements needed for regional innovation, including widespread broadband access, talent cultivation, and re-shoring of supply chains, and underscored the importance of identifying opportunities to help left-behind regions. The COVID-19 crisis has provided an opportunity for transformation, as half of the nation's workforce rapidly shifted to telework, which Ms. Meier Wright said could influence where people choose to live in the future. Eliminating the need to be physically located in existing innovation hubs provides an opportunity to attract talent to other parts of the country, especially with a growing movement among professionals from struggling regions to "give back" to their communities. Additionally, Ms. Meier Wright discussed the importance of business leadership and buy-in for regional innovation initiatives to ensure success, and suggested the Council convene regional competitiveness summits to publicize and catalyze data=driven processes for regional innovation and competitiveness. She also suggested a Council-branded toolkit to help regions understand how to self-assess and position themselves for investment and economic progress. Ms. Meier Wright suggested that these initiatives would generate a groundswell of public support for the work of the Commission as a whole.

Mr. Boney stressed to the group that it was extraordinarily difficult to change market dynamics overnight, and that small investments will not be sufficient to fundamentally reorient investment patterns or people's decisions about where to live. He then discussed his work on regional innovation efforts in North Carolina with Innovate NC, which aims to spread innovation and prosperity beyond the Charlotte and Research Triangle metropolitan areas. Mr. Boney said he would be glad to share the regional toolkit that Innovate NC developed through these efforts, and encouraged the group to consider the information provided in the day's primer. In particular, jobs are continuing to migrate to major innovation hubs, but the switch to remote work during the pandemic is offering the opportunity for people to live where they want, regardless of the physical presence of jobs. However, seizing this opportunity requires robust broadband internet access. Mr. Boney also emphasized that not every region will see the innovation activity of hubs like San Jose and San Diego, but that this does not mean innovation does not reach these areas. He discussed the "hub-and-spoke" concept, in which outlying areas are connected to metropolitan areas, as a model that could spread the benefits of innovation across the country. Finally, Mr. Boney underscored the importance of inclusivity in the innovation conversation. He said that the current system is leaving many talented people from underrepresented groups and underserved communities behind, and that without greater efforts in diversity and inclusion, America is facing foreign competition with "half its brain tied behind its back." Mr. Boney said the Commission needed to make this point loudly, proudly, and enthusiastically in its findings.

The Components of Successful Self-Assessment Kits

Mr. Evans catalyzed discussion by asking what elements were missing from existing self-assessment "toolkits" for regional innovation efforts, particularly on matters of diversity. He also noted the importance securing participation from diverse leaders in order to foment systemic change. Ms. Meier Wright said that successful self-assessment is based around data-driven SWOT analysis (Strengths, Weaknesses, Opportunities, and Threats), combined with bringing the right stakeholders to the table. She said it was crucial to be objective and tough, and to secure participation from leaders who will own, invest, and stay with development initiatives. Mr. Boney provided the group with a link to the toolkits used by Innovate NC, and Mr. John Melville of Collaborative Economics echoed Ms. Meier Wright and Mr. Boney. He said that engagement from the business commu-

nity, and developing a deep understanding of assets and opportunities in both metropolitan centers and outlying regions were essential. He also noted the organic emergence of innovation hubs in places like the Denver-Boulder corridor in Colorado, and said it would be interesting to diagnose the role played by both infrastructure investments and purposeful efforts by companies to expand to new regions. Mr. Melville also said that in spite of examples of successful efforts to link prosperous and struggling areas and expand innovation networks in California, this approach had not been replicated at scale. Mr. Boney added that purposeful asset-mapping was an important part of successful efforts in North Carolina that he had worked on, and Mr. Bill Bates shared a link to work the Council previously published in conjunction with the National Governors Association on toolkits for regional development.

Ms. Erica Volini of Deloitte suggested that the group issue a recommendation on the steps and ingredients. needed for effective regional leadership. The recommendation would address which stakeholders should be involved, including business, community members, government bodies, educational institutions, and influential individuals, along with what every stakeholder needs to commit. Ms. Van Ton-Quinlivan of Futuro Health discussed her experience developing a network of maker spaces with the California Community College System, as well as in regional development with the California Economic Summit. She said that forcing stakeholders to inventory other stakeholders and assets in their backyards was an eye-opening experience for participants that made them aware of the richness of resources at their disposal. Ms. Ton-Quinlivan also highlighted the importance of mentorship, with more mature entities and efforts providing technical assistance and sharing best practices with less developed initiatives. Dr. Altamimi suggested the group publish a framework highlighting key leaders and necessary steps for successful initiatives, including inventories of resources, as the siloing of organizations and efforts was a major obstacle she witnessed regularly in her work.

In particular, she said that eastern Tennessee, where she was based, would benefit from such a roadmap because of its assets. Dr. Carol Dahl of the Lemelson Foundation discussed the work the National League of Cities had done in funding regions that developed innovation initiatives, and how cross-learning and engagement with other regions was a bigger predictor of success than funding levels.

A National Initiative for Regional Innovation

Mr. Evans and Ms. Carol Ann Meares, Senior Advisor to the Council on Competitiveness, suggested a national strategy for regional leadership, fueled by asset mapping and plans for self-assessment and development. Mr. Evans noted that the Council has worked with global partners to develop “academies” that educate young, emerging leaders around the world on competitiveness and innovation issues. He envisioned something similar in the U.S., with regional academies that built and used development toolkits, and engaged a diverse group of young, emerging leaders in different regions of the country. These could be coupled with mentorship programs and the circulation of plans and best practices for regional development, and could be funded through a combination of universities, foundations, the private sector, and government agencies like the Economic Development Administration. Dr. Carlotta Arthur of the Luce Foundation suggested also including older leaders from underrepresented groups, who would also benefit from the increased opportunities such an initiative would provide. Ms. Meier Wright noted that the Economic Development Administration provided funding for the Cali-Baja megaregion initiative, and Mr. Boney suggested tweaking and expanding the existing Build to Scale program to serve this purpose. Mr. Thomas Ruhe of NC IDEA shared the work of Startup Genome, an organization that conducts research and produces reports on startup ecosystems, as a starting point.

Ideas for Innovation Initiatives

Group members identified numerous components that are essential to successful and inclusive innovation initiatives. Ms. Meier Wright stressed the importance of widespread broadband access for "hub and spoke" development, and Ms. McPeak expanded on this theme. She discussed her organization's mandate from California's public utilities commission to close the digital divide in the state, which she characterized as a "digital cliff" as the pandemic increases the importance of remote work and leaves those without high-speed internet further behind. Ms. McPeak stressed that technology provides value by saving time and money, but the segment of the population with the least time and money is the same segment that is already lagging in access to technology and falling further behind during the pandemic. She noted that existing internet infrastructure was not built to accommodate the volume of people working from home, and that the crisis should be used as a springboard for badly-needed infrastructure investment.

Ms. Volini echoed the importance of infrastructure, discussing her husband's desire to build up innovation capacity in his native eastern Kentucky, but how those efforts were hindered by a lack of infrastructure. She also suggested a role for crowdsourcing of startups, using the X Prize model, as a means of galvanizing innovation. By allowing individuals from all over the country to fund the ideas of individual innovators, crowdsourcing could help kickstart innovation in regions venture capital tends to ignore, and would be an especially useful model for professionals who want to pay it forward to their struggling hometowns. Mr. Boney built off of this idea, suggesting a competition between localities to host SBIR and STTR grant recipients, as these companies were new and small enough to relocate easily, and had ideas that had been validated already in the form of a government grant. By competing to attract these firms and the economic growth and jobs they would bring, regions would face powerful incentives to develop hospitable ecosystems for innovation.

Mr. J.R. Edwards of Lockheed Martin suggested the creation of incubation spaces in would-be innovation hubs, as well as the incentivizing of experimentation with new models of partnership among universities, companies, and startups. Dr. Baru advocated for the provision of ancillary services, including legal assistance and real estate services, to help support regional innovation hubs, and Ms. McPeak highlighted the importance of aligning public resources to help support capital investment. She explained that the risks of investing in impoverished communities were too great for the private sector to take on, but that effective provision of education and other community services by the public sector could de-risk investment in communities and neighborhoods in these spaces. She called for the development of "unconventional underwriting of risk" in these areas to encourage investment. Ms. Meier Wright added that in considering regions that have been left behind, distressed urban areas need to be included along with small towns and rural areas. Ms. Meares suggested placing regional innovation academies in areas that do not currently host innovation hubs, are economically distressed, and that have large populations of underrepresented groups

Creating a Test Case

Dr. Jerry Haar of Florida International University advocated the development of a test case in Tennessee, which he said offered unique assets and opportunities and provided an excellent proving ground for validating best practices. He noted that the state possessed pockets of deep poverty alongside world-class assets in the form of Oak Ridge National Laboratory, research universities like Vanderbilt and the University of Tennessee, a robust community college system, and the presence of major companies like FedEx. Dr. Arthur seconded this idea, noting that Tennessee was home to many Historically Black Colleges and Universities that could participate, bolstering diversity and inclusion. She added that if the effort is successful and is scaled, including HBCUs and Tribal Colleges could help

embed diversity and inclusion into the efforts. Ms. Wince-Smith connected this idea to existing plans to develop an innovation corridor in eastern Tennessee centered around Oak Ridge National Laboratory, and noted the Council's connection with FedEx. Dr. Haar suggested approaching FedEx and the Governor of Tennessee to gauge their interest in such a project, and Dr. Altamimi said she would relay the conversation to her colleagues at Oak Ridge National Laboratory. She added that the planned initiative would also involve the Tennessee Valley Authority. Mr. Evans said that the Commission could look into whether other Commissioners would be interested in engaging political leadership in their states in similar regional innovation efforts, and Ms. Meier Wright said having a successful example to point to would strengthen the Commission's case when it publishes recommendations on regional innovation initiatives.

Concluding Thoughts and the Road Ahead

Ms. Volini shared a set of key takeaways from the day's discussion. These included drawing on existing successful initiatives for best practices; taking a "symphonic approach" that brings together multiple entities and individuals as stakeholders; making initiatives sustainable via training and mentorship, as well as toolkits for self-assessment; the importance of addressing infrastructure and the "digital cliff"; the role of competition as a powerful motivator for development; and the benefits of pilot programs to test and demonstrate best practices that can be scaled to other regions. Mr. Evans said that next week, in addition to an introduction of the issues of the displaced workforce and "Main Street" entrepreneurship, the group would open with a discussion of how to embed diversity and inclusion into all of its conversations. Dr. Dahl reminded the group of the resources provided by Dr. Arthur on the online portal, including questions organizations can ask to ensure best practices or policies are inclusive, and emphasized the need for engagement with all communities in any regional development initiatives. Ms. Wince-Smith thanked Mr. Boney and Ms. Meier Wright for their leadership of the discussion, and Ms. Volini for her synthesis and analysis. She expressed great interest in the use of Tennessee as a test case, as it possesses significant assets in the form of laboratories, industry, and research universities alongside pockets of deep poverty. FedEx and the University of Memphis also have relationships with the Council, and have both been involved in economic development and community-building efforts in Memphis, a very diverse community. Ms. Wince-Smith added that developing tools or ideas for aligning public resources to reduce the risk of investing in disadvantaged communities could have a transformative effect on innovation and inclusive prosperity. The next meeting of the group will be Friday, July 31st.

Working Group 4 Calls July 31

Introduction

The Honorable Deborah Wince-Smith and Mr. Chad Evans welcomed the group. Mr. Evans provided an overview of the progress and schedule for the other three Working Groups. Working Group 1 focused their discussions this week on the structure of the U.S. innovation system and foundations for innovation investments. They will continue this theme next week, when Dr. Paul Hommert, former director of Sandia National Laboratory and a Distinguished Fellow with the Council, will discuss the opportunities to be leveraged from optimizing the national laboratory system enterprise. Working Group 2 continued its discussion of the circular economy with a discussion of a network of regional innovation centers that would develop platforms and technologies for sustainability. Dr. Albert Pisano of the University of California, San Diego, who developed the concept, will present the idea to Working Group 1 next week as well due to its relevance to their mandate. Working Group 3 discussed global competitiveness and existential threats, and will spend next week discussing the international rules of the road, U.S. global leadership in standards setting and rules and norms around technologies, and the challenge presented by China to America's innovation leadership.

Mr. Evans and Ms. Yasmin Hilpert have also been developing a tool to help members of the Working Groups think about recommendations and visualize what they should look like and what components they should possess. The Council team has sent examples of past successful recommendations

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emerging from similar initiatives in the past, including how they were integrated into a larger research deliverable. Key features of recommendations include a goal, an issue to address, the relevance of the issue to competitiveness, the details of the recommendation, the stakeholders responsible for implementation and funding, and the expected impact of the recommendation. The Council is also working to integrate questions of diversity and inclusion into this framework, including evaluating the impact of recommendations on the inclusion of underrepresented groups. Mr. Evans also introduced a new member of the Working Group, Ms. Esther Owolabi of Google. He then introduced the featured presentation on the displaced workforce, delivered by Co-Chair Ms. Erica Volini of Deloitte, and reflecting her work along with Co-Chair Dr. Lloyd Jacobs, former President of the University of Toledo and a Distinguished Fellow with the Council on Competitiveness, and Dr. Jerry Haar of Florida International University.

Featured Presentation

Ms. Volini began by presenting a clear definition of which workers were "displaced." She distinguished between the differing needs of workers displaced from agriculture, industry, and services, as well as those in rural and urban areas. She suggested that should the group pursue pilot programs to test new workforce development policies they focus on a region away from the coasts, as workers in the middle of the country were less likely to have transferable skills. She also distinguished between workers displaced from essential employment needed to support themselves, and those displaced from "optional" employment, such as students working part-time in the hospitality industry.

The presentation team discussed several barriers facing displaced workers. Many displaced workers have been in one job for so long that they have a narrow view of their own skills and capabilities, and find it difficult to think about ways their skill set and competencies would translate to other fields or positions. Workers also often have a limited view of what jobs are available, as job boards are often complex to navigate. Workers also frequently struggle to make the networking connections in new fields that give them an advantage in consideration for jobs over "cold" applications. Finally, many workers face immediate financial pressures and are unable to take time off to upskill, or be able to handle a temporary drop in pay scale as they start in a new industry.

Ms. Volini also outlined principles for stakeholders to adhere to. The commitment to skill development and retooling needs to be front and center, as even before the pandemic technology was fundamentally changing jobs, requiring an ongoing upgrading of skills. Solutions also must be linked to employers and markets where there is demand for jobs, and must take advantage of the advanced information technology tools out there. There are many platforms in the corporate world that could be scaled and extended to the general population that will be essential for upskilling the large number of workers who have been displaced by the pandemic. Solutions and efforts must also not remain confined to four-year institutions of higher education. Community colleges and vocational schools can play an even larger role than traditional universities, as they often have greater agility in standing up new programs and courses, and are better positioned to reach displaced workers due to their ubiquity in small towns and rural areas and their lower costs. Successful initiatives must invest in building out those schools and institutions. Finally, solutions cannot just focus on the end state, as many workers will go through financial hardship during the interim when they transition from one job to another.

Finally, Ms. Volini outlined solutions that the presentation group developed. The group called for a central location containing industry-specific information on what jobs and skills are most in demand. Community colleges, high schools, and vocational schools must be adequately funded to start programs directly connected to needed skills, and more efforts must be made to connect displaced workers to online resources like Udacity and Coursera for skills training and education, as well as online college coursework. These resources must also be made more visible to increase their uptake rate among displaced workers.

The presentation group called for the development of a toolkit to help displaced workers break down their old jobs into skills and competencies that are translatable to other positions, and then link those capabilities to jobs that are in demand. For example, a bricklayer could possess skills in managing relationships and coordinating with vendors that are well-suited for managerial roles or supply chain positions. A "translator" program could provide enormous value to displaced workers looking to bolster their resumes. A related recommendation is to extend one-on-one career coaching, popular among executives and professionals, to displaced workers. Technology like the Better Up platform that allows for one-on-one virtual mentoring can democratize these tools and help workers improve their resume building and career skills. Providing subsidies to individuals to bridge the gap between their previous salary and their starting rate in a new industry, along with a "knowledge tax credit" that allows organizations to claim tax credit for expenditures on workforce training will enhance worker and employer uptake of reskilling opportunities. Finally, creating pilot programs to demonstrate these ideas and build support from academia, industry, and communities would provide proof of concept and lessons that could be applied before scaling recommendations nationally. Last week, the group had identified Tennessee as a potential proving ground for these ideas.

Co-Chair Remarks

Dr. Jacobs said it was important to contextualize where the country is, noting that there has been broad recognition of the rapid changes coming to the nature of work for more than a decade. He called for ways to "soften the blow" of the upcoming transition faced by millions of workers, and noted that the pandemic has accelerated many existing trends across the economy. However, the pandemic also provides the opportunity to accelerate positive trends and innovations, and the group should advocate for recommendations that take advantage of this opportunity. Dr. Haar echoed Dr. Jacobs, noting that the trends accelerating today have been in motion for the past two decades. He also advocated a set of principles for the group to adhere to in order to bolster their credibility. Potential solutions should be identified as either short-term, medium-term, or long-term, the costs of implementing solutions must be determined and acknowledged, and individuals and organizations who will be involved in implementing them must be identified.

Experiential Training and Other Support

Dr. Carol Dahl of the Lemelson Foundation emphasized the need to train workers to continually reskill, as jobs will change faster and faster in the coming decades. She advocated weaving into curricula at colleges and technical schools a requirement for experiential training to teach workers to continually learn and upgrade their competencies, and for investments in institutions to allow them to being providing that education. Ms. Volini agreed, and said that as the half-life of specific skills continues to decline, it is important to focus education on "essential human capabilities" that are transferable across a variety of settings. Ms. Amy Lientz of Idaho National Laboratory noted that many workers from low-income communities are unable to take advantage of open tech jobs in hubs like New York because of the disconnect between their skill sets, and the opportunity to improve their skill sets, and job requirements for those open positions. Ms. Wince-Smith discussed the need to provide additional support to displaced workers, as people who lose their jobs often fall victim to addiction, abuse, and family breakdown.

Redefining Skills

Dr. Jacobs pointed to the military as an example of the importance of translating skills and helping workers better market themselves to employers. He noted that military veterans are often at a loss for engaging with the civilian workforce after discharge, in spite of having strong people skills, organizational skills, and logistical skills. Dr. Sundari Baru agreed, noting that the military teaches many highly-valued "soft skills" like punctuality and teamwork. She added that high schools, technical schools, and colleges should also begin stressing these competencies due

to their importance across jobs, even making them part of educational requirements. Ms. Volini said that Deloitte has developed programs to attract veterans because their internal research has found they are valuable employees. Ms. Wince-Smith suggested that a national service program would help develop soft skills in younger workers. Mr. Donald Thompson of Walk West discussed his work with Pitt Community college in eastern North Carolina, and its development of five pillars for future workforce skills: multigenerational and multicultural skills, social media literacy, learning agility, technical aptitude, and developing a "startup" mindset to pivot between ideas quickly. The idea of the program is to help people become competitive independent of their current industry, particularly through the enhancement of soft skills and communication skills. He added that he would share more details about the initiative off-line.

Marketing Skills and Broadening Networks

Dr. Haar urged the group to remember that all the services and support programs institutions can provide for displaced workers will only be effective if those workers are willing to take advantage of those opportunities. He noted that despite a generous federal trade adjustment assistance program that provides two years of unemployment and grants for relocating and job training, only 5 percent of eligible workers take advantage, both due to a failure by the government to publicize the program and in some cases due to lack of interest in relocating and retraining. Mr. Thompson said it was important for all worker retraining programs to be marketed in a way that was appealing to the intended beneficiaries, and Dr. Carlotta Arthur of the Luce Foundation noted that many workers faced competing priorities when weighing whether to take advantage of worker retraining programs. Ms. Volini discussed an ongoing movement at Deloitte to broaden the company's recruiting networks to include a wider variety of universities, as well as community and technical colleges, rather than relying on the elite reputations of a small group of universities. Dr. Arthur agreed, and said it was important for employers to be open to hiring from a range of institutions.

Translating Skills and Stacking Credentials

Mr. Evans noted that since many firms have programs for onboarding veterans, the group should look at best practices that could be scaled for translating their skills, and that this might represent an opportunity for a public-private partnership. He also encouraged the development of a crosswalk to translate private sector best practices and data with government data from the Department of Labor to scale best practices in skill translation. Ms. Julie Meier Wright of Collaborative Economics, a Senior Fellow with the Council on Competitiveness, asked what form the "toolkit" Ms. Volini discussed would take, such as a questionnaire or self-assessment. Ms. Volini said she envisioned a "translator" that takes the skills and responsibilities displaced workers developed at their previous jobs and leverages information technology to match those workers with jobs of the future that are good fits for their capabilities and competencies. She noted that leveraging IT was essential for successfully transitioning displaced workers, as the scale of job loss due to the pandemic was too great for incremental or small-scale efforts to be effective. Ms. Wince-Smith discussed the work that unions have done in retraining both veterans and civilians to become skilled trade workers like plumbers and pipefitters, and Mr. Thomas Ruhe of NC IDEA discussed the Bunker Labs initiative to teach entrepreneurial skills to veterans. Mr. Leslie Boney of North Carolina State University discussed the work Mecklenburg County's community support services does to help workers translate their skills.

Another issue the group discussed was finding common language between employers, workers, and educational institutions. Mr. Evans noted that many jobs have hyper-specific language that leads workers with the requisite skills or competencies to rule themselves out. Ms. Owolabi said that part of her work at Google in the diversity and inclusion space

involves training HR staff to recognize translatable skills on resumes that aren't conveyed in the same language as the job description, especially for veterans and members of underrepresented groups. Ms. Charlotte Alexander of Georgia State University said that employers needed to be flexible in considering candidates whose skills sets translate but who do not have specific job experience in order for displaced workers to successfully deploy their skills in new roles, and called for a platform that unbundles skills and matches them with open jobs using a common language. Dr. Baru added that HR personnel often have trouble cross-walking applicants' skill sets with the job description because of differences in terminology and language, and Mr. Ruhe discussed a tool Google is developing to avoid these translational problems specific to veterans. Mr. Boney discussed the movement towards "stackable" credentials that make it easier for individuals to translate prior experience into course credit when going to college, community college, or vocational school, and developing interoperable learning records that enable employers in different sectors to recognize the applicability of a candidate's prior experiences in different industries. He also said universities are working on recognizing more forms of credentials in order to accelerate degrees for students.

Concluding Thoughts and the Road Ahead

Mr. Ruhe suggested connecting with the National Association of Community College Entrepreneurship, as they work on many similar topics and could act as a vetting source for the ideas the group develops. Ms. Wince-Smith suggested adding members of state workforce boards to the Working Group, and Mr. Boney suggested bringing in more people with community college expertise. Ms. Meier Wright provided a high-level summary of the day's conversation for the Working Group members in order to underscore key themes and keep them fresh in participants' minds. Mr. Evans said the Council would develop a poll to send to the Working Group members asking them to vote for which of the recommendation ideas Ms. Volini, Dr. Jacobs, and Dr. Haar developed the group should pursue and refine. He also promised to send along with the summary a discussion of skills and capabilities of the future the Council developed in its 2016 publication Work. Mr. Evans encouraged members of the group's different swim lanes to reflect on the group's conversations and begin developing ideas for recommendations pertinent to their swim lane and put them down on paper. He stressed that the ideas did not need to be final, as the group would go through an iterative process of editing and refining them. To that end, he said the Council was working on developing a space to allow group members to collaborate on recommendations and discuss and refine them in between weekly discussions, either via the online portal or via Google Docs. The next meeting of the group will be Friday, August 7th.

Working Group 4 Calls August 7

Introduction

The Honorable Deborah Wince-Smith and Mr. Chad Evans welcomed the group, and Mr. Evans said that the day's focus would be on the group's third major "swim lane" of cultivating the innovation talent pipeline. He introduced two of the Co-Chairs, Dr. Lee Cheatham of Pacific Northwest National Laboratory and Dr. Carol Dahl of the Lemelson Foundation, who would lead the discussion. Next, Mr. Evans presented a snapshot of the progress and agenda of the other Working Groups. Working Group 1, which meets on Tuesdays, discussed the National Laboratory system and how to better integrate it with the overall innovation ecosystem, including by expanding the mission and authorities of the labs to take greater advantage of their capabilities and infrastructure. Working Group 1 also discussed Dr. Albert Pisano of the University of California, San Diego's idea, first circulated in Working Group 2, of a national network of innovation centers for platform technologies, and its relevance to the group's swim lane on the structure and components of the innovation ecosystem. Working Group 2, which meets on Mondays, discussed best practices in sustainable production and consumption, and next week will return to a deeper discussion of Dr. Pisano's innovation centers concept, including outlining the necessary steps to develop the system. Working Group 3, which meets on Monday's discussed recommendations in antitrust and competition policy as part of its swim lane on global competitiveness and existential threats. Next week, it

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will engage in additional conversation around opportunities for strategic collaboration with allies in setting international standards and "rules of the road."

Commissioner Videos and Strategic Reflection Period

Ms. Wince-Smith and Mr. Evans shared two developments with the group. The first is a series of video op-eds by Commissioners highlighting elements of the National Commission's competitiveness agenda that are of personal interest or relevance to them. One video will be released per month, and later this month the Commission will release the op-ed of Dr. Gary May, Chancellor of the University of California, Davis. Dr. May's video, the first cut of which was shared with the group, highlights the importance of diversity to successful innovation and better economic outcomes. The video discusses both the lack of diversity in STEM fields and the innovation space and the consequences of that lack of diversity, with examples– from airbags to automatic faucets– of products whose design flaws went unnoticed because of a lack of diversity in the researchers designing and testing them. Dr. May's video also outlines keys to successfully building a diverse innovation pipeline, including making diversity everybody's responsibility, developing benchmarks and metrics, and reaching out to underrepresented students from an early age to get them excited about STEM and about innovation. The video concludes by stressing that the future of the economy and American competitiveness depends on engaging Americans of all genders, colors, and backgrounds to innovate.

Second, Mr. Evans discussed the upcoming strategic reflection period that will begin after next week's calls and last for two weeks. During this time, there will not be regular weekly Working Group calls, and members are expected to work on developing recommendations based on prior discussions, returning the week of August 31st with a set of concrete and detailed ideas to discuss. The groups will then use the next month to establish priorities for the Year One findings to be released at the National Competitiveness Forum this December. During this period, Co-Chairs are encouraged to engage with members in their chosen swim lane, including organizing discussions and putting together documents for co-creation and iteration on policy proposals. The Council can provide logistical support during this period, and will send out contact information to the whole group, broken out by swim lanes, to facilitate this. Mr. Evans added that the innovation talent swim lane had already begun holding such discussions, and that Dr. Cheatham and Dr. Dahl's presentation was a product of those discussions. Mr. Evans expressed hope that this would provide a model for the other swim lanes to emulate.

Featured Remarks: Broad Ideas Around Innovation Talent

Dr. Dahl noted that she and Dr. Cheatham had sent out a synopsis of their swim lane's discussions ahead of the call via email. She encouraged the group to delve into both the high-level overview and the more specific proposals, and to send detailed feedback and critique. She also encouraged members who were not part of the swim lane but who were interested in the topic to join. She also asked for feedback on the specific question of diversity, and noted it would be helpful if guidance on diversity and inclusion in the recommendation generation process was shared across all swim lanes and all Working Groups. Dr. Dahl said the group had come up with 13 policy recommendations during its discussions, with six of them having turned into position papers.

Dr. Cheatham went over the 13 policy recommendations, which he grouped into four broad categories. This includes an overarching category, "Broad Principles for Innovation Talent and Entrepreneurship." These overarching principles did not fit under the other three headings, but need to be considered throughout the group's work. These principles are establishing diversity and inclusion and ensuring recommendations are conducive to inclusion of underrepresented groups; identifying trends and concepts that will be part of the future of work; and recon-

ciling the multiple priorities of workers, business leaders, and educators. The other broad categories are "Develop and Support Entrepreneurs," "Reduce Barriers and Risks to Pursuing Innovation Careers," and "Promote and Expand Innovation Talent."

To develop and support entrepreneurs, the subgroup recommended creating postdoc positions at universities to commercialize and spin out IP without founding a company; developing strategies to allow workers to innovate with few constraints and in areas of personal interest, such as through "personal work time" leave policies funded by some tech firms; and reducing barriers and risk to produce more entrepreneurs. To reduce barriers and risks to pursuing innovation careers, the subgroup advocated finding innovative ways to fund healthcare for entrepreneurs, as many people are afraid to start a business lest they lose health insurance when they change jobs. This section also contains recommendations to address people's concerns about becoming entrepreneurs, including changing perceptions of risk and emphasizing that entrepreneurship and innovation do not only occur in science and technology. To promote and expand innovation talent, the subgroup called for increasing the pool of locally available talent by attracting the best and brightest innovators from around the world with recruitment efforts, and retaining skilled graduates to stay in the area. They also recommended building on existing programs for cultivating talent, and empowering students, especially women and students of color, to pursue entrepreneurship. Finally, the subgroup recommended exploring pilot programs to access innovation talent and capabilities in the population.

Building on Successful Models

Dr. Moody Altamimi of Oak Ridge National Laboratory discussed several successful entrepreneurship programs at Oak Ridge that could serve as models for innovation efforts. The Innovation Crossroads program, currently in its fourth cohort, is a competition in which newly-minted PhDs compete via a rigorous selection process for substantial funding for startup ideas. Winners receive access to Oak Ridge's facilities and researchers and receive two full years of generous funding. Another program, the Bredesen scholarship program, is an interdisciplinary PhD program that combines data science with either an innovation track or a policy track. Students in the innovation track start a company as part of their degree requirements, and students in the policy track prepare for a career in government. A common ingredient in these successful endeavors is that Oak Ridge treats these early-career researchers as staff, providing mentorship, substantial benefits, and three years of postdoc status. In particular, researchers are mentored in a "team science" approach that focuses on engaging across different disciplines to foster innovative ideas. Dr. Altamimi concluded by emphasizing that these programs all required deep institutional commitments.

Mr. Evans added that other national laboratories, including Lawrence Berkeley National Laboratory and Argonne National Laboratory, had established similar programs with considerable success, and that it was worth it for the group to go deeper in exploring how to extrapolate from these successes into general principles that could also transfer innovative ideas into the marketplace. Dr. Altamimi noted that the successful replication of these programs elsewhere, on different topics in different environments, was evidence of their robustness, and suggested it could be a foundation for a model that is replicated further. Mr. Evans suggested it could spread beyond the Department of Energy, which houses the national laboratory system, to other federal departments and agencies. Mr. Phil Weilerstein of the VentureWell Foundation reinforced the idea of building on previously-validated models. He noted in particular the National Science Foundation's I-Corps program, which has already been successful scaled and has engaged with over 2,000 teams. He said the group should think about ways to identify the missing pieces that would connect these successes together into one framework that could offer a path to innovation for entrepreneurs all around the country.

Unique Opportunities and Developing Frameworks

Dr. Dedric Carter of Washington University in St. Louis said there was danger and opportunity in building off of existing models. While he cautioned against the group merely becoming an aggregator of existing models, there was significant opportunity to become "glue" that connects the different pieces of the innovation system together in a way that makes them greater than the sum of their parts. He noted that when he was involved in the development of the I-Corps program the program's architects were aware there were unsolved challenges that would need to be figure out by others. He observed that there were still opportunities to address these challenges and that the group could provide tremendous value in filling that void, such as by developing a general framework for innovation programs whose structure is derived from previous successful examples.

Ms. Julie Meier Wright of Collaborative Economics saw potential to create a general framework drawing on these successful examples, per Dr. Carter's suggestion. She suggested creating a Council-branded website with detailed information for entrepreneurs and economic development agencies on how to turn ideas into innovations, including the budget needed, necessary staff, steps to scaling, and other key components. She said people in the innovation policy space often forget how much the general public is unaware of best practices in this space, and that a website to provide this information could elevate the skill sets of a lot of would-be entrepreneurs who don't know how to take the first step. She added that a benefit of having this information hosted on a website was that it could be filled out and expanded over time. Mr. Evans drew a connection between this toolkit idea and Ms. Meier Wright's previous advocacy of "regional innovation toolkits." Ms. Meier Wright said that successful innovation initiatives need to be business-driven, and that providing clear blueprints for communities gives those communities a chance to create solid plans that businesses will be willing to get behind.

Highlighting Examples and Making Entrepreneurship Accessible

Ms. Erica Volini of Deloitte recommended highlighting examples of entrepreneurs, especially those from outside the coasts and those who began with little available capital or in non-scientific fields, to make innovation more accessible to those outside current innovation pipelines. She noted that Dr. May's video op-ed was powerful, and envisioned a similar impact from highlighting stories of entrepreneurs from different regions of the country as a component of innovation initiatives there. Dr. Jerry Haar of Florida International University endorsed expanding the concept of entrepreneurship beyond science and technology, and noted that in many inner cities and many rural areas there were aspiring entrepreneurs in "Main Street" businesses who needed to be equipped with the tools and mindset to become successful innovators. He also suggested, in conjunction with potential pilot programs in non-traditional innovation areas, having entrepreneurs from small towns and rural areas share their stories with the group and provide feedback on outreach programs. Dr. Dahl added that many entrepreneurs in these areas possessed both the capability and the desire to innovate in high-tech fields as well, and that the group should encourage these goals by articulating the specific steps needed to develop those capabilities. Mr. Weilerstein said that identifying the key enablers to expanding access to advanced technology in rural and inner-city areas will be essential to this objective. Ms. Wince-Smith discussed examples of entrepreneurs outside of high-tech fields and outside of innovation hotbeds who have successfully scaled their businesses into national companies through innovation of business models, including Build-a-Bear revolutionizing the toy industry out of St. Louis and the rise of specialty food companies that began as small local operations.

The Future of Work and Additional Opportunities

Dr. Sundari Baru predicted that the nature of work would change dramatically in the coming decades, with a distinction between "blue-collar" and "white collar" jobs being replaced by a distinction between those who work from home, those who do not, and those who work partially at home and partially outside the home. She noted that many people, especially in high-tech fields, may never return to an office environment as a result of the pandemic. Mr. Bill Johansen of Lawrence Berkeley National Laboratory added that the growing virtualization of work offers opportunities for mentorship, as experts can connect virtually to mentor aspiring researchers or entrepreneurs anywhere in the country, regardless of their geographic location. Ms. Meier Wright noted the potential for "insourcing" many positions due to security concerns with China, especially the manufacturing of technological hardware, and Dr. Dahl noted that in rural North Carolina technology was enabling workers to perform call center and tech support jobs that had previously been done overseas. Other discussions involved organizations and resources the group could use or collaborate with. Ms. Wince-Smith suggested using the Department of Housing and Urban Development's resources for community development to invest in innovation entrepreneurship, and Dr. Haar discussed leveraging the resources of the Economic Development Agency in the Department of Commerce. Ms. Wince-Smith also suggested engaging with the Appalachian Regional Commission for programs aimed at rural areas, and Dr. Carlotta Arthur of the Luce Foundation echoed this idea, drawing on her experiences working in higher education in Appalachia.

Concluding Thoughts and the Road Ahead

Dr. Dahl reiterated that anyone who wanted to join the innovation talent swim lane should send her, Dr. Cheatham, and the Council team a note, and encouraged the group to engage with the detailed proposals and provide feedback and critique. In particular, she sought feedback on ways to incorporate diversity and inclusion principles into the recommendations and the recommendation generation rubric. Mr. Evans promised to send out more information on the two-week reflection period, and encouraged the Co-Chairs to reach out to Working Group members in their swim lanes during this time. He reminded the group that next week's conversation will return to the regional innovation and geographic inclusion swim lane. The next meeting of the group will be on Friday, August 14th.

Working Group 4 Calls August 14

Introduction

The Honorable Deborah Wince-Smith and Mr. Chad Evans welcomed the group. Mr. Evans said the purpose of the day's discussion would be to explain the recommendation writing process during the two-week strategic writing and reflection period, as well as provide an explanation of the Google Doc the Council team created as a collaborative tool. He added that he would send updated "Swim Lane" documents providing contact information for participants to coordinate meetings and collaboration, and noted that Working Group members can also send their recommendations to the Council team or Co-Chairs via email if they do not want to use the Google Doc, in which case the Council team can upload the recommendations. Mr. Evans said this period was a great opportunity for the Working Groups to be able to make an impact on the Year One Call to Action that will be released this December. Ms. Wince-Smith said that now was the time to unleash the group's ideas and creativity, and develop concrete recommendations by the end of the two-week period. Mr. Evans noted that in many respects the group was ahead of the other Working Groups in its recommendation generation, as some swim lanes have already developed concrete proposals that have been added to the online document.

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Mr. Ernest Dianastasis
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Ms. Hanna Dooley
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The Recommendations Google Doc and Call to Action

Mr. Evans described and explained the Google Doc for the Working Group, which will allow participants to share and iterate on ideas in a single space, enabling transparent collaboration. There are tabs for each swim lane and spaces to add recommendations, with slots corresponding to each element of a recommendation as outlined in the rubric the Council developed and shared with the group. Entries to the document, which resembles an Excel spreadsheet, are automatically saved, and there is also a tab listing the contact information for all members of the Working Group to enable offline communications between members and to organize meetings among members of a particular swim lane. Dr. Carol Dahl of the Lemelson Foundation said it was terrific to have a consolidated workspace and means of sharing contact information, and encouraged members of the group to begin contributing ideas. Mr. Evans echoed this, and said that the "call to action" for the group was to begin drafting, iterating, and co-creating recommendation ideas. He said that once people begin submitting material to the online document, it will have a catalytic effect in eliciting other contributions, including elaborations, feedback, and suggested edits. He noted that the document was public and that all additions would be immediately visible when entered, so those who wished to not share their first drafts of thoughts with the entire group were free to share them via email, the online portal, or another medium that was easier.

Addressing Participant Questions

Mr. Thomas Ruhe of NC Idea asked about the different elements of the document, including what should go in each section of the recommendation writing space of a given swim lane tab, particularly the "goal" slot. Mr. Evans said the "goal" section was for listing larger goals that a particular recommendation is meant to address. He added that the writing space was split into different sections to enable those who only had parts of a complete recommendation idea, or suggestions for edits to a particular component of a recommendation, to contribute more easily, and to allow for better co-creation of recommendations drawing on the expertise of different group members. Ms. Sara Lawrence of RTI International asked how to address providing feedback, and how to handle multiple participants having different variations of the same idea. Mr. Evans said the intent of the document was for people to submit new ideas and to make suggestions to adjust ideas that have already been entered. He added that while critique and feedback of ideas was valuable, he wanted to remind the group of the importance of collegiality. Dr. Lee Cheatham of Pacific Northwest National Laboratory asked if the ongoing weekly Co-Chair calls would continue even as the full group sessions entered a hiatus period. Mr. Evans said they could, but in each case it would depend on the consensus of the Working Group Co-Chairs. He added that the Council team was ready to provide support for any such meetings, or to help facilitate meetings of particular swim lanes, and reminded the group that Co-Chairs would be leading engagements for their chosen swim lanes during this time.

Concluding Thoughts and the Road Ahead

Mr. Evans said that this period was meant to provide a chance for group members to move from debating to writing, in order to develop a set of proposals that would be finalized during the remaining month of Working Group discussions and during the two subsequent months prior to the release of the National Commission's Year One findings at the National Competitiveness Forum in December. He also reminded the group that the Council team was ready to provide logistical, technical, or other support, including assistance in navigating the online document or uploading recommendations to it. The next meeting for the whole group will be on Friday, September 4th.

Working Group 4 Calls September 11

Introduction

The Honorable Deborah Wince-Smith and Mr. Chad Evans welcomed the group. Mr. Evans thanked the group for its hard work during the strategic writing period, and said the Council team was still absorbing the output from all four Working Groups. He said he had shared the initial output from the strategic writing period earlier in the week, and that today's discussion would include a period of commentary on the writing period, a report out from two of the swim lanes, and a discussion of ideas to explore in greater depth in the coming months. Ms. Wince-Smith thanked the group for its contributions and said the Council was looking forward to engaging in systems integration and having deeper discussions on areas needing more coverage.

Reflections on the Strategic Writing Period

Mr. Leslie Boney of North Carolina State University said that it was challenging to control the different versions of recommendations that were circulating within his Swim Lane both on the Google Doc and offline. He added that he would work to consolidate his group's output for the sake of coherence. Dr. Carol Dahl of the Lemelson Foundation said it would

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be good to reach out to Swim Lane leaders individually for feedback on what methods and tactics did and didn't work, as she experienced a variety of collaboration styles with varying levels of success across the Swim Lanes she participated in. She also added that her group on Innovation Talent and Entrepreneurship felt they were at a natural stopping point, and wanted to see which areas the Council team chose to prioritize before offering further, more granular recommendations. Mr. Evans said that as the Council begins prioritizing and preparing the final recommendations, it may consult with particularly knowledgeable members of the Working Group, or even external experts, on particular topics or recommendations.

Ms. Julie Meier Wright of Collaborative Economics said that the Google Docs made it challenging to see the edit history due to the lack of a "track changes" feature on the spreadsheets, and the difficulty of determining who had left particular edits or comments. She suggested in the future working on Microsoft Word during the iteration stages and placing the recommendations on a Google Doc once they were ready for sharing and commentary with the whole Working Group. She further noted there were wide variances in participation by Swim Lane members, but appreciated the hard work and expertise of those who contributed to the discussions.

Framing the Recommendations for the New Administration

Mr. Thomas Ruhe of NC Idea said he found it challenging to develop recommendations in light of a new presidential administration coming in in 2021, and not knowing what policies would be prioritized. Mr. Evans said that the Council has gone through regime transitions in the past, and will work with the Commissioners to develop a package of recommendations that will be compelling to the new administration and Congress, regardless of the election outcome. Ms. Wince-Smith said that the Council, as a non-partisan body that works with all administrations, is excited about the timing of the Commission as it comes at a pivotal moment in the nation's history, and that while there may be different orders of prioritization for particular initiatives depending on the winner of the election, there is broad agreement on the need for large-scale investment in inclusive prosperity, innovation, and productivity growth from both parties. Mr. Bill Bates added that the Council will put together the strongest possible agenda for the United States, and that no matter what happens not every recommendation will be turned into a new law. However, the experience with the National Innovation Initiative from 2004-2006 found that many recommendations became administrative actions or state-level policies instead, and that political considerations should not be the driver of the Commission's recommendations. Dr. Lee Cheatham of Pacific Northwest National Laboratory endorsed these sentiments, and said that it was important to create recommendations that stand on their own as powerful, regardless of administration. Ms. Sara Lawrence of RTI International noted the growing appetite at all levels of policy making for the major national investments and structural overhauls the Commission was advocating, strengthening the case for a set of strong standalone recommendations.

Areas for Deeper Discussion

Following the Council team's review of the recommendations generated by the four Working Groups during the strategic writing period, the Phase I recommendations that emerged from Working Group discussions, and the Council's past work, Mr. Evans shared six topic areas for deeper discussion as the Working Groups moved forward during Phase II. First, a greater discussion of national leadership and centralized direction of the innovation agenda, including naming specific bodies to oversee these efforts and questions of finance and governance. Second, to specify target levels of public investment in R&D, and which projects and subject areas should be prioritized for investment. Third, greater discussion of the roles played by universities and National Laboratories in technology transfer, and how those institutions can be more effective in transferring innovations. Fourth, discussion of the future of work, including the skills of the future and how to support the cultivation of these

skills in the workforce. Fifth, addressing the myriad challenges posed by China, including intellectual property theft, confronting the strong Chinese presence at U.S. research universities, and establishing guidelines for joint research and development initiatives with Chinese researchers. Finally, discussion of resiliency, especially in light of the ongoing pandemic.

Ms. Wince-Smith added that the Council was proud of being the first organization to identify and articulate many transformational challenges facing the U.S. economy, and its role in surfacing and articulating bold transformations of public policy. While many of these ideas did not get immediate purchase, their continued discussion in the public policy community eventually shifted public opinion and policy, including on issues like doubling the NSF budget and rebalancing R&D spending between physical and health sciences. She called on the group to suggest similar bold ideas that fit the needs of the moment, noting that the recommendations generated so far ranged from granular and concrete to high-level and complex. She emphasized that without changing the underlying structures underpinning the U.S. economy and government, the country would not see different results no matter how many extra resources it devoted to innovation. She urged the restructuring of government and the policy making process to grapple with these challenges, and noted the lack of coordination on innovation policy between different government agencies and departments, in contrast to the steps taken by many of our competitors. Ms. Wince-Smith also called for numerical targets for metrics like research investment as a share of GDP and U.S. graduate students in critical STEM fields. Ms. Carol Ann Meares, Senior Advisor to the Council on Competitiveness, added that there was lots of discussion in policy circles around what work will look like in the future, what the job market will look like, and what skills workers will need. Dr. Jerry Haar of Florida International University said that there was lots of disaggregated information on different aspects of the future of work, but there was no consolidated, critically annotated compilation of this work, and that such a compilation would be valuable to the national discussion.

Report from the Innovation Talent and Entrepreneurship Swim Lane

Dr. Dahl discussed the major recommendations generated by the Innovation Talent and Entrepreneurship Swim Lane. She said there were robust topic areas around educating entrepreneurs and STEM professional on sustainability, including requiring sustainability curriculum as a core component of business and engineering programs. Additionally, there were many recommendation on cultivating talent, and on helping people with ideas turn them into businesses. Central to these issues were finding ways to reduce barriers to entrepreneurship by increasing access to social services and childcare, de-risking the process of starting a business and forgoing employer-provided benefits. Additionally, the group called for more exposure to entrepreneurship and invention for school-age children in order to increase their aspirations and interest in innovation, especially for students from marginalized groups. Finally, the group called for increased focus on inclusion, including evaluating whether the Commission's recommendations will sufficiently combat the inequality of opportunity affecting marginalized communities. Dr. Dahl said that without greater focus on inclusion these communities will not be able to participate in or benefit from the new innovation economy. Ms. Meier Wright said questions of diversity and inclusion, as well as of left-behind regions, need to be front and center in the Commission's findings and narrative.

Report from the Cross-Cutting Diversity Swim Lane

Dr. Carlotta Arthur of the Luce Foundation shared the recommendations of the Cross-Cutting Diversity and Inclusion Swim Lane. She discussed the use of Equity Impact Assessments, similar to Health or Environmental Impact Assessments, as a tool to ensure that policy recommendations do not exacerbate inequalities and work to dismantle norms and institutions that exclude marginalized groups. Dr. Arthur said many policy makers want to create inclusive policies but are unsure how to do so. She

described the process the group shared with the broader Working Group, based on a tool used by the government of King County, Washington for inclusivity assessments. While the process can be adopted beginning at any step as an improvement over no assessment at all, she recommended beginning with the first step of the process, which involves convening stakeholders from the affected communities. Following this, the steps are to identify disparate outcomes and their causes, as well as contributing factors; anticipate potential disparate outcomes from new policies and measures to counteract them; and finally to develop messages and communications strategies that will advance inclusion.

Ms. Van Ton-Quinlivan of Futuro Health suggested plotting Working Group recommendations along a grid, with one axis tracking the degree of transformation and the other axis tracking the degree of inclusivity. Ms. Wince-Smith asked if there were other examples of templates that could be customized to questions of regional inclusion, and Ms. Meier Wright asked if there were examples from the corporate world that would be useful. Dr. Arthur said that she was unsure how many regional inclusion tools there were, and whether or not corporate assessments were proprietary, but added that the document the Swim Lane shared includes examples of a National Laboratory entrepreneurship program. This tool focused on assessing how the program recruited applicants, how it evaluated skill sets, if it took into account factors that would impede the performance of certain groups, differences in letters of recommendation, and who sat on selection committees. Mr. Evans said the Council could ask corporate partners for ideas on assessment tools, and Ms. Wince-Smith suggested the development of a Council- or Commission-specific assessment tool as a project for the next year of the Commission. Ms. Ton-Quinlivan shared an example of the Community College system in California. Previously, when programs and initiatives required institutions to compete for funding, the largest colleges always one because of their resource advantages. By shifting the competition from individual schools to all of the schools in a given region working with shared resources, the smaller schools were able to be part of winning entries and benefit from additional funding.

Concluding Thoughts and the Road Ahead

Ms. Wince-Smith noted that the discussion of regional innovation was particularly relevant given the recent interest of the Chinese government in building regional technology hubs linked to job training programs. Dr. Dahl suggested sharing the diversity assessment tool with the other Working Groups. Mr. Evans reminded the group about the upcoming Competitiveness Watch Dialogue hosted by the Council's Technology Leadership and Strategy Initiative, featuring new National Science Foundation Director Dr. Sethuraman "Panch" Panchanathan, which will take place next Thursday afternoon. The next meeting of the group will involve a deeper dive into the recommendations from the Innovation Talent and Entrepreneurship Swim Lane, and will occur on Friday, September 18th.

Working Group 4 Calls September 18

Introduction

The Honorable Deborah Wince-Smith and Mr. Chad Evans welcomed the group. Mr. Evans said that the day's discussion would pivot to the Regional Innovation and Geographic Inclusion Swim Lane. He also shared the upcoming schedule as the Council transitions to the writing stage ahead of the release of its Year One findings at the National Competitiveness Forum on December 17th. During the next couple of weeks, the Working Group calls will continue, but beginning in October the weekly calls will be replaced with less frequent and more focused engagements, roughly every other week. Specifically, the Council will socialize with the Working Groups the contents of the Year One findings and the feedback and suggestions made by the National Commissioners, Advisors, Outreach and Engagement Committee, and the Council's strategic communication partners. During this time, the Council may also reach out to specific individuals or small groups to seek clarification, expertise, or solicit feedback on the granular details of particular recommendations or to explore topics requiring particular expertise. Swim Lanes that wish to continue meeting and discussing ideas during this time should also feel welcome to do so.

Five Recommendations for the Digital Divide

Ms. Sunne McPeak of the California Emerging Technologies Fund presented a series of five recommendations for the deployment of universal broadband as an essential component of regional competitiveness

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and inclusion. She said these recommendations, which are focused on federal-level interventions, were derived from the California Emerging Technologies Fund's work, and emphasized that they needed to be connected to other investments in helping underserved communities escape the "wall of poverty," as the same communities lagging in access to broadband also lag in access to other essentials.

First, governments must commit to achieving a particular level of broadband deployment by a specified time. Ms. McPeak noted there were few such goals at the state level and none at the national level. Second, the federal government must be willing to commit the necessary funding to establish robust broadband infrastructure in rural and poor urban areas, in the form of matching funds to enhance state, regional, and local funding efforts. She emphasized that universal broadband would require roughly $100 billion in founding, especially with the rise of virtual work, online school, and telehealth during the pandemic necessitating much higher bandwidth and more synchronous networks for households than previously. Third, the government should pursue a regulatory framework based on performance incentives rather than "command and control" policies, and should establish an official policy of partnering with stakeholders, especially industry, in order to deploy broadband infrastructure. Fourth, the government must work to effectively leverage its investments. Finally, an "internet lifeline" program will be needed to subsidize access to high speed internet and devices that can use high speed internet for low income people. Ms. McPeak noted that such a program previously existed but had gradually withered away. She concluded by asking participants if more recommendations should be added to these five, or if any or all of the recommendations should be reworked or expanded. She noted in particular models like the Idaho plan that could be scaled to increase broadband access, and the connections these recommendations had to those concerning regional innovation roadmaps, as robust broadband infrastructure is essential to effective innovation components, like education and workforce development, as well as inclusive access to that innovation.

Refinement of Broadband Recommendations

Participants offered a variety of suggestions and feedback. Ms. Wince-Smith suggested that a national infrastructure bank, funded through mechanisms like a tax on internet service providers and E-Commerce firms, could help fund the rollout of broadband technology. Dr. Moody Altamimi of Oak Ridge National Laboratory asked how a broadband initiative would affect access costs for the underprivileged, and Dr. Sundari Baru asked if the projected costs included setting up 5G infrastructure. Council Senior Advisor Ms. Carol Ann Meares asked how many households currently lacked broadband access. Ms. McPeak said that various estimates have found that about 10 percent of Americans, or more than 30 million people, primarily in rural areas, tribal lands, and poor urban areas, lack broadband access. She added that the threshold speed for what constitutes "broadband" has continually increased as more and more activity occurs online, and is well above its old standard of 256 kbps. Mr. Leslie Boney of North Carolina State University said that in North Carolina, 95 percent of the population had access to broadband, but only 60 percent of North Carolinians made use of it, due to a combination of inability to afford access and a belief among some that they had no use for broadband access.

Ms. McPeak added that the return on investment to universal broadband in the form of increased economic contributions from those newly connected and the increase in economic opportunity for the urban and rural poor far outweighed the cost of investment- potentially up to $240 billion in additional economic activity per year. She also emphasized the need to couple investment in broadband infrastructure with efforts promoting its use, including digital literacy. Dr. Baru added that digital literacy campaigns should also include education on internet privacy as children attend online classes in large numbers. Regarding funding, Ms. McPeak said there were numerous avenues, including bonds, an infrastructure bank, or the FCC's universal services fund, which already collects $4 billion per year from tele-

com companies and users and could be expanded. The most important element was having some sort of dedicated funding stream.

Participants discussed the potential for an online sales tax to fund broadband investments. Ms. Wince-Smith noted that legacy telecommunications companies pay taxes on their sales, but that online retailers like Amazon do not. Dr. Altamimi asked if there were ways to incentivize tech companies like Amazon and Google to partner with government to fund the deployment of broadband infrastructure. Dr. Carlotta Arthur of the Luce Foundation said that there were prior examples of tech companies contributing funding to internet access, including efforts during the pandemic to establish broadband connectivity on tribal lands and at tribal colleges. She further noted that New York collected taxes on Amazon sales, and Dr. Baru added the same was true in California, establishing precedent for taxing of e-commerce. Ms. McPeak noted that in those cases the consumer paid the online tax, and that the retailers themselves were not taxed. She also noted that big tech companies will volunteer to invest in infrastructure, especially if it results in new markets for them. She said this was the impetus behind establishing partnerships between government and industry. She said routing funds through state governments would result in friction loss, and that direct partnerships would be a more effective use of resources, while adding that ISPs should not be expected to lose money investing in setting up infrastructure in rural and inner urban areas. Rather, their investments in these locations should be subsidized.

Regional Roadmap Best Practices and Innovations

Mr. John Melville of Collaborative Economics discussed the Swim Lane's ideas for a regional innovation roadmap that would help groups of interested stakeholders develop innovation hubs, and in particular outlined ways to avoid the pitfalls that have beset previous attempts at the federal and state levels to foster regional innovation, which he described as four "cornerstones." First, roadmap efforts must be intentionally inclusive along multiple dimensions, including demographically, geographically—both outside of traditional tech hubs and using economic connections rather than political boundaries—as well as occupationally, including all professions and not just STEM fields. Second, there must be an integrated framework that considers all of the elements of an innovation system, including R&D, venture capital, community amenities, infrastructure, and local culture and attitudes towards entrepreneurship. Requiring regions to evaluate all of these factors will break down silos and encourage effective coordination from the outset. Third, the process for implementing the roadmap must be disciplined. Implementation should not fall on a single institution, and there must be strong regional leadership, particularly from local industry leaders in key sectors who are committed to the project. Securing community support is essential, and stakeholders should look to best practices, both from intentional innovation efforts like Austin and San Diego, and from organically developed innovation hubs like Denver and Boulder. Finally, there must be a shared vehicle for implementation. This includes a shared strategy, culminating in a roadmap where stakeholders are mutually accountable and provide feedback to state and federal policy makers about necessary enabling legislation and policies. Requiring state and federal policy makers to be responsive to regional input ensures best practices and knowledge are diffused and scaled and avoids a takeover of the process by special interest lobbying.

Mr. Melville said roadmaps could include region-specific roadmaps as well as cross-regional agreements or compacts like the agreement between San Diego County, Imperial County, and Baja California on the California-Mexico border. He said there was great potential in core innovation centers finding complementary partners and establishing mutually beneficial relationships. He emphasized again that implementation needed to be regionally-driven, and that funding should not come from any specific federal agency to avoid the agency imposing its own culture and standards on the process at the expense of bot-

tom-up innovation from the stakeholders themselves. Mr. Melville suggested that a coalition of foundations provide funding for roadmap initiatives, and that agencies act as active supporters and listeners who help facilitate and take in best practices and ideas filtering up from regions. He also suggested having a neutral, non-governmental intermediary to act as a platform upon which different regions can share best practices, and suggested that the Council was well-suited for such a role. Finally, he said it was essential for regions to share what they learned with state and federal governments, including identifying policy changes necessary for a more conducive environment for innovation, which would allow successful initiatives to scale.

Refinement of Regional Roadmap Recommendations

Ms. Sara Lawrence of RTI International echoed the importance of tailoring interventions to particular regions, and said it was imperative to establish messaging that regional innovation roadmaps are intended to address the growing geographic inequality that has divided the country, and is focused on correcting shortcomings in previous economic development approaches. Mr. Melville agreed on the importance of a clear call to action, noting that most discussion of economic development does not focus on convening a variety of stakeholders, securing local industry buy-in, and other best practices. He added that the President would be best positioned to announce this call to action, and to emphasize to agencies the importance of responsiveness to ideas filtering up from the regions. Mr. Boney noted that the Economic Development Agency's Comprehensive Economic Development Strategies (CEDS) initiative was also focused on regional roadmaps, and Ms. Wince-Smith noted that the National Science Foundation is focused on addressing the "missing millions" and increasing inclusion in the innovation ecosystem. Mr. Boney asked if there was a way to combine the regional roadmap initiative with CEDS. Mr. Melville said that while some regions have used CEDS as a way to develop effective roadmaps, others merely use the money for infrastructure funding, and said the President would need to direct agencies to be in collaboration with regional roadmap initiatives outside of CEDS to knit the two together. Dr. Dahl asked how to ensure regions know how to transform their economies. Mr. Evans said that motivated leadership was essential, and Mr. Melville added that having engagement across a variety of stakeholders as well as establishing credible, trusted intermediaries were essential. Mr. Evans said the Council has conducted and shared research on this topic in past reports as well, including toolkits and best practices for identifying leaders.

Concluding Thoughts and the Road Ahead

Mr. Evans said that the group would finish up the discussion of the Regional Innovation Swim Lane recommendations next week with a presentation by Mr. Boney on strategies for recruiting, retaining, and retraining talent to foster regional innovation ecosystems. Following that, the group will move to discussing the recommendations of the Innovation Talent and Entrepreneurship swim lane, led by Dr. Lee Cheatham of Pacific Northwest National Laboratory and Dr. Dahl. The following week will be a continuation of the Innovation Talent and Entrepreneurship Swim Lane, should it be needed. The next meeting of the group will be Friday, September 25th.

Working Group 4 Calls September 25

Introduction

The Honorable Deborah Wince-Smith and Mr. Chad Evans welcomed the group. Mr. Evans said the day's discussion would begin with a wrap-up of the recommendations from the Regional Innovation Swim Lane, and then focus on the recommendations of the Innovation Talent and Entrepreneurship Swim Lane. He anticipated that discussions on the latter would carry over into next week, and said that as a result next week's call will be the usual full hour. However, after next week, the group will begin meeting every other week, for half an hour instead of a full hour, as the Council moves into the prioritization and drafting stage for the Year One Call to Action in December.

Retaining, Retraining, and Recruiting Talent

Mr. Leslie Boney of North Carolina State University discussed a set of recommendations aimed at recruiting, retaining, and redeploying talent in struggling regions. He noted that the Regional Innovation Swim Lane's other recommendations for regional innovation roadmaps and universal broadband were necessary but not sufficient for talent development. Mr. Boney outlined how many regions were losing their most talented graduates to larger cities each year, which in conjunction with a baby bust was decreasing the talent pool substantially. He empha-

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sized the need to establish strong credentials for students who do not attend college, and to increase attainment of post-secondary degrees and certifications, especially among African American, Hispanic, and low and moderate-income students. Mr. Boney suggested establishing internships for college-bound students in their local communities to showcase job opportunities available in their home towns. He also advocated for creating apprenticeships to provide continuing skill development and job pathways for students who do not go on to college.

Mr. Boney discussed the ways in which workplace "churn" is increasing as a growing share of the workforce finds its skills outdated. He noted that a majority of workers would prefer to receive re-skilling in the workplace, rather than leave the workforce for traditional higher education. He pointed to the Aspen Institute's UpSkill America initiative, aimed at developing customized sectoral training for regional workforces, which he said was a logical outgrowth of the regional roadmap recommendation that could connect to local industries. Mr. Boney also noted the value of apprenticeships for re-skilling those already in the workforce, especially for younger workers.

Finally, Mr. Boney discussed ways in which workplace churn could benefit left-behind regions. States like Alabama are actively recruiting members of their "diaspora" to return to the state and highlighting its economic opportunities and quality of life. Similarly, the city of Pittsburgh is attempting to recruit refugees to settle in the city and become part of the workforce, while the state of Vermont and the city of Tulsa are offering financial incentives to entice skilled workers native to the region to return home. Other opportunities include recruiting new residents without ties to the area, such as Nebraska's efforts to bring in early-30s workers with new families who do not want to live in big cities, as well as early-50s workers looking for a second career. Mr. Boney also suggested that regions develop plans to attract SBIR and STTR grant recipients, encouraging them to set up their startups areas using amenities and lower costs of living as a selling point. Robust broadband infrastructure could also be used to lure freelancers, who can retain their jobs based in other parts of the country but relocate to an area with a lower cost of living. The state of Utah has developed programs to give rural residents the online skills needed for virtual work. Mr. Boney noted that China has been particularly aggressive in encouraging Chinese American immigrants to return home via incentive programs, increasing the urgency of retaining and up-skilling talent for the U.S.

Enabling Talent Cultivation

Participants shared their thoughts about necessary enabling factors to recruit, retain, and redeploy talent. Mr. Donald Thompson of Walk West noted that many up-skilling programs will not require formal degrees, such as social media skills. He said that a social media professionals can support various businesses, and work remotely for multiple clients as freelancers. He also discussed his company's partnership with Pitt Community College in Eastern North Carolina building e-learning courses on entrepreneurship,

sales, and social media. Mr. Thompson said that connectivity and new skills allow people in rural areas to earn higher wages without the higher cost of living associated with urban areas. Mr. Boney said virtual learning was a valuable resource, but reiterated the need for robust broadband to make it work. Mr. Evans noted the connection between these recommendations and the work of the Systems Infrastructure Swim Lane in Working Group 3 on universal interconnectivity, and suggested having a cross-pollination session, especially as that group would like insights into funding their ideas.

Dr. Sundari Baru said that affordable housing and mass transit opportunities were essential to retain talent, especially for younger workers and students. She also recommended having local industry partner with educational institutions to train students for local jobs, citing as a model Genentech's partnership with community colleges in Vacaville, California to create job pipeline opportunities. Dr. Carol Dahl of the Lemelson Foundation added that K-12 school quality was an important consideration for recruiting and retaining families with young children, and Mr. Boney cited North Carolina State's Centennial Campus, which houses over 50 companies that work to train and hire students, as a model for university-industry partnerships that could create local job pathways. Ms. Erica Volini of Deloitte noted that virtual learning and work could also address the challenge of affordable housing by eliminating the necessity of living close to urban centers.

Ms. Sunne McPeak of the California Emerging Technology Fund said that technology was only a tool, and that housing was the linchpin to addressing the "triple bottom line" of economic, environment, and equity in governance. She said it was impossible to tackle the wealth gap and inequality of opportunity without addressing housing policy and residential segregation. Ms. Wince-Smith said that housing, along with education and healthcare, was one of three sectors that comprise 38 percent of GDP but have seen soaring costs and no productivity improvement for decades, and that addressing this was key to ensuring robust economic growth. Ms. Van Ton-Quinlivan of Futuro Health said that community colleges were essential to building talent in rural communities, as they are often the only post-secondary educational institutions there. Ms. Julie Meier Wright of Collaborative Economics followed on Ms. Wince-Smith's remarks by noting the interconnection between healthcare, housing, and education, and the ways that virtual communities could address these challenges. Mr. John Melville of Collaborative Economics said it was especially important for community colleges to partner with industry to prepare students for careers, and

Dr. Carlotta Arthur of the Luce Foundation noted that underrepresented minorities are often harmed by stereotypes that they are not as educated or skilled, and are not given chances to succeed even when they possess the needed skills. She said ending these stereotypes was key to inclusive prosperity. Finally, Mr. Boney and Mr. Evans warned that despite normally being counter-cyclical, community college enrollment was declining during the recession, in particular for African Americans and for rural males. Mr. Boney noted that there was no consensus on the reasons for this decline, but that reversing it was of paramount importance.

Innovation and Entrepreneurship Education

Dr. Dahl said that because high-growth innovative businesses drive net job growth, promote the proliferation of new ideas and processes in existing industries, and lead the way in innovative responses to challenges like the pandemic, it was important to boost innovation and entrepreneurial capacity. She said that effective education prepares all students to either create the high value jobs of the future or develop the skills to fill them, but that there was currently a mismatch between the jobs needed by the economy and the skill sets of workers. As exposure to invention, innovation, and entrepreneurship enhances learning and student engagement in STEM and adjacent fields, like business, Dr. Dahl said ensuring every student has access to age-appropriate innovation curriculum was needed to prepare students for the fluid environment of the future.

Specifically, she called for greater support for scaling and bringing to market student inventions by higher educational institutions, age-appropriate computer science education, and experiential learning opportunities for students to identify and solve problems.

Dr. Dahl pointed out the numerous benefits of universal exposure to innovation and entrepreneurship curriculum. Noting that wealthy private schools already provide this education, implementing these programs universally in the public school system would increase equality of opportunity and increase the diversity of the pool of innovators and entrepreneurs, helping more students reach their full potential and more Americans reap the benefits of the innovation economy. This educational paradigm would also cultivate the flexible and adaptable skills employers are looking for, and would move education from a test-based structure based on memorizing quickly-obsolete information to one focused on problem-finding and problem-solving, teamwork, and student-motivated and student-led learning. Finally, Dr. Dahl noted that cultivating a broad and diverse innovation talent pool boosted America's economic and societal resiliency and created the workforce needed to bring technology from labs and universities to the market, addressing challenges in technology transfer. In addressing the future of work, diversity and inclusion, resiliency, and technology transfer, innovation education also addresses many of the areas the Council team has identified as needing deeper discussion during later phases of the National Commission.

Sustainability Education

Dr. Dahl's second recommendation focused on integrating sustainability education into the curriculum at all K-12 and higher educational institutions in a similar fashion to entrepreneurial and innovation education. She said that among the skills that will be most in-demand in the future, knowledge of sustainable production and consumption was as important as self-led learning, flexibility, teamwork, and communications skills. She argued that the U.S. needs a workforce skilled in developing and using sustainable technology to remain competitive, and that informed policy makers and legal experts are essential to create a policy environment that supports these sustainable technologies. Specifically, Dr. Dahl called for all students to experience age-appropriate experience in sustainability, climate change, and systems thinking to create an informed leadership and citizenry. She noted that with many European countries already adopting this educational model, the U.S. needed to catch up or risk falling behind. As with entrepreneurial education, Dr. Dahl pointed out the benefits for diversity and inclusion and for building resiliency that would accrue from providing this education to all students.

Implementing Curricular Changes

Ms. Meier Wright endorsed Dr. Dahl's recommendations, arguing that more emphasis on resiliency in general was needed in educating the next generation, and Ms. Wince-Smith suggested the development of sustainability standards that were built-in to corporate manufacturing considerations, similar to the Baldrige criteria for quality, which were developed to address U.S. manufacturing's loss of competitiveness in the 1980s. Dr. Dahl said that business should drive a shift to sustainability considerations by seeking out sustainability skills in employees. Mr. Evans noted that there were over 16,000 school districts across the country that set their own curricula, and asked what the first step was for universal and systemic transformation. Dr. Dahl acknowledged that wholesale change of educational curriculum was a bold and challenging endeavor, but noted there were different paths for adjusting curriculum at the K-12 and university levels, respectively.

In higher education, Dr. Dahl recommended starting with disciplines like engineering, where there is already movement towards incorporating sustainability education, and building a framework that can be generalized with stakeholders who are already motivated. For K-12 education, a combination of grassroots and top-down approaches will be needed. Teachers and school administrators who demonstrate that sustainability curriculum can be brought effectively into the classroom can help form a grass-

roots movement to influence state-level policy makers, with funding and logistical support from private philanthropy. This could include voluntary adoption of standards, similar to the Next Generation Science Standards for STEM education. Additionally, cultivating interest in curriculum changes with state and local government officials will provide the top down impetus needed to make these changes universal. Ms. Meier Wright suggested connecting with teachers' unions to build support for these curriculum changes at a state or federal level.

Partnering to Improve Opportunities

Dr. Baru discussed a series of recommendations for developing and retaining local innovation talent, covering various life stages from childhood to mid-career. She noted there were different partners to involve in each stage, and that resiliency in the form of life-long learning was essential to ensuring opportunities for development and skill cultivation at every age. For short-term transformations, Dr. Baru recommended that universities set up funds to get students into innovation programs, and to help bring their ideas and inventions to market. She suggested partnering with philanthropy and local business associations to develop programs to help transfer and scale technologies and ideas. She also called for greater use of the I-Corps program to cultivate young entrepreneurs. For longer-term change, Dr. Baru called for a change in the way K-12 education is funded. She noted that funding schools via property taxes provides more resources to affluent families, depriving talented lower-income students of the resources needed to develop their talents to their fullest potential. She also called for more career and technical education in high schools. Dr. Baru said that in her area of California local car dealerships were partnering with the local community college to offer car maintenance courses, and creating a pipeline for students with mechanic jobs upon completion of the program. She noted that these partnerships help to both develop talent and keep it local.

Ms. Ton-Quinlivan said it was important for employers to recognize the education and training that workers gain over the course of their lifetime, even learning that doesn't come with formal credentials. She said there were ongoing efforts to develop continuous learning records that would transcend formal education and help individuals showcase skills they developed via self-directed lifelong learning, such as via free online courses and other resources. Dr. Baru suggested universities or community colleges develop add-on credentials or certifications to help self-directed learners earn recognition for their re-skilling, and Mr. Melville suggested having businesses involved in this process as well. Dr. Baru added that while businesses complained of a shortage of skilled workers, wages were not increasing in those fields to attract talent as would be expected. She said it would be important to examine the data in greater depth before implementing new policies.

Addressing Barriers to Entrepreneurship

Ms. Amy Lientz of Idaho National Laboratory shared recommendations to address barriers to entrepreneurship. She noted that there were both structural and personal barriers facing prospective entrepreneurs, chief among them challenges of health coverage for younger entrepreneurs, especially families. Ms. Lientz said that Association Health Care Plans, which allow startups and small businesses to pool together to provide coverage for employees, offered a means of providing healthcare benefits to entrepreneurs, and had delivered promising results in Washington state, but that there were ongoing lawsuits that jeopardized the future of these plans. Ms. Lientz also identified the burden of financial challenges facing young entrepreneurs, especially student loan debts that necessitated a steady paycheck so younger workers could pay those debts in a timely fashion. As an alternative, Ms. Lientz advocated income-based repayment plans for student loan debt. Mr. Thomas Ruhe of NC Idea noted that changes to the Affordable Care Act could reintroduce the problem of healthcare job lock, further constraining entrepreneurship.

Finally, Ms. Lientz discussed the barriers facing high-tech science and engineering entrepreneurs in the form of lack of access to expertise, equipment, and mentorship. She noted that many would-be entrepreneurs struggled to access high-performance computing, lab facilities, and the personnel to provide guidance and assistance in using them. She cited the lab-embedded entrepreneurship programs established by Oak Ridge National Laboratory, Argonne National Laboratory, and Lawrence Berkeley National Laboratory as models for addressing these barriers. These programs provide entrepreneurs access to lab facilities, healthcare and associated benefits, and laboratory personnel for mentorship and expertise. She credited Dr. Moody Altamimi of Oak Ridge National Laboratory for highlighting these programs and offering suggestions for their expansion and replication.

Concluding Thoughts and the Road Ahead

Mr. Evans said that the discussion would continue next week from the same stopping point of discussion of barriers to entrepreneurship, followed by a discussion of the final recommendation idea from the Innovation Talent and Entrepreneurship Swim Lane. He reminded the group of the upcoming schedule change and thanked participants for their contributions. The next meeting of the group will be Friday, October 2nd.

Working Group 4 Calls October 2

Introduction

Ms. Yasmin Hilpert welcomed the group, and said the day's conversation would be focused on finishing discussion of the recommendations developed by the Innovation Talent and Entrepreneurship Swim Lane, as well as a discussion of the recommendations developed by the Swim Lane on Diversity, Equity, and Inclusion.

Reducing Barriers to Entrepreneurship

Ms. Amy Lientz of Idaho National Laboratory discussed her recommendation focused on identifying and addressing barriers facing prospective entrepreneurs. She noted that lack of access to health insurance for the self-employed and among small business and startup employees was a major barrier, and discussed the success of Association Health Plans, allowing entrepreneurs and small businesses to pool resources to provide insurance for themselves and their employees, as a means of promoting the formation of more startups. Ms. Lientz said that although data from the Clean Tech Alliance, comprised of startups and entrepreneurs in the renewable energy sector, had found that these plans helped create more entrepreneurs, the current Administration has put a moratorium on states authorizing the creation of Association Health Plans. She suggested looking at whether lifting this moratorium should be considered as a way to boost entrepreneurship. Dr. Carol Dahl of the Lemelson Foundation added that her own organization has found that both healthcare access and student loan debt act as powerful bar-

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riers to people who want to become entrepreneurs, especially those from lower income backgrounds.

Ms. Lientz also discussed the challenges facing entrepreneurs in access to the specialized equipment and facilities, capital, and mentorship they need to establish high-tech startups. She noted that although many people working at universities and national labs have ideas for spinning off companies based on their research, the loss of access to these facilities and personnel when they officially spin off a company hinders their efforts. She discussed the program pioneered by several national labs, including Oak Ridge National Laboratory, that provides entrepreneurs from outside the lab with a residency period including health and other benefits, access to facilities, and mentorship from laboratory personnel. Dr. Lee Cheatham of Pacific Northwest National Laboratory noted the success of this program and its benefits to the labs in exposing them to innovative ideas, and called for it to be further expanded and scaled. Mr. Phil Weilerstein of the VentureWell Foundation added that access to early stage funding was a barrier for entrepreneurs in general, and in particular for those from underrepresented geographies and underrepresented demographics. He advocated for more capital in the Angel Investor and early stages of startups. Council Senior Advisor Ms. Carol Ann Meares noted that venture capital investment was becoming increasingly concentrated in a smaller number of firms, especially as the primary investors are increasingly large tech companies like Intel and Google, who invest narrowly in IT startups.

Building on Successful Programs for Cultivating Innovation Talent

Dr. Dahl outlined a series of successful programs for cultivating innovation talent and entrepreneurship, urging both the deepening and broadening of these programs and the incorporation of a diversity and inclusion lens meant to increase representation for women, underrepresented minorities, and first-time entrepreneurs in these programs to ensure a better and more inclusive distribution of their benefits. She noted there were several initiatives for the creation of regional innovation hubs in pending legislation, including the Innovation Centers Acceleration Act and the Endless Frontiers Act. She also called for the expansion and deepening of both the National Science Foundation's I-Corps program and the Economic Development Administration's Build to Scale program to help develop regional innovation ecosystems and turn scientific innovations into companies. Additionally, Dr. Dahl noted the Small Business Administration's Regional Innovation Clusters initiative as a candidate for scaling.

Dr. Dahl also outlined a series of recommendations concerning the SBIR and STTR programs, including allotting funding for both programs in all federal agencies, increasing participation from underrepresented groups and first-time entrepreneurs, and addressing the problem of "SBIR Mills" that repeatedly receive up to 20 percent of SBIR funding but produce few or no products or jobs. Dr. Dahl also emphasized the need for pre-SBIR mentoring and funding to boost the chances of success for new applicants. Besides existing federal programs, she also urged the expansion and replication of programs at the university, state, and national laboratory level and their scaling into federal-level initiatives. She noted a program in Oregon that provides entrepreneurs access to specialized equipment in high-tech sectors as an example of one such program. She also called for new programs at the federal level to foster and reward mentorship of new entrepreneurs, modeled after successful efforts like MIT's Venture Mentoring Service. Dr. Dahl said that the willingness of experienced sector-relevant entrepreneurs and industry leaders to give back is a major driver of the success of regional innovation hub efforts.

Mr. Leslie Boney of North Carolina State University noted that North Carolina had been successful in providing state-level support for early-stage SBIR companies, and Mr. Weilerstein advocated a greater role for private capital in supporting early-stage entrepreneurs. He noted that current mechanisms and norms provide disincentives for angel investing, especially in science and technology, and advocated the use of tax policy and other incentives to encourage the deployment of patient, long-term capital to

these firms. Ms. Julie Meier Wright of Collaborative Economics also urged private-sector led initiatives, and asked what data supported heavy deployment of federal leadership on entrepreneurial support. Ms. Meares observed that many private firms do not fully commit to funding entrepreneurs until much of the risk has been reduced, and that companies often buy patents purely to prevent their competitors from obtaining them.

Developing a Lens for Diversity and Inclusion

Dr. Carlotta Arthur of the Luce Foundation described the analytical framework developed by the Swim Lane on Diversity and Inclusion for evaluating the root causes of whether a program or practice is fair and inclusive. The framework asks policy makers to determine if they are developing policies that address the root causes of underrepresentation and exclusion, if any policies or programs might be inadvertently exacerbating disparities, and how to craft recommendations that will improve representation among underrepresented groups. Dr. Arthur also stressed the importance of identifying ways to roll out programs so as to maximize outreach to marginalized groups, and noted that this framework should be applied both during the initial drafting of recommendations and policies, and as policy makers are developing plans for implementing them.

Dr. Arthur also addressed two other considerations. First, she noted that it was important to address potential skepticism over the value of a diversity and inclusion lens by making the business case for diversity, as well as finding and sharing data outlining the extent, causes, and consequences of underrepresentation. She also emphasized that the problem of underrepresentation was not solely due to an insufficiently inclusive innovation pipeline, but also to the inability of members of marginalized groups within the pipeline to access resources, gain entry into programs, and access capital for funding. She encouraged participants to think about where to find members of underrepresented groups within the pipeline, including at minority-supporting institutions and major state-supported research institutions. Ms. Meier Wright asked if there were tools that would help policy makers and businesses locate these individuals, and Dr. Arthur suggested the Survey of Earned Doctorates published by the National Science Foundation, as well as surveys of higher education institutions on the graduation of members of underrepresented groups.

Implementing Effective Diversity, Equity, and Inclusion Policy

Dr. Dahl noted that many members of marginalized groups are unable to leverage networking connections that provide access to funding for startups, and also report discrimination in the application process. Ms. Hilpert noted that the Working Group Charters and the online portal provided data and background resources on this subject, and that the Council team was working on putting together further background research. Dr. Arthur said that evaluators of job and program applications often fail to account for the disadvantages students from less-resourced institutions, especially students from marginalized groups, face in access to letters of recommendation and other application support, leading to unconscious bias by evaluators. She also urged the consideration of work experience outside very specific fields with crossover applicability when evaluating candidates to more fairly evaluate their skill sets, and Dr. Sundari Baru said a mindset change was necessary within organization so that ideas were not dismissed on the basis of who suggested them. Dr. Arthur warned that neither these biases nor unequal ability to network were easy problems to solve.

Ms. Hilpert noted that some organizations were changing their hiring process to put less emphasis on specific degrees and credentials for positions in order to level the playing field for applicants who did not have the same opportunities to access those credentials. Dr. Arthur said it was also important to ensure equal access to four-year educational institutions and traditional credentials for members

of underrepresented groups, and not to only steer them to alternatives like certificates or boot camps when degrees would be more beneficial in the long run. Ms. Meier Wright asked about the feasibility of anonymizing applications to remove biases against applicants based on information about their race, ethnicity, or gender, noting the success of anonymity for women in literature and classical music. Dr. Arthur said that while this process could eliminate some sources of bias, it would not be able to address bias in interviews, when it is impossible to conceal the demographics of a candidate. She added that some applicants from underrepresented groups would prefer not to get to the interview stage thanks to anonymity only to then experience discrimination in the interview stage.

Ms. Hilpert asked what challenges and opportunities were presented by the radical restructuring of education during the pandemic, and if there was a way to use this disruption as a "restart." Dr. Arthur doubted there would be much opportunity to address disparities in education given the struggle of so many institutions just to maintain their normal operations during the pandemic, and that pandemic was also disproportionately impacting those same underrepresented groups, making closing the educational access gap even more challenging. Mr. Boney noted that educational attendance had declined the most during the pandemic among African American men, and Dr. Arthur said that Native American communities were also disproportionately impacted by the pandemic due to lack of internet connectivity in reservations. Ms. Sunne McPeak of the California Emerging Technology Fund attributed the lack of access to connectivity on reservations to lack of power infrastructure needed to deploy broadband, and Dr. Dahl shared research from the Brookings Institution's Hamilton Project on the obstacles facing women and minorities in the innovation process. Mr. Boney shared research from the Center for American Progress on addressing the decline in educational access among African Americans, and Ms. McPeak suggested a process for identifying systemic discrimination: first identifying disparities, and then examining the root causes of those disparities.

Concluding Thoughts and the Road Ahead

Ms. Hilpert said in the coming days that the Council would send out a survey to participants asking them to rank recommendations developed during the Working Group calls for prioritization, and that the Council would be working in between the biweekly discussion sessions to develop the Year One Call to Action. She added that future conversations would return to the question of diversity and inclusion, including how to incorporate the analytical framework described by Dr. Arthur into the prioritized recommendations as voted on by the group. Mr. Bill Bates said the Council intended to reach back out to the group during the writing process and bring in expertise as needed, and that the Council did not expect to solve the challenge of incorporating a diversity and inclusion lens into all of its recommendations by the end of Year One. He thanked the participants for their contributions to the call and said the Council was open to suggestions and other thoughts from group members on what to consider for the Year One Call to Action. The next meeting of the group will be on Friday, October 16th.

Working Group 4 Calls October 16

Introduction

Mr. Chad Evans welcomed the group, and opened the session by discussing the current results of the survey of Working Group members' priorities for finalizing recommendations for inclusion in the Year One Call to Action. He noted that recommendations Innovation Talent and Entrepreneurship and around Regional Innovation Toolkits had yielded high interest from survey respondents. He also noted that the Swim Lane around the Displaced Workforce and Main Street Entrepreneurship remained highly relevant to the Commission's mandate and had been the subject of robust discussion by the group over the preceding weeks and months. Mr. Evans said he would send out a note outlining the results and findings of the survey as of next week, and he encouraged those who had not done so to respond to the survey.

Diversity, Equity, and Inclusion

In conjunction with the Commission's ongoing pursuit of greater diversity, equity, and inclusion in the innovation ecosystem, Mr. Evans announced the formation of a focus group, currently with around ten leaders, that would meet to build off the guidelines developed by the Diversity and Inclusion Swim Lane for designing recommendations. This group will work with the material the Commission has already developed while also undertaking more ambitious activities to ensure that inclusive prosperity is an essential component of the Commission's work. Mr. Evans said he would send out a list to group members of those who had already indicated interest in participating, and encouraged participants with interest in joining the group to let him know. He also shared that he had circulated the guidelines developed by the Diversity and Inclusion Swim Lane with the other three

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Working Groups, and would share the current membership of this task force with the whole community as well. Depending on the level of interest and the desires of its members, this group could remain a task force, become a standing committee, or expand into another full Working Group. Dr. Carlotta Arthur of the Luce Foundation, who helped lead the Swim Lane on Diversity and Inclusion, said it was fantastic to see the Commission putting forth effort into an area that was critical to the success of its work. She also expressed gratitude at the number of participants who had expressed interest in further developing policies to advance diversity, equity, and inclusion.

Digital Connectivity and Inclusion

Mr. Evans noted that questions of inclusion were relevant to the recommendations being developed across all four Working Groups. In Working Group 1, conversations around changing the nation's research and development investment portfolio need to include not just changes in the amount of spending and the split between basic and applied research, but also ways to ensure historically marginalized groups are engaged and included in the research ecosystem and receive funding. He noted that during last month's Competitiveness Watch Call as part of the Council's Technology Leadership and Strategy Initiative, Dr. Sethuraman "Panch" Panchanathan, the Director of the National Science Foundation, had expressed interest in advancing diversity and inclusion in the research enterprise as well. Mr. Evans emphasized that this offered a possible collaboration opportunity with the federal government on these issues. Ms. Sunne McPeak of the California Emerging Technology Fund noted that the "digital divide" in access to broadband and other advanced telecommunications was a product of and contributor to continued systemic inequities and disparities in the United States. She discussed how disparities in access to high speed connectivity and home internet reinforced economic segregation and stressed the need to incorporate this lens into discussion of the group's recommendations. Mr. Evans agreed, noting that there was a growing belief that access to high speed internet was a human right given the increasing role of technology in society. Mr. Leslie Boney of North Carolina State University added that it was impossible to increase economic opportunity or inclusion without robust connectivity in a digital world.

Addressing Gaps and Preparing Topics for Year Two

Mr. Evans said that in the weeks to come the Council team would share a couple of areas where it felt it needed to come back to the group and further discuss in order to think through gaps in those issues' coverage. These discussions will not require major rewrites of existing recommendations or substantial new written products, but could include discussions to understand the intent of potential recommendations or pathways towards developing and implementing recommendations. He added that this would be the major engagement during the upcoming

Working Group calls, and that he would send out more specific on this process in the next week. Dr. Lee Cheatham of Pacific Northwest National Laboratory asked if this process would involve mapping the group's discussions against the mandates laid out in the Working Group charters, and Mr. Evans replied that it would involve consideration of the group's original charter, the discussions in the Phase 1 calls and "Nine Pillars" framework developed to organize key themes, and the discussions in the Phase 2 calls. He added that the survey responses would help the Council team gauge which subjects were most important to the Working Group members, and that in some areas there would be topics where there was significant interest but not much information or discussion, and others where there was significant discussion and information but where the ideas were in need of further development. Many of these topics will become priorities and focus areas for Year Two of the Commission, like the hydrogen economy for Working Group 2. The Council is also tracking the platforms of both presidential campaigns to understand where the Commission and Working Groups are in relation to those campaigns, in order to understand the opportunities that will be open and the optimal messaging for conveying the Commission's recommendations to the White House in the new administration.

Critical Technologies and Security

A topic of critical importance to all four Working Groups is the movement of critical technology in strategically important industries out of the country, and Mr. Evans noted that the White House recently released a list of emerging technologies with critical national security implications. This release also stresses the importance of a secure, resilient, sustainable technology platform on which these technologies can operate. The Council will issue a strong call for mechanisms to strategically think about the American position vis-à-vis global competitors in a range of technology areas, such as a "National Innovation and Competitiveness Council." Such a council would be modeled after the National Security Council or National Economic Council and would have budgetary authority along with the responsibility to scan the innovation landscape of competitors as well as our own to take advantage of our assets and ensure the United States remains ahead of the curve on disruptive innovations. Dr. Jerry Haar of Florida International University endorsed both the issuing of a statement around critical technologies by the Commission and the monitoring and enforcement of the Export Control Act by the government in pursuit of that mission. Dr. Cheatham said the importance of the hydrogen economy to continuing discussions in Working Group 2 was an example of how emerging technology influences sustainable production and consumption, and by extension of the relevance of these issues to all four of the Working Groups' mandates.

Concluding Thoughts and the Road Ahead

Mr. Evans reminded the group that he would send an update on the new Diversity, Equity, and Inclusion task force to the whole National Commission community, and will use the response from members over the next few days to determine how to advance before sharing that decision with the community as a whole. Dr. Carol Dahl of the Lemelson Foundation suggested bringing in more members from the corporate world to the Diversity and Inclusion task force, and Mr. Evans said the Commission will continue to look for ways to bring in additional voices and leaders over the lifespan of the effort. He encouraged members to think about those in their networks who might be interested in joining the Commission as Commissioners or members of the Working Groups, and to let the Council team know. The next meeting of the group will be on Friday, October 30th.

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While the players may have changed since its founding in 1986, the mission remains as vital as ever—to enhance U.S. productivity and raise the standard of living for all Americans.

The members of the Council—CEOs, university presidents, labor leaders and national lab directors—represent a powerful, nonpartisan voice that sets aside politics and seeks results. By providing real-world perspective to Washington policymakers, the Council's private sector network makes an impact on decision-making across a broad spectrum of issues from the cutting-edge of science and technology, to the democratization of innovation, to the shift from energy weakness to strength that supports the growing renaissance in U.S. manufacturing.

The Council's leadership group firmly believes that with the right policies, the strengths and potential of the U.S. economy far outweigh the current challenges the nation faces on the path to higher growth and greater opportunity for all Americans.

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