Compete.
Council on Competitiveness

UC DAVIS
UNIVERSITY OF CALIFORNIA

National Commission on Innovation & Competitiveness Frontiers

Phase 2 Launch Summit

Davis, CA
March 27–28, 2023

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Introduction

Over March 27-28, 2023, the National Commission on Innovation and Competitiveness Frontiers convened its Phase 2 Launch Summit at the University of California at Davis. Nearly 100 participants in the Commission community—including representatives from business, government, academia, and non-profits—came together to present keynote addresses, convene plenary panels, and conduct working group sessions to inform Phase 2 of the Commission's work and begin to explore recommendations the Commission could make in its next report to boost U.S. innovation capacity and capability tenfold.

Our host. UC Davis Chancellor and National Commissioner Gary May hosted the Summit. He introduced Summit participants to the diverse Aggie community at UC Davis, its small-town character, and its world-class education, the most comprehensive school in the University of California system. UC Davis is on the front lines of critical issues such as managing climate change, bettering the health of humans and animals, and seeking a more sustainable future. It is well-known for having among the world's best agriculture and veterinary medicine programs, and is ranked first in the Nation in both. It attracts students and faculty from all over the world. The region is thriving with technological development and entrepreneurship.

UC Davis Aggie Square is being built as a new Sacramento innovation district, where companies, researchers, students, faculty, and community advocates will work side by side in emerging areas of research and technology, and where UC Davis will provide training for up-and-coming industries and residents who live in the surrounding neighborhoods. It is projected to inject $5 billion annually to the regional economy and support 25,000 jobs.

University of California at Davis

- 40,000 students
- 4 colleges
- 6 professional schools
- 100 undergraduate majors
- 90 graduate programs
- $1 billion annually in research
- Contributes more than $12 billion to the California economy
- In top ten of U.S. public universities

National Commission activities and impact to date. Council on Competitiveness President, CEO, and National Commissioner Deborah Wince-Smith reviewed some of the National Commission's activities and accomplishment to date. In June 2022, the Commission community convened at the Mountain West Innovation Summit in Laramie, Wyoming, hosted by National Commissioner and University of Wyoming President Ed Seidel. Other hosts included National Commissioner Greg Hill, President and COO, Hess Corporation; Dr. John Wagner, Director, Idaho National Laboratory; and Deborah Wince-

"Aggie Square will be the cornerstone of a regional identity and economic development…with the potential to truly transform the livelihoods of our neighbors there and the economy of the Sacramento region."

Chancellor Gary May
University of California at Davis

National Commission 10X Innovation Imperative

- 10X increase in the number of innovations developed
- 10X increase in the number of innovators
- 10X increase in the speed of innovation

Smith. Participants developed some of the ideas the Commission approved for its 2023 agenda when it met in Washington and at the National Competitiveness Forum.

When the Commission issued its first report—*Competing in the Next Economy*—in December 2020, the United States had elected a new president, and the Council on Competitiveness engaged quickly with new leaders in the Biden Administration and in Congress. Personnel on transition teams reached out to the Council, and many of the Commission's recommendations have moved forward and are reflected in seminal legislation passed over the last year. The Commission is being heard across Washington, but also in U.S. cities, among U.S. governors, and among U.S. allies and partners around the world.

Since its founding in 1986, the Council on Competitiveness has always made U.S. scientific and technological leadership a priority and the heart of the Council agenda to drive U.S. productivity, higher standards of living, and U.S. global competitiveness. Bold investments are needed to secure the Nation's leadership in research and technology, and ensure their translation into goods and services that create value, jobs, and wealth. The Council played an important role in shaping the legislation that culminated in the bi-partisan CHIPS and Science Act that President Biden signed last year. The Council has been an early advocate and leader on the importance of next generation semiconductors that underpin the digitization of everything. During the pandemic, disruption in supply chains resulted in shortages of critical goods, including semiconductors. To ensure U.S. access to semiconductors and

other critical goods, one of the Biden Administration's first initiatives was an Executive Order directed at securing critical supply chains.

In addition to appropriating more than $50 billion to re-shore U.S. semiconductor manufacturing and boost U.S. development of advanced semiconductors, the CHIPS and Science Act authorized generational investments in R&D, critical technology development, and new innovation hubs. Many emerging U.S. hubs will be supported by the Regional Innovation Engines program, part of the new National Science Foundation Directorate for Technology, Innovation and Partnerships. The Assistant Director for this new directorate, Dr. Erwin Gianchandani, joined the Commission community at the Mountain West Innovation Summit in Laramie, providing input to help shape the Commission's agenda and work on the future of place-based innovation.

The Commission called for a new technology statecraft, creating the alliances and partnerships with close allies, democratic nations, and nations that share our values, to counterbalance autocratic competitors trying to reshape the global technology landscape and next economy in their state-led model. This need, identified in the Commission's first report, was reflected in one of the first speeches by Secretary of State Blinken who called for a new technology statecraft. Subsequently, he launched a new Department of State Bureau of Cyberspace and Digital Policy led by an ambassador-at-large, and named a Deputy Envoy and established an Office of the Special Envoy for Critical and Emerging Technology.

At this pivotal moment in U.S. history—in a time of turbulence and rapid change—we have a once in a generation chance to leapfrog into a new future state. The Commission's Phase 2 will focus on four critical pillars of future success:

- The Future of Sustainability
- The Future of Work, the Workforce, and the Workplace
- The Future of Deploying Disruptive Technologies at Scale, and
- The Future of Place-based Innovation

At the Phase 2 Launch Summit, working groups began developing an agenda, strategy, and recommendations for building these four pillars that will define U.S. competitiveness, economic growth, prosperity, and geopolitical leadership in the decades ahead.

Cross-cutting Themes—Drivers for Phase 2 of the National Commission

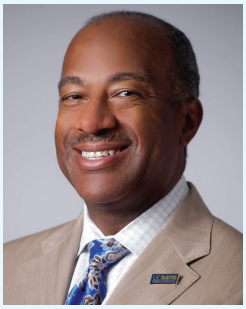
A number of the themes emerged, recurring across different panels, suggesting these issues and findings should be considered high-priorities for the National Commission to elevate in its narratives and address in recommendations. These include:

- The economic, social, national security, and geopolitical environment has changed dramatically in the past several years, presenting new and difficult challenges. For example, the United States has systems and processes that worked well in a more stable and slowly changing environment. These are not well suited for today's environment of rapid change. The national security environment, in particular, requires changes in the innovation system. The United States must innovate faster, translate new ideas and technologies into the field faster, and stay ahead of the adversary.
- U.S. national laboratories play a crucial role in the U.S. innovation ecosystem, working at the forefront of science and technology in areas such as national security, clean energy, sustainability and, increasingly, sustaining and advancing American economic competitiveness.
- Threat to U.S. access to supply chains for critical materials and goods is a threat to the U.S. economy, society, and ability to develop and deploy technologies. The threat is multidimensional ranging from geopolitical risks and extreme wealth to local disease outbreaks and disruption in goods transport. China has expressed "intentions to increase global supply chain dependencies on China, with an aim of controlling key supply chains and being able to use those supply chain dependencies to threaten and cut off foreign countries during a crisis." The United States needs to re-shore, forge partnerships with allies, develop alternatives, and resume sustainable mining to ensure access to critical materials and goods.
- The United States needs to counterbalance China's efforts to shape global rules of the road outside of the value system of liberal market principles, including standards.
- Many international students educated at U.S. universities are returning to their home countries as those countries have advanced economically and technologically. The United States should make it attractive and easier for those students to choose to stay here.
- With the trajectory of current efforts, we are not likely to mitigate climate change. The recent IPCC 6th Synthesis Report states that global warming is more likely than not to reach 1.5°C even under the very low GHG emission scenario and likely or very likely to exceed 1.5°C under higher emissions scenarios. A more aggressive strategy would involve eliminating emissions, removing emissions, radiative forcing management, adaptation, and building new institutions to manage systemic risks on the timescales needed. Half of the decarbonization problem can be solved with existing solutions in the market and should be deployed at speed and scale. Other solutions need to be developed and brought into a market context. Nuclear power is one of the few proven options that could deliver clean electricity at the scale needed, but there are many barriers that would have to be overcome. Other challenges that need to be addressed include the hard to decarbonize sectors, large scale energy storage, and business models for financing.
- The United States must bring a broader population of Americans into higher education, workforce development, innovation, and entrepreneurship to provide opportunities to build generational wealth and help families be successful. Models and partnerships are needed to close geographic and institutional gaps, and connect less resourced communities, higher education institutions, and community colleges to opportunities and assets for innovation. Universities can play a powerful role in nurturing and supporting innovators and prospective entrepreneurs.

- The United States must transform the K-20 education system and pipeline, and establish different pathways through it. The education and training system should be capable of developing a diverse workforce demographically, regionally (Silicon Valley vs. rural Alabama), and for different industries in which people will work. The system should meet knowledge and skill needs with speed to match the pace of industry. More input from industry is needed so students understand what jobs will be available, and educators and trainers can provide them with needed skills.
- For a future of rapid change, students must be prepared with the ability to learn and relearn across their lives, and be adaptable.
- There is momentum for place-based innovation driven by significantly increased Federal government place-based investment, concern about U.S. access to supply chains for critical materials and goods, and growing political attention to Americans and geographic regions being left behind or long suffered disadvantages.
- No one place-based-building or innovation model will work for all. Cities, towns, and regions are designing and implementing a range of place-based strategies, including urban renewal, rural area innovation building, regional asset-driven, university-driven, Federal laboratory-driven, and specialized industry-driven. Place-based strategies need to consider the target—distressed places that need to build capacity, or places with higher capacity that are better prepared to boost regional and national competitiveness in a range of technologies. Government needs to be more open to experiments in programming and partnerships.
- Place-based-building or innovation strategies require a range of partnerships in different forms that involve entities such as political leaders; Federal, state, and local governments; communities; universities and community colleges; Federal laboratories; businesses and industry; philanthropic organizations; and others. Physical proximity that enables close engagement can spur greater innovation.

Painting the Picture of Davis and the California Innovation System

Panel



Dr. Gary May
Chancellor, University of California, Davis
National Commissioner

Dr. Kim Wilcox
Chancellor, University of California, Riverside
National Commissioner

The Hon. Deborah L. Wince-Smith
President & CEO
Council on Competitiveness
National Commission Co-chair

? Key Issues and Questions

The University of California has developed its strong track record in generating start-ups, inventions, and patents with a research portfolio spanning biotech, transportation, AI, energy and the environment to digital technology, materials, agriculture, and food systems.

- What is your institution's "place" in the place-based innovation ecosystem? What pivotal roles do you play? And what has been the impact?
- Companies are looking more frequently to universities for breakthrough innovations, and research universities are increasingly expected to be drivers of regional innovation. What is the role of partnerships with industry in your university's efforts to boost innovation and the capacity of the region's innovation ecosystem?
- What kind of program and organizational infrastructure do your universities have in place to support your engagement with industry, and to foster spin-outs and start-ups?
- How does your research agenda and portfolio differ from traditional academic research, enabling a greater impact on innovation and the regional economy?

+ Key Takeaways

- The interplay between universities, industry, and government—with physical proximity and close engagement—is critical to innovation.
- Institutional gaps—such as lack of access to funding and infrastructure for research—contribute to wide swaths of Americans being left out of the innovation ecosystem.
- STEM studies are a key pathway into the innovation ecosystem and high-tech economy. But many students that enter STEM programs in college are weeded out. If undergraduates have greater access to advanced research laboratories, it changes their trajectory in STEM. But, undergraduates, typically, do not have the research capability and equipment that graduate-level programs have.
- Universities must focus on producing career outcomes for students for the long-term. This includes working with industry to enable students to have a pathway from their studies into a job, into a career, and leadership in their field.

Across American history, place has always mattered. Stockyards and slaughterhouses were located in Kansas City and Chicago due to their proximity to cattle ranches. Cleveland and the North Midwest became centers of steel production because of proximity to deposits of iron ore. Film makers located in Hollywood because it had a predictable and warm climate enabling year-round filmmaking, and a geographic terrain offering diverse film backdrops. While the United States does not make many cars in Detroit anymore, the vast major of the world's automotive engineering is still there.

Physical proximity and partnerships among entities in the innovation ecosystem are important. The interplay between the university, industry, and government—with all three in proximity physically and closely engaged—is critical to innovation. For example, UC Davis is known for having among the world's best agriculture and veterinary medicine programs, and is ranked first in the Nation in both. It built this excellence by bringing together agriculture, agricultural economics, and agricultural policy, combined with strengths in human and animal health, environment, sustainability, and the engineering, business, law, and policy activities surrounding these areas of innovation.

The Honorable Deborah L. Wince-Smith, President & CEO, Council on Competitiveness; Dr. Kim Wilcox, Chancellor, University of California, Riverside; and Dr. Gary May, Chancellor, University of California, Davis.

UC Davis is home to the Mondavi Institute for Wine and Food Science, with departments on viticulture and enology, and food science and technology. The university is a pioneer in food, food as medicine, next generation food systems, and food policy. They intend to build on their traditional strengths and extent those to what they believe will be the next important areas of innovation—food and food systems. Food security is a huge issue throughout the world, and the United States is the world's largest exporter of agricultural products.

The California Air Resources Board build a half billion-dollar facility on the University of California at Riverside campus, and the automotive industry is clustering there to be near the people who set the standards for vehicles of the future. With the research, the university, and the Air Resources Board, Riverside can become the air quality research capital of the world and build that into a broader industrial center for America.

"I'm not trying to undermine our merit system for awarding grants in America, but we have to find some way to address this inequity because it isn't just an institutional inequity, it's a geographic inequity."

Dr. Kim Wilcox
Chancellor, University of California, Riverside

UC Davis's Aggie Square is being built as a new Sacramento innovation district, where companies, researchers, students, faculty, and community advocates all work side by side, and will connect the university with neighboring communities. In addition to cutting-edge research, UC Davis will provide training for up-and-coming industries and residents who live in the surrounding neighborhoods.

Institutional gaps contribute to wide swaths of Americans being left out of the innovation ecosystem. For example, about 900 U.S academic institutions had R&D expenditures in 2021, a total of about $90 billion. Of those, 24 had expenditures of $1 billion or more, 55 had a half billion or more, but more than 800 had R&D expenditures of $50 million or less. It is likely that the gaps between the billion-dollar R&D academic club and those institutions with far fewer resources will only grow. A school with $10 million in research funding does not have the same research infrastructure as schools in the billion-dollar club. Despite schools with far less funding being full of bright students, the billion-dollar club is simply more competitive in winning R&D grants and attracting R&D funding. The bright students in schools with little R&D funding are not going to have the same chance to be part of this innovation ecosystem and grow into it in the same way as their colleagues at the billion-dollar schools.

"It's really important to form these partnerships between the haves and have nots, so that those students who may not have access to some of the labs and state-of-the-art equipment can spend a summer or spend a quarter or spend a year at a university partner that allows them to have that access and to further their careers."

Dr. Gary May
Chancellor, University of California, Davis

STEM studies are a key pathway into the innovation ecosystem and high-tech economy. But many students that enter STEM programs in college are weeded out, and there is a shrunken population of American students moving into graduate level studies. In some areas of STEM, for example engineering and computer science, foreign students on temporary visas earn more than half of graduate-level degrees. Some experiences have shown that, if undergraduates have greater access to advanced research laboratories, it changes their trajectory in STEM. But, undergraduates, typically, do not have the research capability and equipment that graduate-level programs have, and there are only so many labs, so much equipment, and so many mentors. Undergraduate research experiences are also an important opportunity for community college students who transfer.

"Some of my colleagues at other places don't think that's part of their responsibility, that we owe students an education only. But I disagree strongly. I think we owe them access to a career."

Dr. Gary May
Chancellor, University of California, Davis

Universities must focus on producing career outcomes for students for the long-term. As part of their mission, it is incumbent on universities to give students a return on the investment their parents and they are making in the university. Universities need to work with industry to enable students to have a pathway from their studies into a job, into a career, and leadership in their field. That does not mean universities have to be vocational; they should still seek the highest levels of discovery and advancement for research. But, at the same time, they must be in the business of transforming lives. For places such as UC Davis, where 40 percent of students are first generation and from disadvantaged backgrounds, it is critical not only to the university and to those students and their parents lives, but also to the state and the state's economy. The same is true for University of California connections with community colleges. Universities in the system are expected to graduate an equal number of native freshmen and transfer students.

Paving the Path to 10x Innovation
Lessons from the National Commission on Innovation and Competitiveness Frontiers

? Key Issues and Questions

Inspired by the incredible speed and scope of innovation during the pandemic, the National Commission challenged the United States to increase by 10X its level and speed of innovation.

The Commission called for a big increase in Federal R&D spending, new strategies to secure U.S. leadership in critical technologies, new efforts to bridge the valley of death, and efforts to encourage more Americans to become innovators and entrepreneurs. Since then, the Biden Administration and Congress have launched plans to invest hundreds of billions of dollars in research, technology development, semiconductor manufacturing, infrastructure, clean energy, and STEM education and training. This will result in a flood of new research results, emerging technologies, and skills that could stimulate economic growth, productivity, new business formation, industrial development and expansion, new job creation, and U.S. global competitiveness.

- How can the United States ensure that it maintains leadership in critical technology areas, and why is it so important that we do so, in the face of increased global competition from other countries?
- How can the Federal government best allocate increased R&D spending to ensure maximum impact? What are the critical touch points or linchpins in the research enterprise?
- What are some potential roadblocks that could prevent the United States from achieving the goal of 10X innovation, and how can they be overcome?
- What infrastructure must be in place (physical and regulatory) for the United States to take full advantage of new research results, emerging technologies, and skills resulting from increased investment in research, technology development, and STEM education?
- Are current efforts enough to bridge the “valleys of death” between basic research, prototyping, scaling, and commercialization? How could they be improved to support increased innovation?
- How can we encourage more Americans to become innovators and entrepreneurs, and how do we ensure they have the skills and knowledge necessary?

+ Key Takeaways

- U.S. national laboratories play a crucial role in the U.S. innovation ecosystem, working at the forefront of science and technology in service of the Nation, for example, in national security, clean energy, sustainability, net zero and, increasingly, sustaining and advancing American economic competitiveness. They also provide opportunities for students to see science at scale, and world-class laboratory facilities and equipment, which may encourage them to pursue STEM education and careers.
- Partnerships with the private sector are essential to advance technologies being developed in national laboratories, to solve challenges that one university or one region cannot solve alone, and to provide enriching experiences for students pursuing studies toward STEM careers.
- To increase U.S. innovation, more Americans with a creative mind-set are needed. A study commission by the Academy of Arts University found that more than 90 percent of people felt they were creative, representing huge untapped potential. Studies in design and art can encourage people to think creatively about how to be innovative.
- The United States needs to nurture innovators from all demographic groups, and reduce barriers to furthering education, including experiencing art and design, for example, through open access policies and more flexible models of education.
- Priorities to address now to ensure future U.S. innovation and competitiveness include: counterbalancing China's efforts to shape global rules of the road, improving K-12 education, establishing White House-level leadership and coordination on competitiveness, expanding the footprint of innovation across the country, developing ways to identify areas of technology critical to economic and national security, steady and predictable Federal investment in R&D, upgrading intellectual property practices, priming the regulatory process to be ready to accept emerging innovations, developing measures of success for investments and stimulating innovation, ensuring that every child knows that they can be an innovator or run a business one day, and increasing technology and nuts and bolts training in K-14.

Panel

Dr. Steven Ashby
Director, Pacific Northwest National Laboratory
National Commissioner

Jaclyn Shaw
Interim Vice President for Research, Economic Development and Knowledge Enterprise, University of Texas at San Antonio

Elisa Stephens
President, Academy of Arts University

The Hon. Deborah L. Wince-Smith
President & CEO
Council on Competitiveness
National Commission Co-chair

MODERATOR

Chad Evans
Executive Vice President, Council on Competitiveness

Solid Phase Processing (SPP)

Historically, metal alloy and composite production has required that metal first be melted and then subjected to several energy-intensive steps—such as heat treatment, forging, rolling, and drawing—to produce end products. With SPP, metals are not melted, significantly decreasing the energy intensity of alloy and component manufacture. SPP applies mechanical energy—high shear strain—to the metals to create friction heat for deformation. This process enables the microstructure of the metal to be tailored to yield superior properties. As a result, SPP can circumvent the constraints imposed by conventional manufacturing methods, and produce materials and components with truly extraordinary properties.

U.S. national laboratories play an important role in the U.S. innovation ecosystem. It is the role of the U.S. national laboratories to be at the forefront of certain areas of science and technology in service of the Nation, for example, in national security, clean energy, sustainability, net zero and, increasingly, sustaining and advancing American economic competitiveness. Different national laboratories play in each of these areas. Pacific Northwest National Laboratory (PNNL) is working on a variety of them, for example, energy storage needed to address intermittence of renewable energy such as wind and solar energy integrated into the grid. In its Grid Storage Launchpad, PNNL works with industry to test prototypes up to 100 kilowatt hours before they're deployed at scale on the grid.

In advanced manufacturing, Oak Ridge and Lawrence Livermore National Laboratories have worked with industry to advance 3D printing and bring it to a variety of applications. PNNL is working to advance a very promising technology called solid phase processing. For example, using scrap aluminum, you can make tubing with extraordinary performance proper-

"I never would have thought about going to a national laboratory until I visited one as a graduate student. And it changed my career trajectory forever."

Dr. Steven Ashby
Director, Pacific Northwest National Laboratory

ties produced with 90 percent less carbon footprint and 50 percent energy savings compared to typical techniques.

The Federal laboratories have long led the way in computing and, today, PNNL is playing a key role in the quest for quantum computing. PNNL is working with industry to explore different ways of making qubits, the building blocks of future computers.

Each of these areas of technology advancement—in clean energy, manufacturing, and quantum—requires partnerships with academia, other national laboratories, and especially industry.

Partnerships are needed to solve challenges that one university or one region cannot solve on its own. For example, the University of Texas at San Antonio has a lot of the ingredients needed to drive technology innovation. But advancing technology and solving some challenges can be complex and require more resources. In these cases, UT San Antonio looks to its rich, dense ecosystem, which includes Federal defense-related partners, partners in health care and the digital economy, and even partners in Mexico since the university is uniquely positioned along the Texas-Mexico border. The university also partners with Oak Ridge, Sandia, and Idaho National Laboratories which have a presence on the university complex in San Antonio.

Currently, about 90 percent of UT San Antonio is outside of the city. About five years ago, a decision was made to expand the university footprint, and become an urban, Hispanic-serving institution in

"We shouldn't be competing on tax policy. We shouldn't be competing on regulatory issues that tie our hands so we can't do anything. There are whole classes of industrial activity we don't do in the United States because of treble damages and product liability."

Deborah L. Wince-Smith
President and CEO, Council on Competitiveness

downtown San Antonio, then drive their partners to be there too. In January 2023, the university opened a complex of multiple buildings that is going to drive innovation, entrepreneurship, and economic development for the city. This includes a new School of Data Science co-located and working closely with the university's National Security Collaboration Center. About 60 Federal, industry, and education entities contribute to the Center's ecosystem of partners, with several co-locating on campus. The university has built R&D capabilities and applied technology laboratories around it.

To increase U.S. innovation, more Americans with a creative mind-set are needed. Creativity is often misunderstood, with many thinking people have it or they don't. And some people say, "I'm not creative at all." An Academy of Arts University-commissioned study found that more than 90 percent of people felt they were creative, and more than 50 percent said they were known for being creative. We have a huge population of creative people, and art is where it all starts, with drawing and design, and how the idea gets put down on paper. Yet few have the courage to apply to an art school.

Mr. Chad Evans, Executive Vice President, Council on Competitiveness; Ms. Elisa Stephens, President, Academy of Arts University; Mrs. Jaclyn Shaw, Interim Vice President for Research, Economic Development and Knowledge Enterprise, University of Texas at San Antonio; Dr. Steven Ashby, Director, Pacific Northwest National Laboratory; The Honorable Deborah L. Wince-Smith, President & CEO, Council on Competitiveness

There is a big overlap between teams developing technology and innovations, and artists. The Academy of Arts University has eight STEM programs and emphasizes art, for example, in its car design program. The university has long partnered with the auto industry, and the industry is looking at what students can bring to the table for sustainability and lifestyle. University architecture, interior design, and fashion students also partner with industry on sustainability. AI is another example. Creatives think outside the AI box, and we are using AI in almost every field right now.

Technology is vital, and the university tries to stay six months ahead, but it is a challenge. Advertising agencies are using ChatGPT, Lexica, Dall-e, and Midjourney, but it's all moving very, very fast.

The United States needs to nurture innovators from all demographic groups. The Department of Energy has programs implemented by the national laboratories to expose students from underrepresented populations to national laboratory facilities and equipment. For example, the Pacific Northwest National Laboratory alone hosted about 1,000 interns last summer; about 40 percent undergraduate and 60 percent graduate students. For many of them, this is the first opportunity to see what science looks like at scale and have access to world-class equipment.

The University of Texas at San Antonio is one of only 21 Hispanic-serving institutes that are also a research-intensive R1 university, an opportunity to shape a demography that will be a major part of the future U.S. population. UT San Antonio works

to prepare students for in the region. This is a challenge because 20 of the poorest census tracks in the country are within the university's reach. UT San Antonio has a big social responsibility, while also driving the university agenda in "Military City USA" to support national security and defense. (San Antonio is home to one of the largest concentrations of military bases in the United States.)

The Academy of Arts University aims to give everyone an opportunity to experience art and design. The university offers a free tuition scholarship program for 2,000 high school students so they can see if they want to do art and design. The university has an open access policy, and does not require SATs or a portfolio, just a minimal high school GPA. They believe a person's past does not predict their future in art and design, and that transcends age. A person could be 35 and decide they want to now do art and design. The university has always been career-focused, and there is increasing focus today on technical training, trades, and flexible programming, for example, an education while working model or a certification.

Priorities to ensure future U.S. innovation and competitiveness. Panelists were asked what the United States needs to tackle now to be innovative and competitive for the next 50 years. Priorities identified include:

- Counterbalancing China's efforts to shape global rules of the road outside of the value system of liberal market principles, including standards.
- Improving K-12 education.
- Regulatory reform.
- Strengthening innovation infrastructure.
- Modernizing urban transit infrastructure, vital to the working population.
- Establishing White House-level leadership and coordination on competitiveness. (OSTP's mission does not capture many of the factors that drive competitiveness.)
- Creating opportunities to build vibrant innovation centers and innovators across the United States not just on the two coasts.
- Develop way to Identify areas of technology critical to economic and national security, where the United States need to lead, and recognize those are increasingly intertwined.
- Steady and predictable Federal investment in R&D, including in the national laboratories; this would also encourage people to commit to careers in the national laboratories.
- Upgrade intellectual property practices.
- As technology is developing, look beyond the valleys of death to the market in terms of the regulatory process to be ready to accept innovations.
- Develop measures of success for investments in technology, innovation, and regional innovation.
- In K-12, ensure that every child knows that they can be an innovator or run a business one day.
- Increase technology and nuts and bolts training at K-12 and junior college levels.

Keynote Address

Charting the Path: Energy Security and a Net Zero Economy

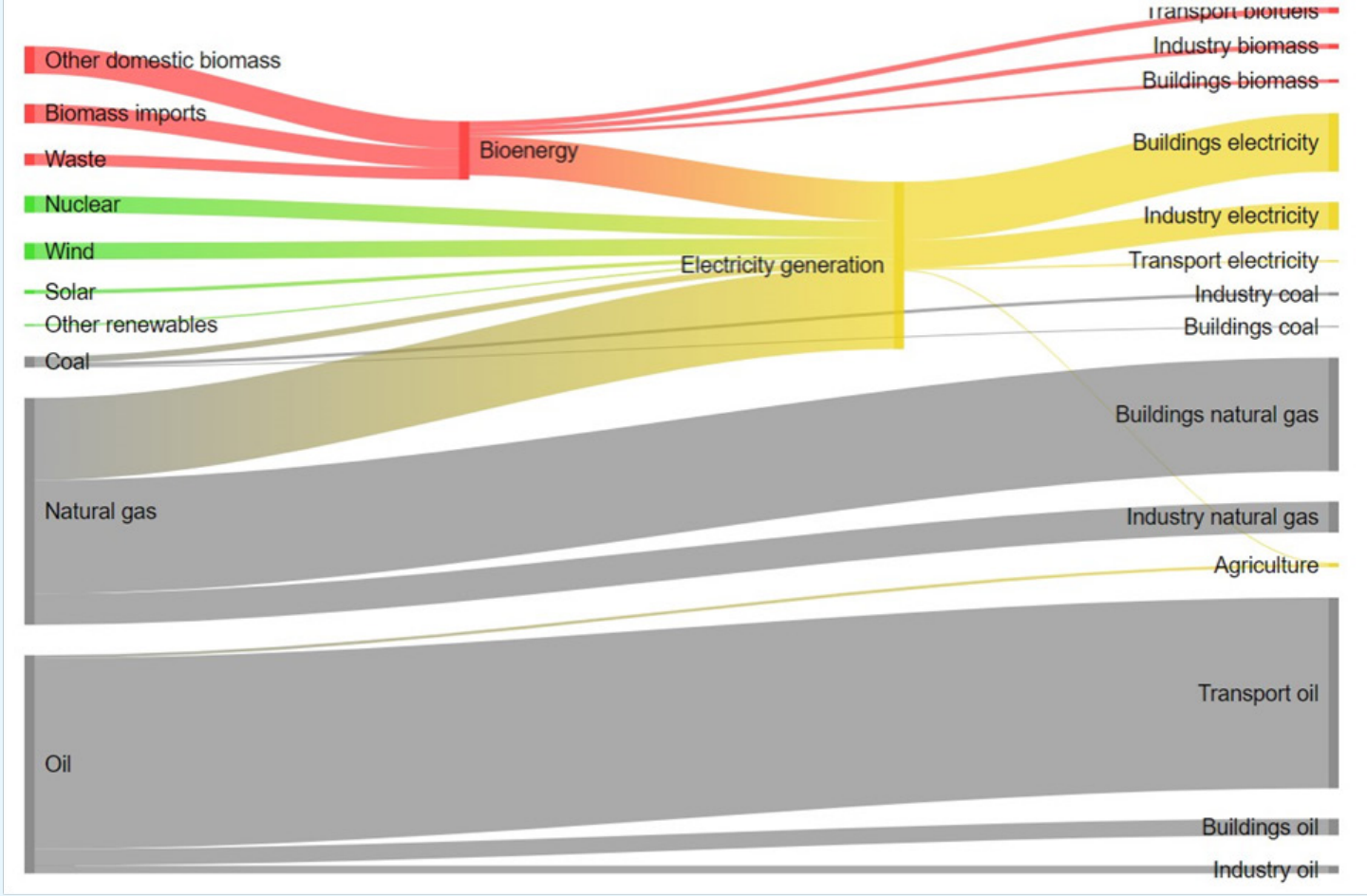
The Honorable Paul Monks
Chief Scientific Advisor, Department for Energy Security and Net Zero, United Kingdom

The recent IPCC *AR6 Synthesis Report: Climate Change 2023* states that global warming is more likely than not to reach 1.5°C even under the very low GHG emission scenario and likely or very likely to exceed 1.5°C under higher emissions scenarios. We need a sustainable, resilient, and measurable path to net zero, and those paths have to be right for the countries doing them.

U.K. goals. In 2019, the U.K. passed a Climate Change Act that set a goal of achieving net zero emissions by 2050, which would require a 100 percent reduction compared to 1990 levels. It also set legally binding five-year "Carbon Budgets" to act as steppingstones toward the 2050 target. On that pathway to net zero, the U.K. set a goal to reduce emissions 78 percent by 2035 during the 6th Carbon Budget period. The U.K.'s British Energy Security Strategy is a series of plans on reducing demand; improving efficiency; low-carbon solutions such as electrification, hydrogen, and carbon capture, utilization, and storage; low carbon energy; and land-use and greenhouse gas removal.

A great systems of systems problem. There are many interrelationships among sources of energy, usage sectors, industry, land, water, finance, and consumer behavior creating a systems problem in getting to net zero—and this challenge exists in a global context, in a global energy transition, and in global financial flows. There is also the political challenge of asking or telling people to do something. Forty-four percent of U.K. emissions savings will require the

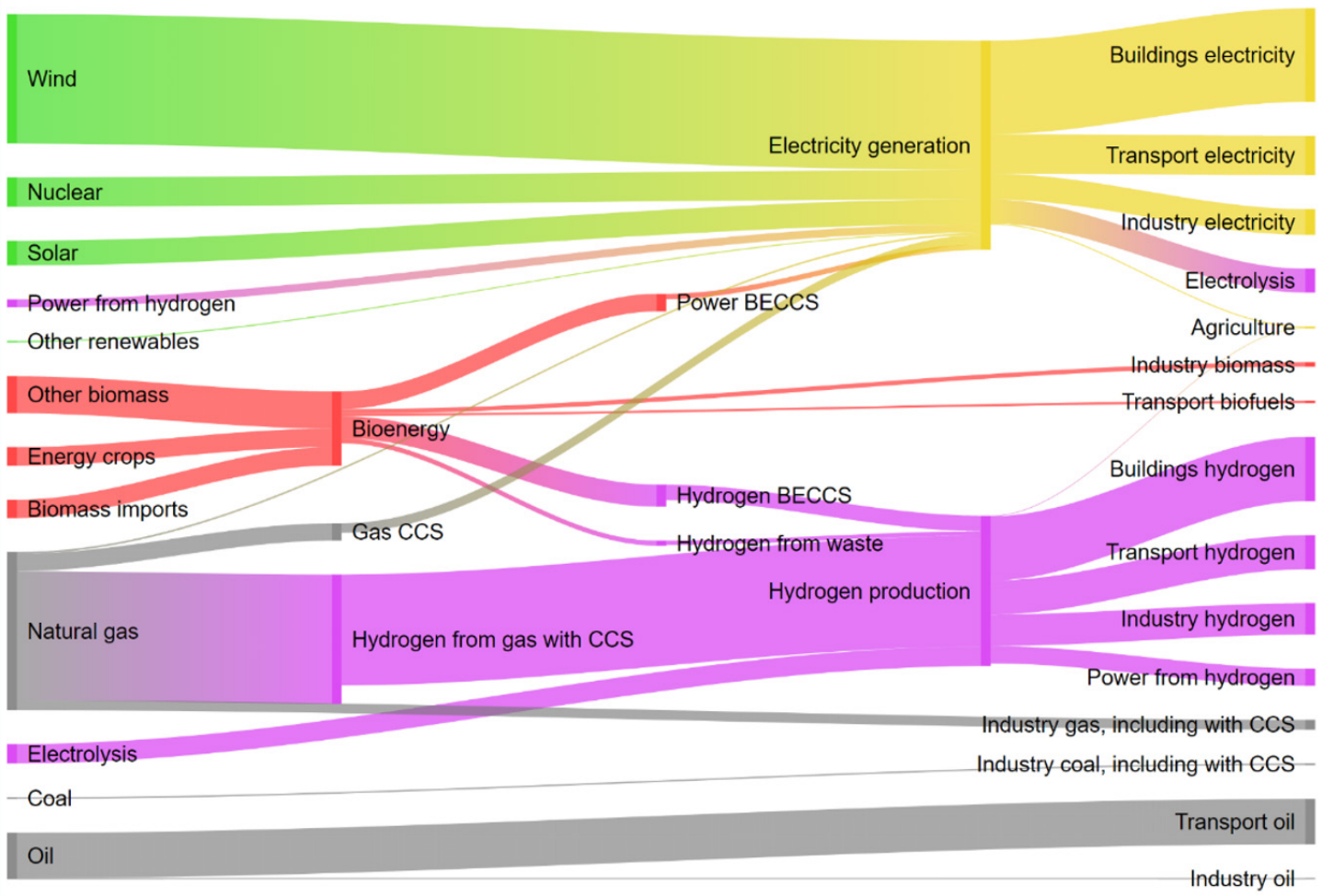
2019 Energy Sources and End Use
Source: UK Department for Energy Security and Net Zero



public to make green choices, so the green choice is being made the obvious choice and there is money to made in that. The U.K. has banned the sale of the internal combustion engine after 2030, Europe has banned the hybrid after 2035, and the U.K. is going to phase out gas heating—all of which is going to force big changes in the market and consumer choices. The system-of-systems challenge cannot be addressed solely with a technocratic and technological approach to decarbonization. A systems approach is needed with multiple small changes that make the system better and more optimized, and thinking about everything through the lens of net zero across transport, industry, power, land use, and buildings.

The U.K. transition to net zero. Coal is being phased out, and much of it replaced with natural gas. There is massive growth in renewables (wind and solar), and nuclear has been about 20 percent of base-load power. But to meet the 2050 net zero goal—and accommodate electric vehicles, electric heating, and electrification in other sectors—electricity demand could double, requiring an increase of 300 terawatt hours a day to 700 terawatt hours a day from low carbon energy. In the U.K. today, natural gas and oil play the biggest role. By 2050, in the high resource scenario, wind, nuclear, solar, and biomass play a much bigger role. The U.K. would still use a lot of fossil fuels, but the emissions would be largely abated.

High Resource Scenario: Energy Generation and End Uses in 2050
Source: UK Department for Energy Security and Net Zero



About half of the technologies needed to achieve net zero are already in the market, and need to be scaled. Challenges that need to be addressed include the hard to decarbonize sectors, large scale energy storage, and business models for financing. The U.K. Net Zero Research and Innovation Framework has five key enablers including digitalization, finance, policy, skills, and engaged citizens and sustainable choices.

The U.K. research and innovation ecosystem. The U.K. formed a new Department of Science, Innovation and Technology with a Secretary of State and cabinet minister, and much of the funding for science and innovation is under the department. The U.K. set a goal of R&D spending at 2.4 percent of GDP which has been achieved (2.93 percent in 2020), and exceeds the OECD average. The U.K. has a complex ecosystem of universities and businesses that work together alongside publicly funded laboratories and national academies.

In March 2023, the U.K. released a Science and Technology Framework as the strategic anchor for government policy. Action plans for each strand of the framework are being developed. Fifty technologies were assessed against criteria—such as sustainable environment, health and life sciences, national security and defense, and market potential—to identify those most critical to the U.K. The five identified are artificial intelligence, engineering biology, future telecommunications, semiconductors, and quantum technologies.

Focus of U.K. Science and Technology Framework

- Identifying critical technologies
- Signaling the U.K.'s strengths and ambitions
- Investment in R&D
- Talent and skills
- Financing innovative science and technology companies
- Procurement
- International opportunities
- Access to physical and digital infrastructure
- Regulation and standards
- Innovative public sector

The right balance between top down and bottom up is needed to build an innovation ecosystem. The U.K. recently launched an Advanced Research and Invention Agency (ARIA), modeled after the U.S. Defense Advanced Research Projects Agency (DARPA). ARIA will autonomously identify and fund high-risk, high-reward research, and operate with minimal bureaucracy, scientific freedom, and a high tolerance for risk and failure. This will set it apart from existing publicly funded programs that respond to the strategic priorities of government.

Charting the Competitiveness Agenda for 2023

Leadership Conversations on Innovation and Sustainability

The Future of Sustainability: Driving Leadership in the Path to a Zero Carbon Economy

? Key Issues and Questions

Sustainability and achieving net carbon zero are essential for the future competitiveness and economic growth of nations and companies. To achieve net-zero emissions by mid-century, the United States will need to: generate electricity using carbon net-zero sources, electrify as many industries and processes as possible, and upgrade energy infrastructure to efficiently store and transfer renewable generation. The Biden Administration set a goal of a carbon-free U.S. electricity sector by 2035. That will require a dramatic acceleration of renewable energy deployment or greater use of nuclear energy. In 2021, renewables accounted for about 20 percent of U.S. electricity generation, and nuclear about 19 percent. The Department of Energy says that meeting the 2035 goal is likely to require solar to supply 40 percent of U.S. electricity, but provides only about 3 percent today, and would have to grow by 20 percent each year for the rest of the decade, or even higher if near-term deployment is stymied by solar supply chain challenges, and substantial cost reductions (50-60 percent from 2020 benchmarks) are needed to make utility-scale solar electricity the lowest cost for electricity without subsidies. Wind energy deployment would need to increase three times the highest annual installation rate the United States has experienced to date.

It is increasingly clear that we must take bold action to reduce our carbon footprint and transition to a sustainable future. Achieving net carbon zero will require increased investments into new technologies, and a concerted effort from the Federal government and industry, as well as public-private partnerships to drive progress.

- What are the main challenges in achieving the goal of a carbon-free electricity sector by 2035, and how can these challenges be overcome?
- How can we best balance the need for renewable energy with other forms of energy production, such as nuclear power, and the fossil fuel sector which will continue to provide energy for decades?
- What role do you think public-private partnerships can play in accelerating progress towards net-zero carbon emissions, and how can these partnerships be fostered and sustained?
- What are some of the key technologies and innovations needed to achieve net-zero carbon emissions, and how can we accelerate their development and deployment?
- How can we ensure that communities and industries that have traditionally relied on fossil fuels for energy are not left behind in the transition to a sustainable future?

Panel

Dr. Todd Combs
Associate Director of Energy and Environment, Idaho National Laboratory

Dr. Helene Dillard
Dean, College of Agriculture and Environmental Science University of California, Davis

Paul Monks
Chief Scientific Advisor, Department for Energy Security and Net Zero, U.K.

Cooper Rinzler
Senior Partner, Breakthrough Energy Ventures

Dr. Cindy Powell
Chief Science and Technology Officer, Energy and Environment, Pacific Northwest National Laboratory

+ Key Takeaways

- The Biden Administration set a goal of a net zero emissions economy by 2050. This will require vast electrification using carbon-free electricity, infrastructure upgrades, reduced energy demand, and greater energy efficiency. Massive changes will need to be made in just a couple of decades.
- Nuclear power is one of the few proven options that could deliver clean electricity at the scale needed, but it is a very heavy lift. Licensing, and the scale and pace of deployment would have to ramp-up substantially; costs per kilowatt would have to be reduced dramatically; there needs to be a 5 to 10-fold increase in supply chains for fuel fabrication, high-assay low-enriched uranium, and other things; 3750,000 additional workers will be needed for the nuclear industry; and a solution will be needed to deal with spent nuclear fuel.
- Other key technologies needed include hydrogen, long duration storage, direct air capture, enhanced geothermal, floating offshore wind, carbon capture and sequestration, and decarbonizing industrial processing heating. Fusion would provide unlimited clean energy and there is significant venture capital investment in fusion technology companies.
- Creating sustainable aviation fuel is a challenge. Growing adequate biomass feedstock for e-fuels would require converting most food crops into fuel crops and food into fuel. A mixture of approaches is needed including improved efficiency, reducing demand, engine technology innovation, and more sustainable feedstocks.
- Agriculture is a good target for carbon reduction. Key technologies include solar and wind energy generated on farmlands, but advancements in energy storage are needed. Agrivoltaics, in which crops are grown or animals grazed under solar panels, is taking off. Storage of carbon in the soil is another approach. However, new agriculture technologies can be costly and have power issues.

- A substantial share of emissions does not come from things currently embodied inside the economy, including methane emissions from wetlands, cow burps, the chemistry used in cement production, the carbon used to make steel, and methane from growing rice.
- Half of the decarbonization problem can be potentially solved with existing solutions in the market today. Some of the 50 percent of problems not yet solved could, hypothetically, be solved within the current system if boundary conditions shift and create a more profitable solution for the market. But a substantial portion of solutions are prohibitive in terms of their economic advantage, which means boundary conditions of the market have to change. For example, there is no version of a carbon capture and sequestration solution that has positive economic value without regulation or a price on carbon.
- Consumer choice and behavior is also a challenge. For example, for some solutions, consumers would have to go outside of their incentive structure and take the more expensive or less convenient option. At the end of the day, the green choice will become the natural consumer choice when the green choice is cheaper than the alternative one. Investors are more constrained in terms of incentive structure, because they have a fiduciary obligation to maximize returns. Until you change the boundary conditions of the market and the drivers of profit incentive, investors are going to respond to the profit incentive because they are legally required to.
- Some communities are experiencing an environmental disbenefit in the transition. We cannot create another left behind class as we decarbonize the economy.

Dr. Cindy Powell, Chief Science & Technology Officer, Energy and Environment, Pacific Northwest National Laboratory; The Honorable Paul Monks, Chief Scientific Advisor, Department for Energy Security and Net Zero; Dr. Helene Dillard, Dean, College of Agriculture and Environmental Science, University of California, Davis; Mr. Cooper Rinzler, Senior Partner, Breakthrough Energy Ventures; Dr. Todd Combs, Associate Director of Energy and Environment, Idaho National Laboratory

The Biden Administration set an aggressive goal of a net zero emissions U.S. economy by 2050. Achieving this goal will require electrifying everything that can possibly be electrified, which will drive the need for more carbon-free electricity. Where electrification is not possible, alternative zero carbon or carbon negative pathways will be needed. In addition, the energy infrastructure will need to be upgraded, for example, to electrify the transportation system, and 500,000 electric vehicle chargers will need to be deployed across the country. We need to reduce demand, for example, reducing the vehicle miles traveled, get more public transit, and increase household energy efficiency, for example, by using more Energy Star appliances. Massive changes will need to be made in just a couple of decades.

Nuclear power is one of the few proven options that could deliver clean electricity at the scale needed, but it is a very heavy lift. Today, nuclear energy accounts for 20 percent of U.S. base-load power, and 50 percent of non-carbon-emitting electricity generation. The Department of Energy's *Pathways to Commercial Liftoff: Advanced Nuclear* report states power system decarbonization modeling suggests that, to achieve net zero by 2050, 550 GW to 770 GW of additional clean firm capacity is needed, and nuclear power is one of the few proven options that could deliver this at scale. Adding 200 GW of new advanced nuclear capacity would get the country to 300 GW from the current 100 GW. In addition, to unlock deployment of advanced nuclear at scale, capital costs may need to approach $3,600 per kilowatt, but are likely to start in the $6,200-$10,000 per kilowatt range.

There could be micro reactors with capacity in the 1 MW to 50 MW range, small modular reactors in the 50 MW to 300 MW range, and large 1,000 MW reactors. (1 MW of nuclear capacity can power about 800 homes per year.) This nuclear pathway will require about 375,000 additional technical and non-technical workers in the nuclear industry that universities and technical schools will need to produce.

"We also have issues of equity to consider. Who's going to benefit, small farms or large farms, and can we scale these innovations where everybody can benefit? We will need to pay more for food in this country…it's a hard choice to make. But that's how you pay for innovation in agriculture. And certainly we will need more private sector investment as well as massive government investment in food and agriculture."

Dr. Helene Dillard
Dean, College of Agriculture and Environmental Science, University of California, Davis

Most Gen IV advanced reactors require HALEU (high-assay low-enriched uranium), uranium enriched up to about 20 percent, but the current supply chain exists in Russia. The United States would require a five, six or ten-fold increase in supply chains for fuel fabrication, HALEU, and other things to achieve 200 GW of new nuclear capacity. There have been component and supply chain issues in the construction of the Vogtle nuclear plants in Georgia including the need for rework and remediation, and supply chain delays increasing costs. The Nuclear Regulatory Commission will need to increase the pace of licensing from the equivalent of about half a GW per year. Ultimately, licensing, manpower, and capability needs to reach about 13 GW per year by 2030. If that is delayed by five years, then 20 GW per year production thereafter will be needed to achieve the same 200 GW deployment goal, and could result in as much as a 50 percent increase in the capital required. In addition, a solution will be needed to deal with spent nuclear fuel.

"How do we make choices as an individual when it feels like we have such limited agency over the real problem?"

Cooper Rinzler
Senior Partner, Breakthrough Energy Ventures

Other key technologies are needed for energy transition and transformation. These include hydrogen, long duration storage, direct air capture, enhanced geothermal, floating offshore wind, carbon capture and sequestration, and decarbonizing industrial processing heating. Fusion would provide unlimited clean energy and now, in the United States, there is significant venture capital investment in fusion technology companies. The U.K. is launching a program to have the first commercial fusion power station on the grid by 2040.

Creating sustainable aviation fuel is a challenge. To make e-fuels of any type, renewable carbon and low carbon energy is needed. However, growing adequate biomass feedstock would require converting most food crops into fuel crops and food into fuel. For example, globally, to replace the amount of aviation fuels used today with e-fuels made from biomass, it would take 120 percent of global agriculture production. A mixture of approaches is needed including improved efficiency, reducing demand, engine technology innovation, and more sustainable feedstocks.

Agriculture is a good target for carbon reduction. Key technologies include solar and wind energy generated on farmlands, but advancements in energy storage are needed. Agrivoltaics, in which crops are grown or animals grazed under solar panels, is taking off. Storage of carbon in the soil is another approach. In Canada, they are capturing heat from data centers and using it to heat greenhouses built nearby and also run some electronics in them. Micro irrigation is another solution.

However, new agriculture technologies can be costly and have power issues. For example, electric tractors can be expensive for smaller farm operations and need to be charged, but many rural farms are located in areas with limited power. Large farm operations need the power that fossil fuel tractors provide. Agrivoltaics could help address the power issue. In addition, the future agricultural workforce needs to be trained to operate the future farm, not the farm of the 1940s, but that is expensive to do.

A broader perspective than net zero economy is needed. A substantial share of emissions do not come from things currently embodied inside the economy, for example, wetland methane emissions.

Cow burps are a major issue. If cows were a country, they'd be the third largest emitter. California is working on methane reduction through regulations on dairy farms. Feed additives can reduce cow methane emissions. Currently seaweed in the best feed additive, but it cannot be sustainably produced in enough quantities to feed the cows.

Big heavy industry is very tough. For example, cement has the highest emissions per dollar value material we make. But more than half of the emissions from cement production come from the chemistry, not from the energy used. Carbon is an integral part of making steel, but not just as an energy source used. Ammonia for fertilizer is an issue, and there are significant methane emissions associated with growing rice. About half the radiative forcing impact of aviation is actually not energy use, but related to aerosols in the atmosphere that can create more, but smaller cloud droplets, reducing the rain that falls, or warming the surrounding atmosphere causing cloud droplets to evaporate. This problem can be addressed but a solution has not been implemented.

Market realities. Half of the decarbonization problem can be potentially solved with existing solutions in the market today, so the focus should be on speed and deployment, and changing consumer behavior and willingness to accept a better and cheaper solution. Some of the 50 percent of problems not

"Having attended a tribal meeting last week, it's clear that communities are already falling behind with the energy transition. The closure of fossil generation stations leaves communities in great need, both in meeting their electricity and revenue demands. We need to move quickly so underrepresented communities are not further left behind."

Dr. Todd Combs
Associate Lab Director, Energy and Environment Science & Technology, Idaho National Laboratory

yet solved could, hypothetically, be solved within the current system if boundary conditions shift creating a more profitable solution for the market. But a substantial portion of solutions are prohibitive in terms of their economic advantage, which means boundary conditions of the market have to change. For example, there is no version of a carbon capture and sequestration solution that has positive economic value without regulation or a price on carbon.

From the consumer perspective, this is a massive problem. Whatever you do doesn't really matter because you are affected by what everyone else does in aggregate. There are opportunities for the consumer, and obligations on the public and private sectors to help enable consumers make green choices. For example, when there is a good solution with an advantage from a cost or value perspective—for example, improving air quality in the home or reducing the cost of transport—we need to make it easy to make that green choice.

For some solutions, consumers would have to go outside of their incentive structure and take the more expensive or less convenient option. While that may be feasible for higher income groups, that is not a solution that sums up to a totality for solving the problem. We must enable more of the potential choices for consumers who make the underlying decisions to align with the green incentive. The power of the vote is on average more powerful than the power of the dollar even today in the U.S. democracy. So, it is important to enable consumers to feel the agency of participating in the regulatory and policy process by showing up and voting. At the end of the day, the green choice will become the natural consumer choice when the green choice is cheaper than the alternative one.

Consumers can value whatever they want. But investors are more constrained in terms of the incentive structure. For example, consumers can value a Tesla because it is a good-looking car, and that does not change whether or not it has a green or economic advantage. But investors have a fiduciary obligation to maximize returns. To accelerate innovation and transition, we need investors to apply the lubricant of finance in the right place. But until you change the boundary conditions of the market and the drivers of profit incentive, investors are going to respond to the profit incentive because they are legally required to.

Some communities experience an environmental disbenefit. For example, if there is an onshore wind farm nearby then, perhaps, that community should get cheaper energy. There are ways to incentivize the customer to make the green choice. But we cannot create another left behind class as we decarbonize economies.

U.S. national laboratories are playing a key role in advancing new clean energy technologies. The Department of Energy national laboratories are involved in large scale public-private projects—for example, $4 billion projects in which the government and industry each contribute half the funds—such as the Advanced Reactor Demonstration. National

laboratory staff are embedded in these projects on a daily basis providing R&D and decades of experience in their research areas to boost these projects. The department is supporting the establishment of hydrogen hubs.

The national laboratories have a lot of user facilities at various scales. For example, there are massive user facilities such as the Advanced Proton Source at Argonne National Laboratory and the Spallation Neutron Source at Oak Ridge National Laboratory. At Idaho National Laboratory, the Biomass Feedstock National User Facility works on early stages of the supply chain, for example, how you bring in biomass from the field, optimize it, and get biomass feedstock data to companies so they can produce biofuels and other products. About half of the work is related to sustainability in the area of municipal solid waste—how you bring this waste in, process it, and then get data to industry so that they can build value-added products.

Third party validation is another role the national laboratories play. For example, the Idaho National Laboratory spent a year testing a company's high temperature electrolyzer for producing hydrogen. It performed very well and is being scaled to support hydrogen hubs and the hydrogen industry.

The Future of Innovation—Developing and Deploying Technology at Speed and Scale

? Key Issues and Questions

Innovation is the lifeblood of progress and economic growth. As we look to the future, developing and deploying technology at speed and scale is essential to creating a sustainable, prosperous, and equitable world. A tornado of technology is sweeping the landscape, transforming every domain of human existence at every scale. During the next two decades, the evolving dimensions, disruptions, pace, and impact of technological change are likely to increase and fundamentally reshape civilization—its economy, business, society, and human experiences. These technologies—and the products and services they enable—will revolutionize entire industries and transform how people work, live, learn, interact, and experience the world. They will create new competitive advantages for nations that are able to lead the way with rapid development and deployment at scale, supported by a domestic innovation ecosystem. At the same time, China seeks to supplant the United States as the world's technological leader, and has strengthened its technological capabilities through decades of increased R&D investment, and absorption and theft of foreign technologies and intellectual property.

- How can the United States best position itself to compete with China and other countries that are investing heavily in technological innovation? How do we scale domestically?
- With the passage of the CHIPS and Science Act last year, the United States took a major step towards embracing a form of industrial policy, particularly as it relates to the semiconductor industry. Is this the right path for the country to follow? Is this the right role for government policy and investment in supporting technological innovation and ensuring that value—jobs, businesses, and products—is created here in the United States?

+ Key Takeaways

- The United States has systems and processes that worked fine when things did not change very quickly. However, these are not well suited for today's environment of rapid change.
- Traditionally, the United States refrained from adopting an industrial policy. However, recent legislation such as the CHIPS Act is getting close to industrial policy. This shift recognizes that the Federal government can no longer set the agenda just by investing in R&D and through its purchasing power.
- Collaboration and partnerships enable innovators and innovating institutions to move much faster than is possible working alone. For example, university research partnerships with industry help ensure universities are working on the right problems, and workforce partnerships with industry and government help ensure universities are teaching the right things.
- Universities receive Federal funding for research in support of national interests, but also receive investment and support from states with the goal of economic development. Universities must ensure there is alignment, and leverage the interests of both.
- Universities can play a powerful role in nurturing and supporting innovators and prospective entrepreneurs. They can invest in and create an ecosystem for new venture incubation, mentoring, network development, and entrepreneurship education.
- Lines between commercial and defense technology are blurring, but have not totally disappeared. Where technology for national security is well aligned with commercial technology, there are great opportunities to build new markets and innovate faster. However, defense has some unique requirements. Even in those areas, there may still be opportunities, but may require exploring new business models.
- International cooperation may enable innovation and scaling of technology at faster speeds. However, as technologies get closer to national defense, the United States needs to protect technology we do not want to share.

Dr. Albert Pisano, Dean and Walter J. Zable Distinguished Professor, Jacobs School of Engineering, University of California, San Diego; Dr. Joseph Pancrazio, Vice President of Research and Innovation, University of Texas at Dallas; Dr. Sally C. Morton, Executive Vice President, Knowledge Enterprise, Arizona State University; Dr. Andre Marshall, Vice President of Research, Innovation, Economic Impact, George Mason University; Dr. Valerie Browning, Vice President for Research and Technology, Corporate Technology Office, Lockheed Martin; Dr. Thomas Mason, Laboratory Director, Los Alamos National Laboratory.

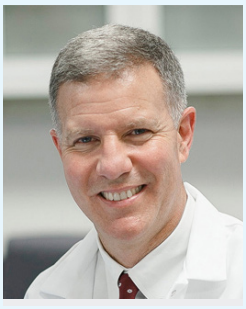
Panel

Dr. Valerie Browning
Vice President for Research and Technology
Corporate Technology Office, Lockheed Martin

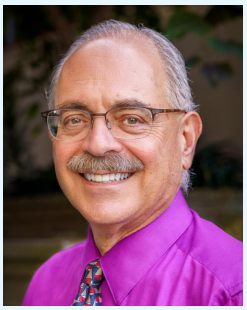
Dr. Andre Marshall
Vice President of Research, Innovation, and Economic Impact
George Mason University

Dr. Thomas Mason
Director, Los Alamos National Laboratory

Dr. Sally C. Morton
Executive Vice President, Knowledge Enterprise, Arizona State University



Dr. Joseph Pancrazio
Vice President of Research and Innovation, University of Texas at Dallas



MODERATOR

Dr. Albert Pisano
Dean and Walter J. Zable Distinguished Professor
Jacobs School of Engineering, University of California, San Diego

The United States needs to do things differently to accelerate innovation in an era of rapid change. The United States has systems and processes that worked fine when things did not change very quickly. However, these are not well suited for today's environment of rapid change. We have better tools for research and technology development that did not exist 40 years ago, and that is part of the solution.

The United States is stepping into industrial policy. Traditionally, the United States refrained from adopting an industrial policy. To the extent it had one, it was a policy of spending money on R&D and defense. However, some recent legislation, for example the CHIPS Act, is getting close to industrial policy. This shift, with semiconductors being a prime example, recognizes that the Federal government can no longer set the agenda just by investing in R&D and through its purchasing power, despite semiconductors being crucial for both national and economic security. The government is irrelevant in the semiconductor business and that required a different approach. However, for emerging technologies where it would be desirable to deploy at speed and scale, but no industry and capability at scale, there may be a role for Federal investment in innovation, particularly when there is a national security need.

If innovation is driven by need and enabled by discovery, the strategy becomes self-evident and self-motivating. This requires a process for identifying, understanding, and prioritizing capability needs based on their urgency and impact on national, economic, and climate security. This includes assessing the broad spectrum of very complex and dynamic challenges driving those needs. That understanding creates both focus and direction for innovation, but also incentive and motivation to innovate with purpose and urgency. Enabling the discovery needed for innovation requires the ability to survey and scour the broad landscape of technologies that could be advanced to provide capabilities and solutions.

"Los Alamos is a national security lab, and we function in an environment where actually, quite frankly, for the last 30 years, we haven't had to go very fast… And now, all of a sudden, we find ourselves in a situation where we are being asked to go very fast. And we have built up systems and processes and ways of doing things that work just fine when you weren't doing anything quickly and actually are not so well adapted to an environment where we're facing rapidly evolving changes."

Dr. Thomas Mason
Director, Los Alamos National Laboratory

Collaboration and partnerships enable innovators and innovating institutions to move much faster than is possible working alone. For example, university research partnerships with industry help ensure universities are working on the right problems. If universities only work with academic partners in research, they may not understand applications and the need to develop new technologies at speed and scale. When it comes to transdisciplinary research and translation, universities need to work with those outside of academia. In workforce development, partnerships with industry and government help ensure universities are teaching the right things.

Universities need to balance state interests and Federal interests. Universities receive Federal funding for research in support of national interests, but also receive investment and support from states with the goal of economic development. With both Federal and state partners, universities must ensure there is alignment, and leverage the interests of both. The National Science Foundation's Regional Innovation Engines program is an example; both the Federal government and state government make an investment. As the United States experiments with new models of innovation, we need a "learning innovation system" to generate knowledge, collect data, and apply what we learn in the future.

Society must be a partner to ensure the country has people able to employ new technologies. This includes not only educating undergraduate and graduate students, but also community college students, the community, and cultivating interest in innovation among K-12 students. Technology can play a key role. For example, Arizona State University is teaching introductory biology to more than 3,000 students via augmented reality, and with educational outcomes better than those students taking those classes in the regular lab. Many students do not have access to large laboratory machines and equipment, and augmented reality has the potential to bring that capability to students and others.

Universities can play a powerful role in nurturing and supporting innovators and prospective entrepreneurs. Universities can invest in and create an ecosystem of venture development and partnerships with a local community that enable faculty, students, and those who will become entrepreneurs of the future to engage with that ecosystem.

For example, the University of Texas at Dallas established an Institute for Innovation and Entrepreneurship that spans the entire university and involves programs for students and faculty to develop and bring their technologies from the bench toward the marketplace. Also, the university has five centers, mostly industry-facing, in the Richardson Innovation Quarter, part of the Dallas Urban Innovation Corridor. However, it can take years to develop that culture at universities but, when you do, you start to see payoffs in terms of start-up companies, licenses, and licensing opportunities.

Arizona State University has an Entrepreneurship + Innovation Institute, and tries to nurture entrepreneurship in all of its students, and give them the

University of Texas at Dallas
Institute for Innovation and Entrepreneurship Programs

- Big Idea Competition (student pitch competition)
- Blackstone LaunchPad (mentoring and network development)
- Bridge Venture Fellowship (venture capital career exploration for underserved students)
- CometX Accelerator (student teams incubate ideas and engage prospective customers)
- Entrepreneurship Mindset Bootcamp (helps students learn an entrepreneurial approach to work and life balance)
- GalXc Accelerator (entrepreneurship education, training, networking, and mentoring for female students)
- UT Design Startup Challenge (capstone course to help bring high-potential tech start-ups to life)

tools and agency that will enable them to use what they learn. This includes programs where students apply and compete for venture capital for various ideas. But, in other universities, a cultural change is needed.

The National Science Foundation Accelerating Research Translation program provides grants of up to $6 million each to build capacity and infrastructure for translational research at U.S. universities to enhance their role in regional innovation ecosystems. The National Science Foundation I-Corps is another model. It is an immersive, entrepreneurial training program that prepares scientists and engineers to move their research projects toward commercialization,

One challenge for state-funded universities is that they may not be able to use state money to help fund new start-ups. The National Institutes of Health Research Evaluation and Commercialization Hubs (REACH) program includes eight proof-of-concept hubs with 51 universities and technical colleges participating. It provides financial support for technology development projects, including those in spinouts from universities, that have advanced from scientific discovery into the early stages of product development.

"I think the real issue for academics is that we are not prone to risk taking. The promotion and tenure process, as you know, is very incremental. The single academic paper by an individual researcher makes one step forward and results in tenure. We need to change that culture. And many places are starting to do that, including my own institution. But how do we allow faculty, how do we incentivize them, to take risks, and how to we teach them how to do that, train them on IP and technology transfer? That's a fundamental change that has to take place at universities. I think it's happening slowly. I don't think it's happening quickly enough."

Dr. Sally C. Morton
Executive Vice President, Knowledge Enterprise, Arizona State University

"There is a win-win where there is really good alignment between defense technology needs and what the commercial world is innovating."

Dr. Valerie Browning
Vice President for Research and Technology, Corporate Technology Office, Lockheed Martin

Lines between commercial and defense technology are blurring, but have not totally disappeared. Where technology for national security is well aligned with commercial technology, there are great opportunities to build new markets, innovate faster—particularly on the defense side—because the defense industry can leverage the investments the commercial industry is making in a broad range of technologies. However, defense has some unique requirements, for example, deploying technology in areas without ready access to power, or size and weight constraints. Even in those areas, there may still be opportunities, but may require exploring new business models, and new types of collaboration between the defense industry and commercial industry to ensure that the needs of the defense industry are met.

The United States needs to draw a balance between international cooperation in technology and protecting U.S. technology. Foreign entities use both legal and illegal methods in competition with the United States. As Congress weighs increased investment in science and technology, there is debate over ensuring that U.S. taxpayers, rather than China, ultimately benefit from the investments taxpayers are making.

International cooperation may enable innovation and scaling of technology at faster speeds. However, as technologies get closer to national defense, the United States needs to protect technology we do not want to share.

"The situation is that the United States finds itself competing with autocratic governments that are investing heavily in technological innovation. US companies are competing with a government. So, you're not only competing with the companies and the technology and the people, you're competing with the person who's making the rules."

Dr. Albert Pisano
Dean, Jacobs School of Engineering University of California, San Diego

The development of GPS is an example of defense technology that led to commercial benefits. Johns Hopkins Applied Physics Laboratory set up a system to measure the position of Sputnik as it flew overhead using three ground stations that measured the time differential of the beep, beep, beep, and triangulated that. Then physicists at the Hopkins Laboratory had the idea that, if we had three satellites, a position on the Earth's surface could be determined by the same timing and triangulation. That solved a really important problem—how to locate and target Russian Cold War submarines when they emerged. That became GPS. DARPA made it easy for companies to manufacture receivers. The power of the Federal government driven by national security imperatives got GPS deployed, and then it got out of the way and let the private sector take over. There was a lot of protection around the development of the technology but, in the end, it became open for innovation.

"If we adopt purely defensive measures, I believe we will fail. What do I mean by that? If we just say, well, the solution is we want to erect higher and higher walls then, in fact, the byproduct of that is we will have less stuff worth protecting. That's true because there is a benefit to being engaged internationally, and trying to get stuff out quickly inevitably means you're trying to disseminate it. If your sole strategy is to try and ratchet that back, you get to a point where you don't have to worry about theft because you've got nothing worth stealing."

Dr. Thomas Mason
Director, Los Alamos National Laboratory

The Future of Innovation—Cutting-Edge Tech and Over-the-Horizon Opportunities

? Key Issues and Questions

The world is experiencing an unprecedented wave of technological innovation, with powerful technologies scaling at an incredible rate. The widespread deployment of sensors and connected devices has created a state of hyperconnectivity, driving the datafication and quantification of human existence. The deployment of autonomous systems and robots is rapidly expanding, reaching new areas of application, providing new capabilities for national defense, and extending into sectors ranging from healthcare to personal transportation. Artificial intelligence is now hitting the mainstream in a range of applications. Biotechnology is also shifting into high gear, as new gene-editing tools enable researchers and producers to achieve rapid and precise results. Convergence of seemingly unrelated areas of science and technology is creating a new innovation space, leading to new innovations at the intersection of disciplines such as nanomedicine, biocomputing, and ecological economics.

However, even more disruptive technologies are on the horizon. General AI has the potential to transform society, the economy, and human production by scaling scientific discovery and innovation to unimaginable heights, and revolutionizing the way we live and work. Quantum science has the potential to solve previously unsolvable problems, and be a game-changer in fields involving complex problems and systems such as medicine, encryption, and materials development. Genomic technologies could enable large-scale environmental restoration and nearly unlimited capacity for data storage on DNA. Human augmentation is also being explored, Including innovations to augment human cognitive processes and expand perception, and mechatronics to augment human strength and motion. “Materials by design” could replace off-the-shelf materials with novel and functional materials that exhibit previously unimaginable or unattainable properties.

- As seemingly unrelated areas of science and technology are converging, new crossover opportunities are arising in the innovation space. What are you seeing at the intersections of disciplines and domains that you think could be competitiveness game changers for the United States?
- As we consider technology at the cutting edge and we see things like ChatGPT disrupting everything from college essays to computer programming, what concerns you during this time of rapid technology deployment?

+ Key Takeaways

- Culture is a vital factor in innovation. The United States has long had a culture that fosters innovation and creativity, allowing ideas to flow and flourish, and that culture needs to be maintained and updated. Also, the United States tends to do the ethical and right thing for people and its citizens.
- To foster innovation and creative thinking, organizational culture must allow the right amount of risk taking. Matrix and flat organizations, rather than hierarchy, help the innovation process because people do not have to have permission to go up a chain, but instead can go to anyone and talk about ideas and innovations.
- Research and the innovation ecosystem must have persistent and steady investment.
- It is critical to know who the talent is and where you find them. Once that talent and their work in the research lab is recognized, they should be nourished and fed.
- Educating in computing is vital. For the future, not only do we have to educate people to be creative and entrepreneurial in STEM fields, but also educate them in understanding how computing is permeating all of society and how it's changing the way we do business, how we learn, how we create, and how we drive businesses forward.
- Telework works. A key lessons is the need for a very adaptable workforce and, if you give them better technology, they can perform their jobs better and more efficiently.
- Cities are ground zero for change and need to be ready for it. Today, cities are in a state of dynamism primarily due to the remote work phenomenon, including business districts and public transit, snowballing into homelessness and crime issues. Looking to the future, most change will happen in and to the people who live in cities.
- Artificial intelligence/ChatGPT, quantum, and space have the potential for competitive advantage accruing to the United States.
- Partnerships are needed. The more we share problems, the more we will know about them, and the more we will be able to solve them. The United States needs to fund an environment where we can experiment with new kinds of partnerships, try many things, and tolerate failure.

Culture is a vital factor in innovation. From AT&T Bell Labs to Silicon Valley, the United States has long had a culture that fosters innovation and creativity, allowing ideas to flow and flourish. This culture needs to be maintained and updated.

To foster innovation and creative thinking, organizational culture must allow the right amount of risk taking. Also, matrix and flat organizations, rather than hierarchy, help the innovation process because people do not have to have permission to go up a chain, but instead can go to anyone and talk about ideas and innovations.

Also, the United States tends to do the ethical and right thing for people and its citizens. Not all governments work that way. For example, about 40,000 lives are lost on U.S. highways annually. If there was a law that required everyone to drive an autonomous vehicle because it would save 30,000 lives a year, is it unethical not to create that law? If there is a belief that fewer lives will be lost with machines doing the decision-making, and not falling asleep or drinking on the road, would that be the right choice?

Persistence is crucial for discovery and innovation. Research and the innovation ecosystem must have persistent and steady investment. For example, the Department of Energy recently announced a major advancement in fusion energy. The breakthrough came on one day in December 2022, but it has been 60 years coming. The breakthrough came at the National Ignition Facility, which experienced decades of development and construction challenges, with rising costs, and delays that worried Congress. However, Ed Moses, the project director appointed in 1999, had faith; it would be one of the bigger inventions and investments that the United States has made this century, but he trusted that the advancement would come.

In another example of persistence, LIGO—the Laser Interferometer Gravitational-Wave Observatory—was designed to open the field of gravitational-wave astrophysics through the direct detection of gravitational waves predicted by Einstein's Theory of Relativity. The original instrument, a proof-of-concept model, did not make any detections for years.

> "At a company, one thing you have to start with is a culture where there's the right amount of risk taking; create incentives for your teams that push them beyond maintaining the status quo."
>
> **Tom Mildenhall**
> Global Head of Technology Partnership Development
> Bank of America

But enormous strides were made in detector engineering that were applied to the observatory's interferometers when they were overhauled. The Advanced LIGO project improved the capabilities of the detectors and, within days of beginning its first run with the new and improved instruments, LIGO made its first detection of gravitational waves, generated by a pair of colliding black holes some 1.3 billion light years away, and many more gravitational wave detections have since been made. With continued refinement and upgrading, LIGO's detectors will achieve a sensitivity 10 times greater than Initial LIGO, bringing 1,000 times more galaxies into our observational range.

Talent and scouting talent are crucial to innovation. It is critical to know who the talent is and where you find them. And, once that talent and their work in the research lab is recognized, they should be nourished and fed to encourage them to continue.

A company needs ways to stay in touch with what's going on and what's out there to help it develop talent in that area, and to make sure that employees are reskilled and retrained to stay up-to-date. Also, it will help the company retain talent; if employees are not working on the most cutting edge and new innovative things, they won't want to stay, creating a retention risk.

Educating in computing is vital. Computing is everywhere. In educating people for the future, not only do we have to educate them to be creative and entrepreneurial in STEM fields, but also educate

"I think the U.S. has a competitive edge because of our country's ethics, our attitudes and our belief framework which in anchored in doing the right thing. That is our biggest advantage."

Dr. Tommy Gardner
Chief Technology Officer
HP Federal, HP Inc.

them in understanding how computing is permeating all of society and how it's changing the way we do business, how we learn, how we create, and how we drive businesses forward.

We need to focus also on the edge between people and computing with human-centric design. With powerful computing technologies, such as AI, we need to understand the risks; and understand that, when AI comes to a decision, it may not be from the same sense of understanding that humans have, and there is no way to validate or quantify it.

Telework works. During the COVID-19 pandemic, companies and other organizations had to make a huge pivot in a very short period of time. For example, Bank of America sent 40,000 workers home with laptops, but had to acquire the computers. Zoom was critical but not secure. Cybersecurity is vital to Bank of America; it faces attacks at a scale that most of the private sector does not face, and spends about $1 billion a year on cybersecurity. Bank of America worked closely with Zoom to enhance the security of its product used at the bank.

A key lessons is the need for a very adaptable workforce and, if you give them better technology, they can perform their jobs better and more efficiently. At Bank of America, some employees were able to shift jobs and do something completely different—such as banking branch employees shifting to call center work from home—with the right amount of training.

"Think about being able to type something in. It literally will create a video from scratch out of thin air…So, the cost for someone doing something in a video game or music or something goes low enough you can do it with an iPhone, instead of millions and millions of dollars."

Tom Mildenhall
Global Head of Technology Partnership Development
Bank of America

Cities are ground zero for change and need to be ready for it. Eighty percent of the population resides in urban areas, and 90 percent of U.S. economic output comes from urban areas. Today, cities are in a state of dynamism primarily due to the remote work phenomenon. Central business districts are different than they were. They're not vibrant because people aren't coming into the office 40 hours per week. This is also having a significant impact on public transit systems. Ridership is off by about 50 percent, creating a snowball effect in terms of homelessness and crime issues.

Looking to the future, most change will happen in cities and the to the people who live in them.

Louisville, Kentucky is historically a manufacturing logistics town. In 2016, the Brookings Institution laid out the top ten cities most at risk for automation. Cities love top ten lists when it comes to being the best at something such as best at tourism, best at number of jobs, best bourbon. Louisville did not want to be the eighth city in the country most at risk for loss of jobs from automation. This is true for many American mid-sized cities, cities that aren't on the coasts, aren't the top five cities getting the innovation dollars. The vast majority of America has a serious workforce development problem, and cities

Mr. Tom Mildenhall, Global Head of Technology Partnership Development, Bank of America; Dr. Tommy Gardner, Chief Technology Officer, HP Federal, HP Inc.; The Honorable Patricia Falcone, Deputy Director for Science and Technology, Lawrence Livermore National Laboratory; Dr. Padma Raghavan, Vice Provost for Research and Innovation, Vanderbilt University; Ms. Mary Ellen Wiederwohl, President and CEO, Accelerator for America; Chad Evans, Executive Vice President, Council on Competitiveness.

are the places that problem occurs and where it has to be addressed through partnerships. Leaders need to focus on getting more people trained to innovate, but we are not doing this at scale. It is going to take investments at the local, state, and Federal levels.

Accelerator for America works at the intersection of the public and private sector. It launched I3—a new Innovative Infrastructure Initiative—which will try to take cities in a cohort approach into greater depth in use of technology. Most cities have technology, and many have chief innovation officers or chief data officers. But there are many demands on a city budget and the time of city leaders, so these types of initiatives get put on the back burner. Accelerator America is trying to pull these things forward and give city leaders a safe space in which to learn and grow, and try things out.

On-the-horizon technology for U.S. competitive advantage. Several areas of technology and their applications have the potential for competitive advantage accruing to the United States.

Artificial intelligence is likely to be embedded in a lot of industries, and could become a differentiator in software across difference spaces from cyber to data or anywhere else. And, for other emerging areas of technology and opportunity—from quantum to space—AI may not be separate, but a layer on top of all of that, making it all more automated, faster, and better.

For example, with AI-based systems such as ChatGPT, the cost to produce content could go really low. There are companies now where you can type in text and it will do text-to-video, and music and other things can be added. Entertainment is one of the United States' top global exports.

"A decade ago, as autonomous vehicles were this thing we were talking about, city leaders were scrambling to think we had to redesign our cities in order to figure out AVs, and what were we going to do with our rights of way and new technology. And then, of course, the technology got so good we didn't have to redesign our cities. We just have to get used to it ourselves."

Mary Ellen Wiederwohl
President and CEO, Accelerator for America

"Experimentation flourishes when we're able to break down boundaries separating universities, the private sector, and national labs. The more we can intentionally engage across those sectors through long-term, trusted partnerships, the more innovation will thrive. In that process, we should not be afraid to fail, and learn from failure to create something new."

Dr. Padma Raghavan,
Vice Provost for Research and Innovation, Vanderbilt University

The U.S. could be the leader in quantum.

Space is another area of opportunity. Several companies are using additive manufacturing—3D printing—to produce rockets and parts for space-bound craft such as propulsion, turbomachinery, engines, and high-pressure storage tanks in days rather than months. This enables accelerated innovation, faster time-to-orbit, and faster time-to-market. The world's first 3D printed rocket was launched in a test in March 2023.

Partnerships are needed. The more we share problems, the more we will know about them, and the more we will be able to solve them. The United States needs to fund an environment where we can experiment with new kinds of partnerships, try many things, and tolerate failure.

As an example of partnership, the Quantum Economic Development Consortium (QED-C) is a consortium of stakeholders that aims to enable and grow the quantum industry. QED-C was established with support from the National Institute of Standards and Technology as part of the Federal strategy for advancing quantum information science and as called for by the National Quantum Initiative Act of 2018. It has more than 250 member partners spanning the private sector, academia, and national government.

When it comes to new technologies, particularly in advanced energy or carbon capture and sequestration technologies that people have to accept, there needs to be training. When we invest in developing prototypes, we should also have training programs at the same places, where we're training people for the new jobs. For example, that would require partnerships between universities and people who work on

"There are concerns about the government picking winners and losers. And that's valid. But we need to move away from thinking about specific companies that win or lose and instead be laser focused on smart investments that will move our economy forward."

Dr. Tommy Gardner
Chief Technology Officer, HP Federal, HP Inc.

prototyping technologies, and the communities that might receive the technology. It could require mixing of funds to pay for training, the facilities you need for training, and also for new technology. That is not just a classroom or a standard laboratory, so someone would possibly have to pay for students to travel from the regions where it will be deployed. But we don't have programs that would fund something like that, and rules for spending government funds may not accommodate it.

Keynote Address

A New Era for Placed-Based Innovation

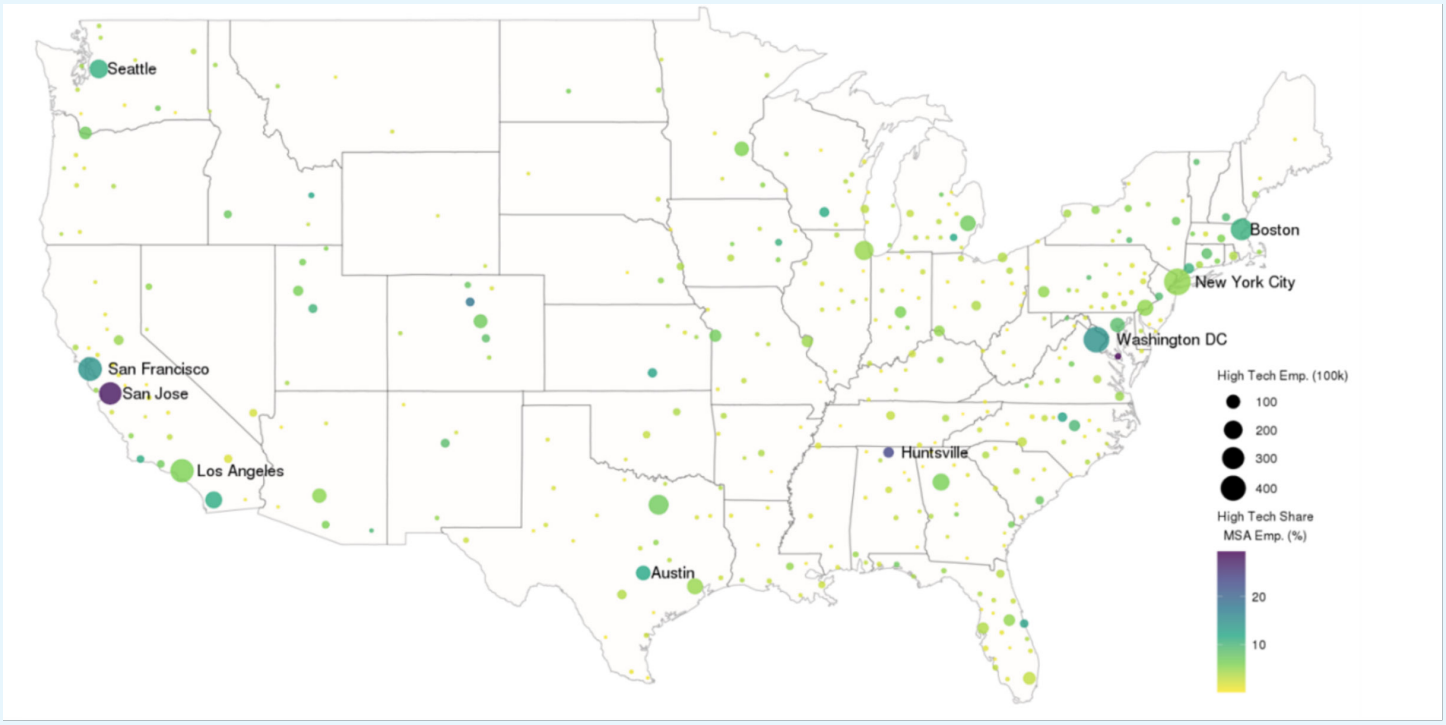
The Honorable Jed Kolko
Under Secretary of Commerce for Economic Affairs, U.S. Department of Commerce

Geographic inequality—the spread between high-income and low-income places—has steadily widened in the United States. The growing gap is at least as much about the top places pulling away as it is about the bottom places falling further behind. There has been relatively little movement in which places are high and low income, and high and low education. Ranking by educational attainment—percent of population holding a bachelor's degree—looks almost the same in 2020 as it did in 1980. When places have moved-up in economic rankings, it is almost always because an industry or a company took root and created a sustainable agglomeration that drives income growth, and workforce development that lifted educational attainment.

There is strikingly less geographic mobility. Possible reasons include high housing costs that prevent people from moving to places with greater economic opportunity, or occupational licensing making it hard for people in some careers to continue to practice their work if they move to a different state. This makes closing economic gaps harder, since people are less likely to move where incomes are higher and opportunities richer.

Despite changes resulting from the pandemic and remote work, the geographic pattern of economic activity changed fairly little. Migration patterns during the pandemic look largely like pre-pandemic patterns. Most people moved within metros, not across the country or between labor markets.

High Tech Employment and Employment Share in 2020 in U.S. Metropolitan Statistical Areas
Source: U.S. Census Bureau



Local economic challenges vary across the United States. In some declining but also in some thriving places, it is housing affordability. Some places lack infrastructure, others struggle to attract talent, while others need to create opportunities for existing residents. Lack of a diverse industrial base can be a problem because industries and companies rise and fall.

If programs aim to combat geographic inequality by targeting distressed places, investments may be needed to build capacity or infrastructure. If programs are focused on boosting competitiveness, places with higher capacity are better prepared to boost regional and national competitiveness in a range of technology fields.

There is a new and distinct focus on placed-based investments in the Biden Administration. For example, the Department of Commerce is administering more than $100 billion in placed-based investments. The Economic Development Administration's (EDA) $200 million Recompete Pilot Program seeks to revitalize regions with unusually low employment rates. The National Telecommunications and Information Administration is investing tens of billions of dollars to bring broadband to unserved and underserved communities. These two program are focused more on narrowing geographic gaps, on places in more distress, and are industry agnostic.

EDA's Tech Hub program has a half billion dollars to create and seed new technology or innovation hubs across the country. It is focused on places with higher capacity, and aims to boost regional and national competitiveness in technology fields. The $50 billion CHIPS Act program is focused on supporting domestic semiconductor manufacturing and related activities. This effort is about finding the places and companies with the greatest capacity to do this work although, in practice, CHIPS investment will be transformative in whatever local economy that receives the money. Other place-based programs include the National Science Foundation Regional Innovation Engines program, and the Department of Energy's program to establish regional clean hydrogen hubs.

There is momentum for place-based policies. There is growing focus on supply chains, resilience, and critical goods, for example, U.S. dependency on semiconductor production concentrated in Taiwan. It is resilience-building not to have an entire sector concentrated in an area prone to natural disaster or dependent on a power company's shaky grid. Also, much of U.S. politics is geographically-based, Congressional districts are geographically-based and, increasingly, partisanship is correlated with education level. As a result, geographic inequality may be contributing to political polarization. Also, distressed places cross the political spectrum. There are blue places struggling and red places struggling, a kind of inequality that could find bipartisan support to help address.

There has been an intellectual shift within economics about place-based policies. The traditional view among economists was you help people not places, for example, help people move to places with better economic opportunity. Other disciplines were more sophisticated in understanding place-based policies and economic development, and economists are catching up. Another traditional view in mainstream economics is the value of agglomeration—industries are more productive when they agglomerate together, fostering innovation, random exchange of ideas, making it easier for workers to find jobs with alternatives if one company fails. However, with the opioid crisis, deaths and despair, and geographic concentration of economic and social distress, there is a sense that it is an externality. It is harder to thrive in places that aren't thriving. Economists are also recognizing limits to agglomeration such as housing supply and congestion. In a world where, in practice, housing supply is near inelastic in places that score highest on traditional productivity measures, then the way to get growth in innovation is not to just add to existing agglomerations, but rather to encourage additional tech hubs and centers around the United States.

Whether it is the government, private sector, or non-profit, investing in places is hard. It is hard to pick the right places. Program goals have to be clear: are the right places those with the most capacity or those in greatest distress, and it is hard to measure both capacity and distress. Different measures of distress tell different stories. The places with the highest unemployment in the United States right now are not the same as the places with the slowest growth. Also, you want to avoid zero sum games, having localities competing with each other with tax breaks to lure companies from one state to another. This is not where most job creation comes from. Rather it comes from new establishments being born or existing ones expanding.

Data and research are essential for getting all these things right. The Department of Commerce is launching a new Regional Economic Research Initiative to provide research data products and data services to help inform place-based policies. The initiative will bring together and showcase the local and regional data that exist within the federal statistical system and beyond, and track where federal investments are being made across multiple programs. The aim is to improve program design, implementation, and evaluation.

Expanding Place-based Innovation and Opportunity

? Key Issues and Questions

The United States has long been a leader in technological innovation, with major hubs such as Silicon Valley and Boston's Route 128 attracting top talent and investment from around the world. However, while these centers of innovation generate significant economic growth and job creation, many communities across America are left out of this high-tech economy. These communities often lack the infrastructure, resources, and expertise needed to foster innovation and attract investment.

As a result, they lag behind in R&D and venture capital investment, which are critical drivers of innovation and economic growth. In addition, they struggle to develop and retain the talent necessary to drive innovation, leaving them at a significant disadvantage compared to high-tech hubs. This lack of access to the innovation economy risks creating a bifurcated country with stark disparities between high-tech centers and rural or rust-belt communities. Without intervention, these underserved communities are likely to fall further behind and miss out on the benefits of the innovation economy.

Federal agencies plan to inject billions of dollars to stimulate the development and growth of new regional technology and innovation hubs, and new research and innovation capacity. In addition, the planned generational Federal investments in research and technology development could help build innovation assets in these under-served communities.

- Are there potential solutions to address the disparities in innovation and investment across different regions in the United States that are not a part of current efforts associated with the CHIPS and Science Act and similar efforts?
- How can the government work better with private industry to promote innovation and investment in underserved communities?
- What role can academia play in promoting innovation and economic growth in underserved communities?

+ Key Takeways

- Globalization and economic shifts have left many American cities and towns behind. The government and other institutions have not always paid attention to these declining cities and towns, and rural communities have been ignored too. Underserved and underdeveloped urban communities have a lot of issues similar to rural communities.
- Every region and rural area has talent, innovative people, and assets. They do come up with creative solutions, but need to build institutions of excellence and may be missing things such broadband, functional public schools, or public services.
- Places with little opportunity lose their young people and, if you do not have a population to build on, companies are not going to be able to grow there and scale-up.
- Focus on the local, and match resources with need, opportunity, and capacity. Local institutions and leaders have greater on-the-ground awareness, and being aware of the surroundings is important because no one solution fits all.
- Universities are good at identifying what is needed in a town, community, or region because they are embedded in these places. Universities can provide sustainability for placed-based initiatives because they will exist in those places for the long term.
- When considering place-based investment, it is important to think about goals and what is to be accomplished, for example, investments in distressed communities where there is no capacity versus investment in communities with capacity.
- Partnerships—for example, among elected officials, government, business leaders, universities, foundations, and philanthropists—can drive revitalization of cities and towns.
- Change is difficult in large complex organizations, such as educational institutions. Embedded culture can be difficult to overcome. However, times of crisis—such as budget cuts or the COVID-19 pandemic—may offer an opportunity to do new things and make changes more quickly, laying the foundation for the longer-term.

Panel

Dr. Suresh Garimella
President, University of Vermont

Dr. David Greene
President, Colby College

Dr. Shashank Priya
Vice President for Research, University of Minnesota

Dr. Ed Seidel
President, University of Wyoming

MODERATOR
Josh Parker
Chairman and CEO, Ancora L&G

Globalization and economic shifts have left some American cities and towns behind. Cities and towns up and down the coasts and across the Midwest have been left behind. For example, Waterville, Maine was a mill town. It had both textile mills and paper mills for over 100 years, completely sustaining the economy and middle-class income for people. But during the 1970s-80s, the mills and their jobs disappeared. The city has been on a slow decline and losing population for decades. The government and other institutions have not always paid attention to these declining cities and towns. In places like Waterville, there is distrust of political institutions, educational institutions, government, and democratic principles. Rural communities have been ignored as well. And underserved and underdeveloped urban communities have a lot of issues similar to rural communities.

Places with little opportunity lose their young people and, if you don't have a population to build on, companies are not going to be able to grow there and scale-up. There is capital everywhere, but investors are encouraging people and companies to move out of places where they could actually build. The University of Wyoming loses 70 percent of its graduates to other states. Wyoming needs to create opportunities for people inside the state. It is focusing on entrepreneurship, but does not have a critical mass anywhere, so it must have partnerships. At the National Commission's Mountain West Innovation Summit, Wyoming's leaders were exposed to people on the national scene that could become partners, such as the national laboratories. After the Summit, they convened a National Lab Day.

Cities and towns in decline, and rural areas do have assets, innovative people, and come up with creative solutions, but they may be missing other things such as institutions of excellence, infrastructure such as broadband, functional public schools, and public services.

"For many of the people who live here, there's been a sense for a long time that everything has been urban, urban, urban in terms of U.S. policy. And places like Waterville, a small city, have been the places that have been completely ignored."

Dr. David Greene
President, Colby College

Wyoming has ten times as much energy as it uses. So, it is a big exporter of energy. It has a lot of water that comes from the Tetons that ends up in Los Angeles Basin, so it is a very important source of water. These things are important for the whole nation.

Focus on the local, and match resources with need, opportunity, and capacity. Local institutions and leaders have greater on-the-ground awareness, and being aware of the surroundings is important because no one solution fits all. In working with the states, sometimes the Federal government thinks communities or regions in a state are very homogeneous, and they are not. Each part of a state is very different.

For example, the Twin Cities in Minnesota is very urban, while Morris and Crookston are rural. The Twin Cities are on the cutting edge of research, so the focus there is innovation, intellectual property development, and commercialization. Morris has sunshine and wind, so they are focused on growing the infrastructure for generating solar and wind energy. Crookston is very agricultural, so they are thinking about next generation agriculture and the infrastructure to advance that. In Mower County, the goal is to bring together farmers in the region, the university, and local companies to work together to develop next generation seeds and animal breeding

"We also have assets. It's not just about why it's important to help out rural states because they're part of the United States, but they have assets that are important for the whole nation."

Dr. Ed Seidel
President, University of Wyoming

Mr. Josh Parker, CEO, Ancora; Dr. Ed Seidel, President, University of Wyoming; Dr. David Greene, President, Colby College

strategies, with the hope of bringing vendors in and mobilizing the population because they want to get jobs. Rochester is close to the Mayo Clinic, so the university is developing the Bio-imaging Center, a one-stop shop for imaging a disease, computationally modeling it, and drug trials.

Similarly, the University of Vermont has some great work in insurance and actuarial science, and an institute on small scale sustainable farming and food systems. They are successful because they are both important and relevant to the Vermont economy.

Universities are good at identifying what is needed in a town, community, or region because they are embedded in these places. They are in continuous conversation with leaders in the state. Once a university identifies a project, government can help it execute the project at speed. Also, projects can be launched, but then need to perform at expectation for years to come. Universities can provide that sustainability, because they will exist there for the long term.

When considering place-based investment, it is important to think about goals and what is to be accomplished, for example, investments in distressed communities where there is no capacity versus investment in communities with capacity. Also, look at places that are doing something right, where there is momentum, where the partnerships are rich, compelling, and effective. Those places can show other cities and institutions that revitalization is possible because we cannot have just one city thriving and booming in a state.

Partnerships can drive revitalization of cities and towns. For example, Waterville, Maine brought together 25 leaders from across the city, including elected officials and business leaders, and got a planning grant from a foundation. The group got a sense of purpose that they could work together and develop a plan for the city that would give it new hope. Waterville got a commitment from the community, and is investing $200 million in the downtown area, including in two new art centers, a new hotel, and downtown housing for 200 Colby college students who are engaged in the city, and supporting business, civic, and community organizations. There is also an effort in digital economic development, and a coworking and innovation space. This revitalization effort involved a partnership between private philanthropists, foundations, government, and Colby College, which put in $33 million of its own funds.

The change has been dramatic. For the last four years, the population of Waterville has been increasing. Job growth has outplaced job growth in the state. Income levels in the county are twice what they are in neighboring counties. Homes that never saw an equity increase are now seeing prices going up. And new private investments are finally coming for the first time in generations.

"We're best when we take on local problems by working with our local communities and local industry, and apply local wisdom."

Suresh Garimella
President, University of Vermont

The University of Vermont recently launched an Institute for Rural Partnerships, supported by a $9.3 million award from the U.S. Department of Agriculture. The new institute will combine the resources and expertise of multiple University of Vermont entities to help find solutions to problems that rural communities face. In its "spin-in" model, partnerships with community-based groups seeking academic expertise will be seeded and supported by the university, so they are in a better position to find community-based solutions. An Innovation and Research Incubator will allocate funding and technical assistance to teams of collaborators comprised of university faculty, students, staff, and external partners. The awards will fund research projects, stakeholder engagement initiatives, student internships and service-learning experiences, and business plan development for early-stage start-ups and non-profit businesses working to address rural challenges. The institute will also provide intellectual property and SBIR help across the state, similar to what they provide to the university's faculty.

In one of the small towns in Mower County, Minnesota, there are about 40 different languages being spoken. That creates a very attractive proposition for various populations to migrate and move from different part of the country. If opportunities and jobs are created, and you have schools and housing, people will find friends in that community, and they can see their kids and family growing in there.

Driving change and overcoming cultural barriers is challenging. Embedded culture can be difficult to overcome. However, times of crisis—such as budget cuts or the COVID-19 pandemic—may

"I think this topic of migration would be a great topic for us to promote. If we can lower the burden for people to move from state to state and from out of the country to in the country, we can add additional talent that will generate new growth and ultimately better pay and quality of life for people in our local workforces."

Dr. Shashank Priya
Vice President for Research
University of Minnesota

Testbed Helsinki

As part of its "A Place to Grow" strategy, the City of Helsinki established Testbed Helsinki to make it easy for companies and other partners to test solutions in an urban environment through a single channel. The goal is to support product development, new business opportunities, and strengthen the city's own innovation capabilities and cooperation possibilities with companies. The city's development and testing platforms—known as testbeds—are physical or virtual environments accessible to all partners of the city. Development and testing of new products and services are carried out in real-life conditions together with companies, city staff, end-users, universities, polytechnics, and research institutes. The city's resources, such as buildings or data, as well as service units, such as schools and health centers, are used as product development environments.

Dr. Ed Seidel, President, University of Wyoming; Dr. David Greene, President, Colby College; Dr. Suresh Garimella, President, University of Vermont; Dr. Shashank Priya, Vice President for Research, University of Minnesota

offer an opportunity to do new things and make changes more quickly, laying the foundation for the longer-term.

University of Wyoming President Ed Seidel faced challenges selling the university on a school of computing and statewide program on software engineering, cyber security, and AI. Fewer students than expected applied for the program because they weren't being guided there. Adults and counselors were still thinking how they grew-up in mining and agriculture, and some saw efforts to change as undermining the way of life of the State of Wyoming. Also, the largest town in Wyoming has about 70,000 people, and Wyoming is about the size of the United Kingdom—very low population density. People want the economy to grow, but do not want to make the state population any bigger.

A university board may have a business or financial mindset, looking for the financial return on a place-based investment. But it is a social good. If done right, it will create a sustaining economy for the city, the college or university will be stronger, and the ability to attract talented people to the area will improve significantly over time.

"When you think about where it's worth investing, and the government should be investing in this, it shouldn't only be looking at the Chicagos and LAs and San Francisco and Boston. They're doing fine. What you should be doing is looking at these under represented places that are actually doing something and already demonstrating real progress with institutions, cities, foundations, working together to make a difference. Those are the places that, to me, are worth a bet."

Dr. David Greene
President, Colby College

"There can also be geopolitical barriers to collaboration. State rivalries can inhibit collaborations that might otherwise serve to drive economic benefit for all. For example, having university employees live remotely in rival state because of the benefits they can bring the home state from afar can be seen as problematic."

Dr. Ed Seidel
President, University of Wyoming

Expanding Participation in the Innovation Ecosystem—Bringing in the "Missing Millions"

? Key Issues and Questions

Mega trends are affecting U.S. labor markets, the occupational mix in the country, what people do on the job, and the skills they need to compete and succeed. U.S. workers are caught up in a

turbulent economy shaped by globalization, shifts in economic drivers, hyper global competition to perform the world's work, and rapid technological change. The economy is now driven by ideas, information, and the constant application of new technology. Advances in automation, artificial intelligence, and other technologies are changing the way many jobs are performed, creating new opportunities for workers with specialized skills in areas such as data analysis, cybersecurity, and software development.

As a result of these mega-trends, the demand for workers with greater knowledge and skills is on the rise. Employers are looking for workers who can think critically, solve complex problems, and adapt to changing circumstances. Being a part of the innovation economy is crucial not just for the competitive performance of our nation as a whole through economic growth, productivity, etc., but also for individuals to increase wages and have opportunities for entrepreneurship. But today, many Americans are not part of a high-tech economy or innovation ecosystem, or benefit from the wealth and jobs they create. Many potential innovators and entrepreneurs do not view themselves as part of this system. We are leaving people behind, and not fully leveraging our innovation and entrepreneurial potential.

- What role do different organizations need to play in ensuring that workers who are not part of the high-tech economy or innovation ecosystem can access the education, skills, and opportunities they need?
- Is the Federal government doing enough to bring the missing millions to the innovation table? How about state governments?
- DEI has become controversial in certain circles, yet there's no question as to the importance to U.S. competitiveness of encouraging and facilitating the participation of individuals from diverse backgrounds and communities to participate in the innovation economy and become innovators and entrepreneurs. How can we move beyond the politics and back to the policy?

Panel

Maj. Gen. Ed Bolton
Senior Advisor, Diversity, Equity, and Inclusion
The Aerospace Corporation

Dr. Robert Johnson
President, Western New England University

Dr. Elizabeth Loboa
Provost, Southern Methodist University

MODERATOR
Van Ton-Quinlivan
Chief Executive Officer, Futuro Health

+ Key Takeaways

- The Census Bureau forecasts that the United States will be a majority-minority country in about 20 years. It is essential that we bring a broader population of Americans into higher education and workforce development, and provide opportunities to build generational wealth and help their families be successful.
- We must think about the full K-20 education system and workforce development pipeline, and establish a diversity of pathways through it.
- The United States needs models and partnerships to connect less resourced higher education institutions and community colleges to opportunities and assets for innovation.
- In a world of rapid change, higher education institutions need to give young people a skill set to get a job, but also a mind-set to learn, unlearn, and relearn as a steady state.
- Employers play a key role in partnering with the education community to provide students opportunities to learn about jobs, industries, and the work environment.
- Internships can make a big difference when it comes to students being successful in school and in their first job.
- Universities need to communicate better about what they do, to push back on the current diminished trust the public has in them.
- The United States and its employers need to examine the impact of remote work on employee development and work organization.

"You have to have a broader spectrum of people in this great country see a path to success. And I believe we've lost that. I believe we have lost some emphasis on that."

Maj. Gen. Ed Bolton
Senior Advisor, Diversity, Equity, and Inclusion, The Aerospace Corporation

It is essential that the United States bring a broader population of Americans into higher education and workforce development. The Census Bureau forecasts that the United States will be a majority-minority country in about 20 years. A broad population of Americans needs to make it, to get to college or be the first person in a family to go to college to build generational wealth and help their families be successful. There is a direct correlation with education and lifelong earnings, and that is likely to be true for years to come.

College is tied to personal success. But over 2009-2020, undergraduate college enrollment declined for some groups. According to the Department of Education, American Indian/Alaska Native enrollment decreased by 43 percent, white enrollment decreased by 25 percent, Black enrollment decreased by 21 percent, Hispanic enrollment increased by 42 percent, and Asian/Pacific Islander enrollment remained steady. However, all racial/ethnic groups had lower undergraduate enrollment in fall 2020 than in fall 2019. Enrollments rates at four-year colleges rebounded from 2020 to 2021. But public two-year colleges saw a 9.3 percent decline over that period, with a 13.6 percent decrease for black students, 11.9 decrease for white students, 8.1 percent for Asian students, 7.3 percent for Hispanics, and 7.1 percent for Native Hawaiians and Pacific Islanders.[1] Four-year college enrollment rates of the 2021 cohort increased the most at colleges with the lowest shares of Pell students. By contrast, two-year college enrollment rates declined the most at colleges with the lowest shares of Pell students.[2]

"I think community colleges specifically have to go back to the future; that is, focus on the things that they do best. Stop trying to be technical, /comprehensive and/or provide associate degrees. There should be some technical schools. There should be some two-year degree schools. There should be some skill specific schools and go from there…I think our HBCUs play a very critical role in this D-I pursuit in terms of building our workforce."

Dr. Robert Johnson
President, Western New England University

1 Figure 4: Percentage Change in Regression-Adjusted Enrollment Rates of the 2021 Cohort Compared to the 2020 Cohort, by Race/Ethnicity, College Enrollment and Retention in the Era of Covid: Fall 2021 Update on Continued Pandemic Impacts, College Board, October 2022.

2 Figure 19: Percentage Change in Regression-Adjusted Enrollment Rates of the 2021 Cohort Compared to the 2020 Cohort, by Pell Share, College Enrollment and Retention in the Era of Covid: Fall 2021 Update on Continued Pandemic Impacts, College Board, October 2022.

"Understanding that my son and daughter, who are now 27 and 29, will have upwards of 17 jobs in five different industries, three of those industries don't even exist. We're educating young people for jobs. We can't just give them the skill set."

Dr. Robert Johnson
President, Western New England University

We must think about the full K-20 education system and workforce development pipeline, and establish a diversity of pathways through it. For example, students at a rural junior college may not aspire to be an engineer. However, if they are shown pathways, and the processes are easy and streamlined, such as how to get financial aid, more students could push through. For example, Southern Methodist University launched Access SMU. Full-time, first year students who live in Texas, enter SMU directly from high school, receive a Pell grant, and have a high enough GPA can receive a financial award and attend the college for free.

The Harvards and Yales of the world only enroll about 5 percent of all college-going students. The other 95 percent of higher education institutions need to look at student success, outcomes, placement rates, and jobs. These universities need to create an ecosystem, and industry can partner with local colleges and universities as part of that ecosystem. These universities also need to develop a faculty and staff that look like and reflect the communities they serve. Also, not everyone goes to college, but may still seek skill development.

Internships can make a big difference. One of the biggest building blocks and difference makers when it comes to being successful in school and the first job, particularly for people of color, is having an internship, and it compounds with the second and third internships. Students can start an internship as a freshman at a company, and build on that with a summer long, multiple year opportunity.

"There's one thing about the distrust and it's across the political spectrum. It used to be only the far right who were suspicious of higher ed for whatever reasons. Now the far left also have serious concerns. And, frankly, there's just a distrust in higher ed at a level that I haven't seen. So, I think part of what's inherent on us is to communicate better about what we do, and we need to think about the accountability or the metrics or what can we do ourselves personally at our own institutions to push back that distrust."

Dr. Elizabeth Loboa
Provost, Southern Methodist University

We need models to connect less resourced colleges and communities to innovation assets. Smaller communities, diverse communities, and rural communities are served by smaller education institutions and local community colleges that have limited resources to tap into opportunities and assets for innovation. The United States need models to connect these communities to the exciting work going on at high-tech companies, national laboratories, and major research universities.

For example, in a suggested model, a set of partnerships could connect around a National Academy of Engineering grand challenge or something similar with a hub institution with primary expertise at the center, with spokes going out to a multitude of other institutions, companies, and local governments. Another potential model is sending faculty to the campus of a university that is a world leader in areas of science or technology, where they can learn the fundamentals and take them back to their schools seeding that knowledge at the local institution.

Prepare students for a job and with learning agility for a future of change. Many young people and young workers will have multiple jobs and work in multiple industries, some of which do not exist today. Western New England University sees its job as helping students get that first job and then every job thereafter, even if they work for the same company or organization for the next 20 years, even if they are getting stackable credentials such as a certificate in cybersecurity. But whatever they learn today, when they graduate with that certificate, in 3 to 5 years it is likely to be obsolete.

The university seeks not only to give young people a skill set to get a job, but also a mind-set to learn, unlearn, and relearn as a steady state. It is launching an institute on personalization and the future of work, as part of a public-private partnership with federal, state, local, and university funding to bring the community together to talk about the skill set and the mindset. For example, the university held a robotics institute on campus, giving a couple thousand young people a hands-on experience. Business students must have 100 hours of volunteer experience or hands-on working within their specific discipline. For example, if they are studying to become an accountant, they must go work with someone who is in accounting. If they are in finance they have to work in finance, in entrepreneurship, they have to work in entrepreneurship, and so on. As a group, law school graduates spend 21,000 hours working with the community.

"We haven't rethought what work is required to actually be done in the office versus what is to be done at home. What is it you really need to be in the office to do? And, if you're not in the office, how do you learn and absorb an organization's culture? How do you learn the tricks of the trade?"

Maj. Gen. Ed Bolton
Senior Advisor, Diversity, Equity, and Inclusion,
The Aerospace Corporation

Dallas-Ft. Worth is a large metroplex with an immense socioeconomic range in terms of wealth, 40 percent are people of color, and a significant underserved population. College readiness and college graduation rates are around 30-35 percent among high school graduates. A partnership between the Toyota USA Foundation, Southern Methodist University, Dallas Independent School District, and West Dallas Community established the West Dallas STEM School to focus on innovation and equity, equip students with industry aligned skills for future jobs in STEM, and help develop the technical workforce Toyota USA needs. The West Dallas STEM School Program at Pinkston is a neighborhood school that serves 7th and 8th grade, and a 50/50 Transformation school (a lottery-based 50 percent enrollment of economically-disadvantaged students) for PreK through 6th grade. It offers an integrated STEM education with hands-on activities such as robotics, experiments, and computer coding, as students use what they learn in science, technology, engineering and mathematics. They believe they have established a model that can scale nationally.

Employers can play a key role. The space industry is at a pivotal moment. It has grown by 20 percent over the last four years, with rapid growth across all sectors, and is a source of good paying jobs. The industry needs a strong, vibrant, and inclusive workforce to stay at the cutting edge of innovation. However, women, blacks, and Hispanics are under-represented in the industry.

The Aerospace Corporation, operating the Department of Defense Aerospace Federally Funded Research and Development Center, is focused on diversity, equity, and inclusion to create a work environment where all people can do their best work. The focus includes recruiting, representation, and retention, and benchmarking with fellow FFRDCs.

Aerospace's CEO along with 30 other CEOs formed the Space 2030 initiative, pledging to:

- Significantly increase the number of women and employees from underrepresented groups in their collective technical workforce, including those who hold senior leadership positions.
- Work with universities to increase the percentages of women and students from underrepresented groups receiving aerospace engineering degrees to levels commensurate with overall engineering programs.
- Sponsor K-12 programs that collectively reach over 5 million underrepresented students annually.

As part of this commitment, the companies have pledged to significantly increase the number of diverse interns with a goal of hiring at least 3,000 interns by summer 2030. The group is collects data to benchmark progress.

Ms. Van Ton-Quinlivan, CEO, Futuro Health; Dr. Elizabeth Loboa, Provost, Southern Methodist University; Dr. Robert Johnson, President, Western New England University; Maj. Gen. Ed Bolton, Senior Advisor, Diversity, Equity, and Inclusion, The Aerospace Corporation.

Universities need to communicate better about what they do. There has been diminished trust and faith in higher education as the pathway into economic mobility. Universities need to communicate better about their value and affordability, the dimensions of student success, the lifelong community they develop, and their role in the community.

The United States and its employers need to examine the impact of remote work on employee development and work organization. For example, what work is required to be done at work vs. what can be done at home, and how do new workers get inculcated with the company culture, and 'learn the ropes" and "tricks of the trade"—knowledge that is often passed on by more experienced co-workers. This could be an issue with students who have had less interaction in high school and college during the pandemic, and may be behind.

Beyond 10x Innovation
Next Steps for the National Commission on Innovation and Competitiveness Frontiers

The National Commission on Innovation and Competitiveness Frontiers is launching the next phase of its work to increase U.S. innovation capacity and capabilities. The Commission will initiate a new wave of dialogues to build on prior work, dive deeper into critical topics, and refresh collective thinking on how the United States can out-innovate and out-compete other nations in the 21st century. This next phase of work will build on the Commission's 2020 report, *Competing in the Next Economy*, which found that to remain globally competitive, we will require a radical transformation of the national innovation system, and established the ambitious goal of achieving a tenfold increase in U.S. innovative capacity and capability by:

- Increasing the number of innovations Americans develop, deploy, and scale,
- Increasing the speed of innovation, and
- Increasing the number and diversity of Americans engaged in innovation.

These recommendations included coordinating national policies, increasing Federal R&D funding, and expanding innovation capacity in underserved communities. Since then, the Commission has engaged with leaders in the public and private sectors to advocate for these recommendations and collaborated on the United States Innovation and Competitiveness Act. The next phase of work will build on the previous report, explore new challenges and opportunities, and shape the national innovation agenda. It will also explore certain aspects of innovation at a deeper level, including the future of sustainability, future of technology, future of work, and future of place-based innovation, in four new working groups.

+ Key Takeaways

- The economic, social, national security, and geopolitical environment has changed dramatically in the past several years, presenting new and difficult challenges. These include inflation, housing affordability, a militarizing China threatening U.S. national security, and fragility of supply chains for critical materials and goods.
- One of the biggest challenges America and its leaders face today is our fading sense of cohesion and culture. There seems to be no forward vision shared by Americans. Public trust in government is low.
- We need to create organizations that can address challenges and opportunities as they evolve, not organizations built to do one thing or a portfolio of things.
- The national security environment requires changes in the U.S. innovation system. The United States must innovate faster, translate new ideas and technologies into the field faster, and stay ahead of the adversary. U.S. universities have capabilities that can help strengthen national security and U.S. warfighter capabilities.

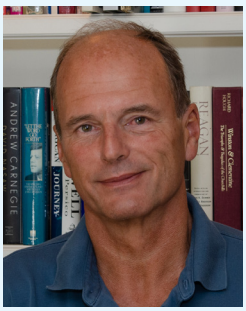
Panel

The Honorable Sandy Baruah
President and CEO, Detroit Regional Chamber

Dr. Tomás Díaz de la Rubia
Vice President for Research and Partnerships
The University of Oklahoma

Joan Gabel
President, University of Minnesota, National Commissioner
Vice Chair for Academia, Council on Competitiveness
National Commissioner

Dr. José Marie Griffiths
President, Dakota State University



Andrew Thompson
Managing Director and Co-Founder, Spring Ridge Ventures

MODERATOR

The Honorable Deborah L. Wince-Smith
President and CEO, Council on Competitiveness
National Commissioner

- A high school education is not sufficient to sustain a person, a family, or community business needs in the 21st century. The United States needs to consider a 12+2 standard for education, and ensure that education and skill attainment opportunities are available across the board for workforce development. However, that should not come at the expense of doctoral-level research or educating and training more minority engineers.
- Universities and their partners need to think about their role across the education continuum. But companies may not see preparing students for the workforce as their role. That is starting to change with recognition that we must ensure access, equity, and opportunity for all.
- Placed-based economies can be both local and global. There are U.S. metros with multiple headquarter companies. Universities in these places need to think about how they connect with the local and regional community, and also how they partner with global firms in research and workforce development.
- There are places in the country with pockets of expertise that have not been exploited. Universities in these places could form consortia connecting them so they can work together.
- Placed-based innovation and economic development initiatives need to access resources through partnerships with the state and Federal governments. But these governments operate on political timelines, often 2 and 4 years, while placed-based initiatives develop and deliver over a longer term. And partnerships with companies driving the R&D edge may create a disincentive in the ways in which universities measure success in projects with Federal support.
- The United States needs a mind and organizational shift in thinking about technology in healthcare, education, and energy: in health care, a shift from investing in sick care to investment in health care, prediction, and prevention; in education, and training, a shift from a mindset of teaching and universal college to learning and diverse pathways to universal capabilities;

in energy, energy security should be the priority in the short term, and the United States should deploy small modular nuclear reactors.

- The achievement of fusion ignition is a remarkable scientific breakthrough. Now the challenge is moving from a scientific breakthrough in the laboratory to commercial fusion, creating the needed technology, reducing the technology risks, and getting students prepared for the future of fusion energy.

The economic, social, national security, and geopolitical environment has changed dramatically in the past several years, presenting new and difficult challenges. Economic challenges such as inflation have impacted American pocketbooks, for example, in housing affordability, and the prices of food and energy. The Russian invasion of Ukraine has threatened energy security, and China is rapidly militarizing posing a serious threat to U.S. national security. There is growing focus on ways to move disadvantaged populations ahead, and an increase in political polarization.

The issue of U.S. resiliency has come to the forefront with widespread recognition that U.S. access to critical materials and goods such pharmaceuticals and semiconductors is fragile if not already under threat. The CHIPS Act was a response to the risk to U.S. access to semiconductors, and the United States is working to forge partnerships with allies on rare earth critical materials. The United States need lithium, for example for EV batteries; there is a lot of lithium in Nevada, but it cannot be mined today due to Federal government restrictions. Developing synthetic rare earths or new materials, and being more agile in the regulatory environment will be important. Generative AI is coming up with new synthetic chemical compounds with properties that could make new pharmaceuticals, and the same thing is going to happen in material science.

One of the biggest challenges America and its leaders face today is our fading sense of cohesion and culture. There seems to be no forward vision shared by Americans. For example, in Michigan, which is trying to lead the transition to EVs,

"We live in a very, very different geopolitical environment today than we did even five years ago. Being at a university today, after having been at the National Security Laboratory in the past, I've seen the transition from the end of the Cold War, when we were all friends around the world—Ch was a friend, Russia was a friend—to today where everything is looked at from the lens of peer competition, near-peer and peer adversaries."

Dr. Tomás Díaz de la Rubia
Vice President for Research and Partnerships,
The University of Oklahoma

17 percent believe its companies are moving to EV platforms because of market forces and consumer demand, while about 70 percent believe they are caving into environmentalists and/or government. Seventy percent of Michiganders believe that a high school degree is the minimum level to lead a successful life in the 21st century, but only 65 percent of Democrats and 40 percent of Republicans believe college is worth it. Sixty percent of Democrats think the economy is expanding, but only 15 percent of Republicans do. Seventy percent of Democrats support the shift from internal combustion engines to EV electrification, but only 20 percent of Republicans do. Where the populace stands has a direct impact our ability to move the country in a given direction.

In addition, public trust in government is low, particularly trust in the Federal government, with higher levels of trust in state and local governments. Busi-

"The reason why America is such a powerful country is freedom. That's the really big thing. And technology has been redefining the future of freedom for the last 20 years socially, economically, politically and militarily. And people are just beginning to realize that. But it's very, very powerful. So I think the most important thing that the National Council can recommend is that the federal government and state governments use technology to promote freedom."

Andrew Thompson
Managing Director and Co-Founder, Spring Ridge Ventures

"We create programs at the Federal level. We create institutions at the local level, and we don't do anything with them over time. We just kind of assume that what was created in 1990 or 1950 or 2023 is going to be the same organization or the same need that we're going to need going forward."

The Honorable Sandy Baruah
President and CEO, Detroit Regional Chamber

nesses are trusted more, raising the importance of business leaders' participation in solving community problems, and engaging in efforts to drive placed-based innovation and economic development.

The United States needs to build structures that are adaptable and can stand the test of time. We need structures at the Federal, state, and regional level that can constantly adapt to whatever the challenge is today. We need to create organizations that build capacity that can address challenges and opportunities as they evolve, not organizations built to do one thing or a portfolio of things.

The national security environment requires changes in the U.S. innovation system. To some extent, we still have an environment of openness, which has enabled the United States to develop the largest, most successful, most innovative, and most creative and diverse economy on the planet. But we face threats today we cannot ignore. The United States must innovate faster, translate new ideas and technologies into the field faster, and stay ahead of the adversary.

The University of Oklahoma believes that, as a flagship, public research university, it has a duty to help the Nation and U.S. warfighters succeed against the adversary. The university has significant programs in national security, and concluded it needed faculty security clearances and areas of the university to perform classified work. The university believes it needs to partner with the private sector, with the Department of Defense and military services, and national laboratories to advance innovation, and generate discoveries that can be quickly translated through the ecosystem into solutions for the warfighter in the field. The university is working with Department of Defense partners in areas such as advanced radar technology, manufacturing, and materials.

A high school education is not sufficient to sustain a person, a family, or community business needs in the 21st century. Today, 63 percent of adults aged 25 or older have some post-secondary education, and that is not adequate going forward. Instead, the United States needs to consider a 12+2 standard; that is, everyone needs to have some post-secondary credential. Universities can do a lot

Building a Cyber Powerhouse in a Rural Region

Dakota State University—a rural university in the Great Plains—has developed into a cyber powerhouse. When Citibank set up a regional headquarters in Sioux Falls, it needed mainframe programmers, so the legislature and governor gave the university a new mission to support the growing computing industry in South Dakota. The university got involved in cyber security and developed a strong relationship with the National Security Agency.

While they became highly regarded in the cyber security arena, they were not performing much research. So, the university set about to create a research culture, and built a major new research facility with a portion devoted to classified research serving the national security and defense mission, and a portion—the multidisciplinary "Mad Labs"—for unclassified research on cyber security and other areas of technology. Once built, the university's classified research grew by leaps and bounds. And they ask the community to bring them problems related to computing, cyber security, networking, etc. Attracting more and more research, the university is building another facility with $90 million in public and private funding.

The region needs a pipeline of workers to fill new jobs being created, so they reached out to school districts to create dual credit programs, in which students can take a year of college courses in the majors. They are launching this Governors Cyber Academy this fall, and opening the opportunity to every high school and homeschooled student in the state. They will divide students into "houses" for internal competition and community development.

The university's graduates are doing very well in the security environment, they have a 99 percent placement rate, and started to spin off a couple of small startups.

in two years in a 12+2 model. Similarly, the University of Minnesota has a four-year degree that can be completed in two and a half years with competency-based credits.

The University of Oklahoma launched a Polytechnic Institute in Tulsa, in which students can thrive in technology without having to get the most rigorous engineering education—an intermediate level between vocational technology and a full four-year engineering degree. The degrees offered include cybersecurity, data science, digital engineering, and artificial intelligence. There will not be mechanical, chemical, or electrical engineering, rather there will be a foundation of engineering underneath. The goal is to open up the aperture to bring in students from all areas of the social spectrum. Oklahoma has 39 tribal nations, and the university works closely with them, including at the university's Native Nations Center, to build this new type of workforce training program that is academically rigorous, accredited,

U.S. Adults Aged 25 or Older in 2021
Source: Census Bureau

- 8.9% had less than a high school diploma or equivalent.
- 27.9% had high school graduate as their highest level of school completed.
- 14.9% had completed some college but not a degree.
- 10.5% had an associate degree as their highest level of school completed.
- 23.5% had a bachelor's degree as their highest degree.
- 14.4% had an advanced degree such as a master's degree, professional degree, or doctoral degree.

but somewhere in between. It gives opportunity to more students to be able to get a degree that is highly sought by industry, with 99 percent placement.

While it is important to ensure that education and skill attainment opportunities are available across the board for workforce development, regardless of starting point or lived experience, that should not come at the expense of doctoral-level research or educating and training more black engineers.

Universities and their partners need to think about their role across the education continuum. Universities need to think about their role upstream in the pipeline, about students from their very earliest days and into the fields that put them on campus, and into the positions that allow them to be innovative. The rest of the world is going this, including our competitors.

Companies may not see preparing students for the workforce as their role. They may do some service in K-12 to be good neighbors and partners, for example, philanthropically supporting a summer camp, a campus visit program, outreach, or after school programming. That has started to change due to a variety of tragic and painful experiences, raising the question as to the role we all play in ensuring access, equity, and opportunity, if we're going to remain the country we want to be.

Placed-based economies can be both local and global. There are U.S. metros with multiple headquarter companies. Universities in these places need to not only think about how they connect with the local and regional community, but also how they partner with global firms in research and workforce development. For example, the University of Minnesota in the Twin Cities works with global companies around innovation, R&D, and student development to drive the discovery and incentives that create jobs and growth for the local economy. But, as the only research university in the state, they also think about Rochester and the partnership between the campus there and the Mayo Clinic, and the rural areas heavily tied to agriculture and the food economy.

"While we think about university life beginning as freshmen and later with graduate students, we also need to be thinking about the full education continuum, from preschool students to terminal degrees and beyond. If we fulfill our role, our competitiveness is unstoppable with our entire society elevated."

Joan Gabel
President, University of Minnesota
Vice-chair for Academia and National Commissioner, Council on Competitiveness

There is venture capital in the University of Minnesota ecosystem, largely from legacy companies. What would typically be the component of the ecosystem filled by angel or venture capital is filled by corporate acquisitions often at earlier stages than you would see in other markets.

There are places in the country with pockets of expertise that have not been exploited. An alternative model to the hub—a single center with spokes—these pockets could be connected and work together. For example, in the Mountain Plains region, a five-state consortium connects 10 or 11 research universities that have a variety of different areas of expertise.

Placed-based innovation and economic development initiatives need to access resources through partnerships with the state and federal governments. But these governments operate on political timelines, often 2 and 4 years, while placed-based initiatives develop and deliver over a longer term. While, corporate partnerships are desirable, corporate partners are driving the R&D edge for the country, and may create a disincentive in the ways in

which universities measure success in projects with Federal support. It may be more effective if the Federal government comes into initiatives once a region has brought together its civic, business, and academic leaders, and they are committed to working together to build or strengthen innovation capacity and an innovation-based economy in the region.

The United States needs a mind and organizational shift in thinking about technology in healthcare, education, and energy.

- **Healthcare and technology.** We need a mind shift and organizational shift away from investing in sick care and start investing to create a health care system to complement the sick care system. We need to focus on prediction and prevention as opposed to diagnosis and treatment. And that will be a fundamental shift in the economics of how we buy and invest in things. We also need to onshore our pharmaceutical supply chains from India and China.
- **Education and technology.** To bring more people forward in the country, we need a shift from a mindset that it is about teaching and universal college to a mindset that it is about learning and diverse pathways to universal capabilities. We should stop thinking about importing technical skills from India and China, and start thinking about how we build a much stronger K-12 education system in this country that uses technology to enable personalized learning for everyone, including learning remotely and virtually.
- **Energy and technology.** While we must move toward addressing climate change and net zero, energy security should be the priority in the short term. We should employ small modular nuclear reactors, and a U.S. company (NuScale Power) recently received Federal government approval for a design for a small modular reactor. China deployed their first small modular nuclear reactor on their grid in 2021, so the United States is behind. Another U.S. company (Helion) raised $1.5 billion to develop the world's first fusion powerplant; nuclear fusion is a huge opportunity and could be here sooner than we think due to private sector support and initiatives.

"I believe very strongly that we are now at a point in which U.S. competitiveness in the global energy markets of the future will be dependent on our ability to be the first to bring fusion energy to market as a clean, sustainable global energy solution to the planet…There's all kinds of deniers out there…It will happen. The question to me is, will it happen here? Will it happen in China?"

Dr. Tomás Díaz de la Rubia
Vice President for Research and Partnerships, The University of Oklahoma

The achievement of fusion ignition is a remarkable scientific breakthrough, but who will bring it to market? The challenge now is going from a scientific breakthrough in the laboratory to commercial fusion, creating the needed technology, reducing the technology risks, and getting students prepared for the future of fusion energy. The Federal government is spending hundreds of billions for research and tax incentives for clean, sustainable energy, but only about $25 million for fusion energy. The private sector has woken up to this disconnect and there is a lot of venture capital going into fusion ideas.

Innovation Snapshots

Four thought leaders gave their rapid-fire take on future trends at the heart of America's productivity and inclusive prosperity potential—technology, manufacturing, climate change, and education.

The Future of Disruptive Technology

Dr. Thomas Campbell
Co-Director, LEAP Manufacturing
Senior Fellow, Council on Competitiveness

! The Big Idea
Threats to supply chains are among the biggest issues for the country, cutting across all technologies. The United States is not doing enough and needs to put policies in place to mitigate the current threat, and anticipate and prepare for future supply chain issues.

The United States is great at inventing but often loses the manufacturing of the things it invents.
The United States has developed and patented many great technologies over the last several decades such as semiconductors, biotechnology, and 3D printing. However, manufacturing of the technologies the United States creates often goes overseas. For example, the United States invented metals 3-D printing but, when the patents expired, much of the manufacturing went to Europe and Asia. The loss of manufacturing is very unfortunate for the U.S. economy, national security, and our position in technologies because we become dependent on other countries, including competitors. China is rapidly rising in all these technology sectors, and a fierce competitor in a spectrum of emerging and critical technologies.

China dominance of supply chains is a threat to the United States, Europe, and our allies.
The Annual Threat Assessment of the U.S. Intelligence Community is a consensus document from 17 intelligence agencies that lays out, among other things, the situation in crucial technologies and big geopolitical threats to the United States. This year, they called our China prominently. The assessment noted that "China is central to global supply chains in a range of technology sectors, including semiconductors, critical minerals, batteries, solar panels, and pharmaceuticals." It warned of its leader's "intentions

to increase global supply chain dependencies on China, with an aim of controlling key supply chains and being able to use those supply chain dependencies to threaten and cut off foreign countries during a crisis."

For example, Japan and South Korea are leaders in use of robotics and automation. However, China is the biggest producer of robotics and automation systems. When Tesla was building its gigafactory in Texas, it had to import Chinese robotic equipment because the company could not buy those robots in the United States. The vast majority of rare earth minerals and critical materials are mined and/or processed in China, including the vast majority of lithium needed for batteries including those used in cell phones and EVs. The CHIPS Act was a recognition that 92 percent of the most advanced microchips that go into the most advanced U.S. products are made in Taiwan by TSMC. And there are those in the national security community who believe China will invade Taiwan in 2-5 years. In addition, China produces 40 percent of the world's active pharmaceutical ingredients needed to make medicinal drugs, for example, antibiotics and medicines for chronic diseases. The Department of Defense is pouring money in to try to re-shore critical materiel it needs.

The threat to U.S. access to supply chains is a threat to the U.S. ability to develop and deploy disruptive technologies. The United States ability to make a supercomputer, a new drug, an EV, and many other technologies and products is dependent on other countries. It is a multidimensional threat from geopolitical risks to extreme weather to local disease outbreaks to the availability of ships and trains. For example, in 2021, when a cargo container ship got stuck in the Suez Canal for six days, it blocked an estimated $10 billion in trade per day, and disrupted U.S. supply chains for three months.

The Mass-Customization Revolution and Agile Manufacturing: A Future for Blockchains

Dr. Ali Nejadmalayeri
John A. Guthrie Endowed Chair in Banking and Financial Services
University of Wyoming

! The Big Idea

The United States could scale-up a new model of mass agile manufacturing as a service.

U.S. manufacturing has evolved, but is not well aligned with the 21st century idea economy. The United States used to produce products, perfect things for what people needed, and our production cycles were long. Our capacity to serve very low industrial production changed that and reduced production cycles. While we served many people, we lost the intimate touch and the perfect fit. In past few decades, we gained some of that back through mass customization and personalization. Today, we can produce near perfect fits, still maintain shorter production cycles, and serve many people. Our creativity has been hands on.

Today, however, we make big ideas, we are an idea economy, and our creativity is digital. The United States has legions, millions of young, brilliant American minds who can create fantastic stuff digitally at the touch of a button. They can react fast to change in innovation. But the competition is fierce. Taste and preference change rapidly. And, even if we could recreate the old manufacturing ways, it would be costly. We would reach across the ocean to access unfriendly places, the gatekeepers have no respect for intellectual property, supply chains are stretched and stressed—and all of this is in the context of a chaotic, volatile world power struggle.

The United States could scale-up a new model of mass agile manufacturing as a service. This model is predicated on a triangle of digital ideation, compartmentalized manufacturing, and network protection. It starts with our brilliant young minds creating digital creations, machine ready digital blueprints that would be sent to a prototyping capacity leased to break down the prototype into pieces that are then sent to leased 3D printing capacities. This process would be encapsulated in cryptography-protected networks that protect intellectual property, system secrets, process secrets, and finance secrets.

Bits and pieces of this system and service are here today. Proto Labs does prototyping on demand. Stratasys manufactures on demand. Xometry does financing and process management in one place. This is a microcosm of mass agile manufacturing as a service. This model could be scaled to a system in which digital ideation is protected by cryptography, sent in a tamper proof way for prototyping, then sent in a peer-to-peer encrypted way for bidding. Bidders then can use 3D industrial capacities through lease to produce things—all in real time. "Trustless" process management and financing work in the background and, as they sell this in real time, they can assess the market, the taste, the capacity, or any change that is needed.

The Future of Sustainability–Climate Change is the Innovation Megatrend

Cooper Rinzler
Senior Partner
Breakthrough Energy Ventures

! The Big Idea

Climate change is the mega trend we are not paying attention to, and it is the single biggest threat to our innovation capacity as a nation and society. We need to put new systems and institutions in place, and a flux of talent, ideas, innovation, and capital.

With the trajectory of current efforts, we are not likely to mitigate climate change. The recent IPCC 6th Synthesis Report states that global warming is more likely than not to reach 1.5°C even under the very low GHG emission scenario and likely or very likely to exceed 1.5°C under higher emissions scenarios. And that does not assume tipping points.

The United States spends about 3 percent of GDP on R&D, and the Federal government R&D investment is less than 1 percent of GDP. But imagine spending a double-digit percent of GDP on climate adaptation alone, the cost of just moving Floridians, or the potential of a 30 percent reduction in growth year over year. There could be 300 million climate refugees, food and water insecurity, and the collapse of the insurance industry. Often just focusing on what is in front of us for the next four years, the United States is bad at thinking about tail risk, and the tail risk of climate change is unbelievable and, even taking Hofstadter's Law into account (the project always takes longer than you expect), we are certainly underestimating it.

"If we are to do this, it will be the greatest single achievement of our species. It would be a transcendental accomplishment to overcome the greatest challenge in scaling innovation of all time, and to deploy this innovation at a pace that is unprecedented."

Cooper Rinzler
Senior Partner, Breakthrough Energy Ventures

Climate change is going to be the dominant driver of innovation. About half of the solutions we need are already profitable in the market context. They need to be deployed at scale and with speed. But we cannot solve all of this problem with a profit-driven model. It is fundamentally an externality, and policy changes are needed to develop, advance, and enable more solutions to come into the market-driven context. We need innovations in finance to fund and invest across the life cycle of technology.

The problem could get worse because, it is not only how much of the problem we can solve, but also how quickly we can get there. It took about a century for coal, oil, and natural gas to provide the majority of the energy supply. And renewables are following the same timeline trend. There is nothing to believe that it is going to be different this time unless we do something vast.

If we have any chance at meeting the threat, innovation is going to be required across these four levers—the solutions we have now, deploying them at scale, deploying them with speed, and solving the parts of the challenge for which we currently do not have market viable solutions.

There will be massive opportunities for business, and solving the climate challenge will form the foundation of national competitiveness going forward. Industries will be destroyed and reinvented to form the bedrock of our economy. There is going to be multiple trillion-dollar industries reinvented and created in the things that matter most in climate—food, water, energy, materials, and transportation—and national competitiveness and security both depend on leadership in these industries.

We lack a fundamental vision of our climate future and working back from that vision. It is incumbent on our leaders in government and industry to work from a vision of the future and what we are trying to build, and work back from that. The maximum temperature we hit or the total amount of time we spend above a certain temperature threshold are radically impactful in terms of the total amount of human suffering and the probability of hitting irreversible tipping points. So, you can envision what things look like in 2100 or 2150, and where things are today, but the shape of the curve matters.

There are five main playbooks:

- Eliminate emissions. There is no version of a positive climate future without net zero.
- Remove emissions. Carbon removal probably requires removing both CO2 and methane, and potentially nitrous oxide as well.
- Radiative forcing management. That is how much energy we absorb compared to the energy leaving the atmosphere, and there are ways to modify that.
- Adapt. We tend to spend money when it benefits us in the short-term, but we will choose to spend money on adaptation, because there is massive opportunity for innovation in reducing the cost of the adaptation that is coming.
- Build institutions to manage systemic risks and to operate on timescales that existing institutions are not set up to manage.

The Future of Education

Roy Mathew
Principal, National Practice Leader for Higher Education
Deloitte US

! The Big Idea

Apply the fundamental elements of what makes U.S. professional sports successful to education.

The United States has one of the best, if not the best, education ecosystems in the world. For the past century, the U.S. education system has enabled families to establish career pathways into the middle or upper class because of education or a college degree. It remains the greatest equalizer in society and uplifting families and communities. What is it going to take for us to make sure we maintain that position for the next 50 years and beyond?

Troubling trends suggest we have been resting on our laurels on the work done over the past century. There are some troubling macro trends:

- Faith in U.S. education has dropped more than any other institution as measured by Gallup and others, greater than the losses in faith in the presidency, Congress, big business, and the criminal justice system.
- Compared to other countries in the OECD, and other developed and developing nations, since 2000, the United States has dropped from 2nd to 16th in the number of 25–34-year-olds who have a bachelor's degree. Over that period of time, in other member countries, the population of 25–34-year-olds who got a bachelor's degree grew 200 percent.

- In the forecast for population growth, in 2,100, five of the top ten countries in terms of population will be in Africa, but we talk a lot about India and China, but not so much about Africa.

There is another comparable institution and discipline where the United States has been and continues to be a leader on the global stage—professional sports. For example, the U.S. performance in the Olympics continues to be a track record of excellence and success despite other countries catching up. There are three foundational elements that have allowed the United States to maintain that excellence:

- **A bottom-up feeder system for early identification of talent.** You start off by identifying talent at three or five years old.
- **Smart funding.** Compare the Olympic training facility in Colorado Springs to our classrooms or average lab at an R1 university, where they struggle to find $300,000 to buy chemistry lab equipment for a world-renowned professor. In contrast, we take care of athletes with mental health well-being, training facilities, uniforms, and nutrition coaches.
- **Sense of pride and achievement.** In the sports arena, the culture celebrates athletes. If an Olympic athlete lives in our community, we say, "I'm neighbors with that person who went to the Olympics." If we have somebody who lives in our zip code, we say "that Olympic athlete lives in our zip code." We put them on Wheaties boxes. We do not put a Ph.D. in physics on a Wheaties box.

"You don't go to Michael Phelps at 18 years old and say, hey, I saw you swimming. You're a good swimmer. You want to come swim in the Olympics? That's not how that happens. My daughter plays club volleyball. At eight years old, she's getting trained by coaches who used to play on the US national team."

Roy Mathew
Principal, National Practice Leader for Higher Education, Deloitte US

We can apply these three fundamental elements to education.

- **Early identification and nurturing of talent.** In the K-12+2 model, we can ensure a person does not necessarily have to complete a four-year experience, but rather have credentials or stackable credentials over a six- or eight-month period in cybersecurity, artificial intelligence, analytics, automation, or blockchain. Then get them connected to the private sector, get them into a job, or get them experience in a national lab. We can use these new modalities of learning

and technology to identify that talent early and put them through the system in the way that we do athletes.

- **Smart funding.** Imagine if we funded our schools and colleges at the same level we fund our Olympic facilities in Colorado Springs and other athletic facilities in our country and neighborhoods that allow these students and children to grow up and thrive in their sport. More funding would help, but more smart funding would help.
- **Sense of pride and achievement.** Change the culture to one where we celebrate education, celebrate research, when the conversation at Thanksgiving changes from "are you going to college?" to "where are you going to college?" and to one where communities and society acknowledge, respect, and admire those who figured out mRNA, which allowed us to create the COVID 19 vaccine.

This is not like a problem we have not solved before. This is something we as a country solved in a different discipline. We need to apply those principles to education. It is hard, but there is a primer for success.

"If you ask the average teenager who the two scientists are that enabled the creation of the COVID 19 vaccine, I bet most of them couldn't answer that. If you ask them who has made the most three-pointers in the NBA, most kids are going to say Steph Curry."

Roy Mathew
Principal, National Practice Leader for Higher Education, Deloitte US

Working Group Breakout Sessions Setting the Stage for Phase 2 National Commission Working Groups

Summit participants engaged in a series of four parallel sessions and progressive conversations held over two days—each serving as the kick-off dialogue for the National Commission's 2023-2024 policy-generating working groups. The sessions were opened by a kick-off discussant who scoped and set the stage for moderator-led working group deliberations. Each working group proceeded independently and in different ways in carrying out its work.

Working Group 1
The Future of Sustainability—Accelerating Innovation in Clean Energy Technology

Table Setting Points

- Huge, unprecedented investments are being made in clean energy technology through the Inflation Reduction Act and the CHIPS and Science Act. Yet, China invested more than $500 billion last year; in that context, U.S. investments seem modest versus overwhelming on the international stage. The EU is responding with their own plans amid concern that the United States has embraced industrial policy and is skewing the market.
- Overall, while we have not yet "turned the ship" on emissions, there is a lot going on to address the challenge, for example, in solar, wind, LED, electric vehicles, etc.
- A focus should be on research in areas where we have a no viable path to meeting net-zero.
- The Inflation Reduction Act did not address critical aspects of the climate challenge such as what to do with high energy intensive and emission industries such as steel and cement, and the impacts on climate from agriculture.

Panel

MODERATOR

John Thompson
Technology and Markets Director, Clean Air Task Force

KICK-OFF DISCUSSANT

Dr. Karma Sawyer
Pacific Northwest National Laboratory

RAPPORTEUR

Bill Bates
Senior Advisor, Council on Competitiveness

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Retired President, Greater Sacramento Region
Bank of America (retired)

Mr. John Thompson
Technology and Markets Director
Clean Air Task Force

Ms. Dana Topousis
Chief Marketing and Communications Officer
Strategic Communications

Working Group Points of Discussion

Areas of priority and needs for greater R&D funding:

- Significant interest in research that addresses systems such as the grid, energy storage, and pipeline infrastructure. There is a sense that these areas are being underfunded by the Federal government or addressed in stovepipes rather than as an energy ecosystem with parts that interact.
- Strong interest in focusing on grid modernization.
- R&D needs to include applied research (not just basic), and government should push further toward applied research and scaling than it currently does because the market is not picking up new technology early enough.

Dimensions of clean energy and policy program development:

- Resilience must be baked into every aspect of the clean energy system.
- Energy security and climate objectives need to be linked.
- The U.S. transition to clean energy and addressing climate change cannot be done in a vacuum. It must be part of a global effort.

Goal of Recommendations: Accelerating clean energy innovation.

Scope of recommendations. The working group will develop:

- General policy recommendations.
- Focused recommendations for industry, for specific problems (i.e., where a specific type of solution is needed), and for advancing technology.

- For both general and focused innovation recommendations, short-term and long-term timescales will be considered.
- For focused policies, the working group will seek greater quantification in targets, multiple policies, and model impacts.

Process of policy option development and prioritization. The working group will develop filters for prioritization, such as recommendations likely to gain bipartisan support, high level of impact and scalability, deliverability, and meeting long-term goals but also has short-term benefits for average person.

In each area of recommendation, the working group will prioritize issues and opportunities to address, identify and develop policy options and stakeholders and partners, evaluate policy options with modeling where appropriate, and finalize recommendations.

Work plan. The working group recommends convening in four workshops:

- Workshop 1-Prioritization: In this workshop, the working group would identify what success looks like, finalize filters, finalize and review questions, prioritize areas, review/modify next steps, and develop sample recommendations. Read ahead material for the group would be prepared for each of these agenda items.
- Workshop 2-Recommendation Development: The working group would start with a large number of policy recommendation options to be evaluated before the next workshop.
- Workshop 3-Evaluation of Recommendations: The working group will review the quantification of impacts of the recommendations from Workshop 2.
- Workshop 4-Select Recommendations. The working group would select approximately ten recommendations.

Working Group 2
The Future of Technology—Developing and Deploying Disruptive Technologies at Speed and Scale

Table Setting Points

- The CHIPS and Science Act included many important provisions for U.S. competitiveness including a focus on critical supply chains, support for partnerships with industry, and support for literacy and inclusion efforts.
- Disruptive technologies either "create a new market or change a market." While the United States should not pick winners and losers, there are clear benefits to supporting particular critical technology areas like semiconductors.
- The National Science Foundation Technology, Innovation, and Partnerships program will likely offer important lessons for the working group's work, particularly in the way the program aims to strengthen institutional diversity.
- The top 20 percent of higher education institutions receive 90 percent of Federal R&D funding despite only enrolling one-third of students of color in universities; two-thirds of students of color receive 10 percent of Federal R&D funding. We need to be thoughtful about where research funding is going and ensure that we include geographic and demographic diversity considerations as we think about scaling.

Panel

MODERATOR

Adriana Kuiper
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MODERATOR

Dr. Thomas Campbell
Co-Director LEAP Manufacturing and Senior Fellow, Council on Competitiveness

KICK-OFF DISCUSSANT

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KICK-OFF DISCUSSANT

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Ms. Elisa Stephens
President
Academy of Arts University
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Dr. Frederick Streitz
Chief Computational Scientist
Lawrence Livermore National Laboratory

Mr. Andrew Thompson
Managing Director & Co-Founder
Spring Ridge Ventures

- Disruptive technology development leans on the understanding of the problem that you are trying to solve. Need to know issues, end users, etc.
- University of Texas at San Antonio is a case study for how to engage with challenges of the new economy. San Antonio is bringing together end users in the national security space and identifying that as a unique specialization they can succeed at.
- Should have state or regional leadership that assesses regional capabilities for economic development and inform these efforts of particular advantages.
- Partnerships with national labs have also become critical for technology development.
- Should not just be consortium-building for the sake of consortium-building. Need to be strategic about when it makes sense to lean in and invest and be particularly thoughtful about teaming in these efforts.

Working Group Points of Discussion

High priorities for R&D funding, technology development, and national attention:

- The United States needs a process for identifying and selecting critical technologies to support. Technologies and areas of research critical to national security are a priority, and trust that business opportunities will emerge from those.

- Quantum. The United States cannot afford to be #2 in the world given the military advantages quantum will enable. At about $1 billion annually in Federal investment, the United States is underinvesting in quantum research. The Chinese are spending $10B a year which would be equivalent to $50 billion here given wage differences. But even if Congress provides significant R&D funding, the United States does not have the people who can execute the research. The United States needs to invest in quantum education, particularly workforce training, and may need to boost immigration. The United States also needs to explore quantum applications beyond quantum computing and quantum sensing, such as quantum chemistry.
- Biotechnology is the next frontier. There are extremely high-level military threats that come from bioengineering, so the United States needs to be ahead in this area. CRISPR and more advanced versions of CRISPR will drive this.
- Other areas of priority include advanced materials, nanotechnology, alternative battery chemistries, and hypersonics.
- Need new paradigms for energy storage; there is not enough lithium in the world to do what is needed. Need to find alternatives for critical materials and minerals for which the United States is dependent on China for refinement and extraction. The United States needs to resume processing and sustainable mining.
- Need ways to align more venture capital funding across these national priorities.
- There is debate over the degree to which the United States needs to produce microchips domestically verses having reliable access to trusted and secure semiconductor supply chains in allied countries. The United States could encourage some foreign companies such as ASML and TSMC to bring systems and people to the United States.

New models of technology development and innovation:

- The United States needs to invest and encourage collaboration at the intersection of disciplines and convergence points across technology areas. Congress needs to come out of its appropriations stovepipes and fund cross-disciplinary technology convergence efforts. We need a process that makes interagency collaboration on research and technology development easier and more streamlined.
- Funding by stovepipes makes it difficult for communities to engage with the Federal government. Congress could appropriate funds to give every national laboratory director $100 million with the contingency that it cannot be spent at the laboratory. The labs could work with communities to help them navigate across stovepipes.
- We must confront cultural barriers at universities. The culture around partnerships, collaboration with the private sector, and even cross-departmental research collaboration presents challenges. Participation in these types of collaborative efforts may not contribute to tenure, a disincentive for academic researchers to engage. Should study universities that have a culture of engagement, partnership, and collaboration to see how that culture can be brought elsewhere.

Federal R&D, policies, programs, and partnerships:

- Leadership on high priority technology issues should be at the highest level of national government.
- The CHIPS and Science Act has great potential as a model if the United States can find and develop the people to onshore and maintain high quality-defect free production in domestic fabs. Workforce development is a high priority in reshoring the U.S. semiconductor industry.

- There was some discussion about reworking the Bayh-Dole Act. In university-industry collaboration, renegotiation occurs every time there is interest in working with a new technology; that process needs to be streamlined. Universities and industry are often challenged to develop terms for intellectual property rights; there should be standard expectations about how universities and industry work together.
- The Small Business Innovation Research Program should adopt more rigorous reviews and assessments. Also, there could be greater alignment with venture capitalists with parallel infusions of cash.
- In forming its partnerships, the Federal government should differentiate between large companies, which have the resources to engage, and small companies and tribal nations which do not. There needs to be a different engagement approach for each, including cost-sharing requirements and the burden of developing proposals for Federal funding. The level of cost-share should also be considered in collaborations to support national security, as private sector incentives to engage are weaker there. Structured intellectual property rights could help facilitate private sector partnerships with academia, national labs, and Federal agencies, with each partner having rights to their own applications.

Building innovation ecosystems:

- In building innovation ecosystems, bring in individuals across disciplines and jurisdictions, and build critical mass through networks. They need capabilities across the full knowledge base, from community college-trained technicians to Ph.D.-level researchers. Also need venture development centers to help catalyze growth and build critical mass.
- Open facilities such as university laboratories to companies to attract them, and benefit both partners' efforts. Could create models where a state puts money into a facility that everyone can use. The National Science Foundation Technology, Innovation and Partnerships program can stand up these efforts at institutions that do not have them.

International partnerships:

- The United States needs to work more with allies and like-minded countries on technology issues, but ensure approaches benefit U.S. domestic industry. Funding in the Inflation Reduction Act and CHIPS should not be seen as competing against allies, but rather competing with them against common threats.
- The United States should collaborate with allies in developing international norms and ethics in certain areas of biotechnology. Nuclear non-proliferation treaties and bans on the offensive use of chemical weapons offer models for developing international norms and agreements to monitor and ensure safety in biotechnology.
- Greater engagement with allies and the U.S. research ecosystem is needed to develop the "rules of the road" for industry and university engagement with China. Heavy restrictions on industry could send companies to China. China should be allowed to compete when they compete fairly.
- The United States should welcome the best talent in the world, and use our freedom as an asset to attract them. The United States trains a lot of Chinese students, but needs to entice them to stay and contribute their talents here. To do that, the United States must present itself as the global antithesis to China's authoritarian approach. However, some Chinese nationals do not seek U.S. citizen as it could prevent them from having a relationship with parents living in Beijing due to restrictive immigration rules.

Working Group 3
The Future of Work—Developing, Supporting, and Expanding the Modern Innovation Workforce

Panel

MODERATOR

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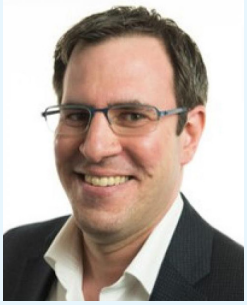

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Megan Yeh
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Table Setting Points

Three areas of focus are at the forefront of the future of work:

Attracting, retaining, and developing talent in the United States: It is in the competitive interest that the United States invest in its native population. And, attracting, retaining, and empowering skilled workers will require greater emphasis on employee wellness, impacts and outcomes, employee development, and work culture. Upon graduation, international students increasingly return home with the knowledge they gained in the United States because their home countries have advanced, or companies are bringing them back home. While the majority of Asian graduate students stay in the United States, visa delays and issues are causing some students to leave. Immigration policy changes and visa slots may need to be changed.

Balancing place-based and place-agnostic work: The recent dramatic increase in remote work presents both opportunities and challenges for creating a work environment that is flexible, dynamic, and human-centric. It can open up a new pool of talent for companies that previously could not be reached, and expand job opportunities for some workers. However, there is tension between remote work and generating the knowledge spillovers characteristic of regional innovation systems, complicating innovation and investment.

Automation and knowledge work: Jobs that required higher levels of education largely have been insulated from automation. Generative AI and its rapidly increasing use have changed that, raising questions about AI as a job threat or asset. Advances in automation, AI, cloud-based work, and collaboration platforms have the potential to significantly increase efficiency, but also require technical fluency and strong social skills for changing modes of interaction.

Working Group Points of Discussion

Key U.S. Challenges in Developing People for the Future of Work

- The United States is lacking a national conversation about the purpose of education and how it relates to U.S. competitiveness in the 21st century. The system needs disruption in both K-12 and higher education to develop the talent to compete with other countries, retain talent, and to cultivate the U.S.-born population. However, in our high-tech economy, the training model for K-12 teachers is rooted in a rote, mechanical, agrarian model and, in an era of rapid economic and technological change, the United States largely follows a static linear model of educate/train-to-job. In addition, the United States is not preparing enough of its population for a high-tech workforce. Entrepreneurship and innovation are rarely taught, despite their vital importance to U.S. competitiveness and success of Americans in the 21st century.
- Multiple stakeholders are involved in funding and shaping education and training to develop the future workforce—states funding K-12, the Federal government funding higher education, and parents who are taking new interest in influencing K-12 curricula. Concerns about free thinking have been raised across K-12 and higher education. There are competing interests among these stakeholders, for example, over the allocation of state funding across K-12 school systems, what can be taught in K-12, Federal government influence in higher education, and Federal influence in K-12 education despite little Federal funding for K-12. The impacts on students are not always clear, and raise questions about levers for and political barriers to change.
- Due to differences in K-12 education across the country, higher education often restarts students' learning journeys and baseline knowledge, or must compensate for what was not learned earlier.
- The United States has long attracted international students at the graduate level, and many have stayed in the United States, but the picture is changing. Visa access is difficult, and many international students are no longer choosing to stay in the United States after graduation.

Elements of a 21st Century Education and Training System

- The United States needs an education and training system that develops a diverse workforce demographically, regionally (Silicon Valley vs. rural Alabama), and for different industries in which people will work. The system should meet knowledge and skill needs with speed to match the pace of industry.
- Learning agility—skillset and mindset—needs to be built into our ecosystem of learning. The workforce must be instilled with a lifelong learning mindset. The educational system must teach students how to learn and adapt because jobs of the future may not even have been created yet.
- Consensus on skills that everyone needs to know. In the military model, everyone gets the same basic training before they pick what occupational path to pursue.
- Able to help students with different abilities.

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- More input from industry is needed so students understand what jobs will be available, and educators and trainers can provide them with up-to-date skills. Industry stakeholders should help guide university leaders in designing curriculum and systems. Also, greater investment and engagement with industry is needed for those who guide and advise students.
- Industry incentivized to cultivate and develop talent.
- The U.S. education system needs to focus more on developing a technically adept workforce, and teach and reinforce innovative and entrepreneurial traits.
- Increased transitional workforce funding to ensure that existing workers are not forced to leave the workforce because their jobs are changing or going away.
- Investment in work-study. Ensure student work experiences are relevant and beneficial to them in the world of work.
- Systems-level thinking to connect K-12-to university-to careers.
- Messaging to help parents understand in pragmatic ways how to help their kids get a job.

Driving Change

- Levers that can drive change include funding, teaching and learning mindset, digital literacy, and retooling existing programming.
- Involve more people in the conversation and collaboration. Identify and engage with stakeholders who need to be involved in updating the broader education ecosystem (e.g., industry leaders, K-12 leaders and teachers, universities, employers, politicians).
- Messaging about the diversity of jobs and higher education, their importance to state economies, and how education is a vehicle for a better life and leveling the playing field. Create a value proposition for the role of higher education and its impact on the state economy.
- Learn what we can about the structure of schooling from our global competitors. For example, the role of standardized exams, or how to identify and select for creativity or innovation.
- Use pilots to demonstrate what works and can be scaled. Provide Federal support to implementation demonstrations to guide future Federal funding.
- Develop regional approach with matrix of best practices to equip students that reflects regional, industry, and skill demand variability, and what similar states are doing. Increase access to knowledge and information about programs.
- Increase collaboration between regions and similar communities through consortia, networks, and best practice sharing.
- Develop data and new metrics of success for student and education system performance. This could include development of technical skills, critical thinking.
- Funding from CHIPS and Science Act could be used to encourage engagement and collaboration, and build capacity at the regional level.

Working Group 4
The Future of Place-Based Innovation—Broadening and Deepening the U.S. Innovation Ecosystem

Panel

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Table Setting Points:

- Whether looking at inequality or competitiveness, STEM education is important.
- There is concern about brain drain in some communities. Need to develop and cultivate local talent with access to education and opportunities. Community-engaged work and workforce could create a more equitable environment for innovation.
- Remote learning and remote working create both opportunities and challenges for communities.
- Communities can learn from other communities facing similar issues.
- People do not move as much anymore; 80 percent live within 100 miles from where they grew up. Ambition peeks around 33 years of age; after that, people want to settle down.
- People with children need childcare and social support.
- Regions where there has been transformation, such as Silicon Valley and the Research Triangle, have good universities, and engagement from government and the private sector. However, just because those three exist does not mean they help—there has to be a champion and motivation in the population.
- Should seek collaboration rather than competition to avoid a zero-sum game.

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The working group had several shifts, trends, and issues impacting place-based innovation at the top of the mind including accelerated reshoring, the need for an all of government effort, partisanship hurting the United States compared to the laser focus of other nations, there are no initiatives without champions, consistent funding needed for place-based innovation, financing and private sector relevance, adequate physical infrastructure, and barriers to success for those regions that have not undertaken placed-based innovation initiatives before.

Working Group Points of Discussion

- The National Commission is seeking large-scale, continuous (not episodic driven by periodic grants), and widely distributed building of regional innovation ecosystems through place-based strategies. The Commission could identify and engage in significant future-facing place-based thought leadership. The working group should recommend strategies that move beyond the immediate focus of the Inflation Reduction Act, current funding for clean energy and technology hubs, and Regional Engines of Innovation, and keep policymakers focused on long-term ecosystem-building needs.

- No one model will work for all regions; the approach must allow for local flexibility in the design and implementation of place-based strategies. Need different types of strategies, for example, urban, rural, university-driven, Federal lab-driven, specialized industry-driven, and supply chain/industrial policy driven. In addition, we need a new model for communities pursuing place-based work.
- Could place-based strategies be mapped to a deep analytical understanding of industrial policy? For example, if the United States needs to advance the reshoring of essential technologies, where should that be done, and can a region build a place-based strategy around that?
- The National Commission could advocate for higher requirements that efforts at regional and place-based innovation ecosystem building be more driven by industry, not the government.
- The working group intends to integrate the need for immigration reform into its recommendations.
- The rising concern in Washington around the national security imperative to re-shore essential technologies and supply chains, and re-militarization could be harnessed to provide impetus for place-based innovation initiatives.
- Building on recommendations from the National Commission's 2020 report, there must be a coordinated Federal government approach to place-based innovation. Currently, placed-based terminology is not clear for regions, a myriad of funding sources is not aligned to long-term place-based building, and navigating the system is exceptionally hard for smaller regions.
- Predictable funding is essential to building long-term place-based success. The National Commission should revisit the block grant concept for regional place-based building, and explore models such as the Department of Treasury's New Market Tax Credit as an example of predictable funding. The New Market Tax Credit incentivizes community development and economic growth through the use of tax credits that attract private investment to distressed communities.
- Distinguishing economic distress and need from capacity building is essential for regions to direct their efforts and fundraising strategies. There was considerable debate about focusing on fewer regions able to advance more quickly to produce high economic impact versus spreading resources around.

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