Compete.
Council on Competitiveness

Technology Leadership & Strategy Initiative Fall Dialogue

Summary Report

Lawrence Livermore National Laboratory

September 21, 2023

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Introduction

On September 21, 2023, the Council on Competitiveness convened its Fall and 28th Technology Leadership & Strategy Initiative (TLSI) Dialogue, hosted by the U.S. Department of Energy's Lawrence Livermore National Laboratory in Livermore, California. Nearly two dozen leaders from technology companies, universities, and national laboratories gathered to explore the issues, challenges, and opportunities shaping the U.S. innovation ecosystem. Discussions were centered around three key themes:

- Session 1: Changing the Culture of Research and Innovation Ecosystems
- Session 2: Enhancing the Innovation Workforce in Critical Technologies and Industries
- Session 3: Building Innovation Ecosystems through National Domestic Strategies

The dialogue was hosted by TLSI Co-Chair, the Honorable Patricia Falcone, Deputy Director for Science and Technology at Lawrence Livermore National Laboratory. Fellow Co-Chair, Dr. Sally Morton, Executive Vice President, Knowledge Enterprise at Arizona State University, was also in attendance and co-leading the session, along with Council Executive Vice President Chad Evans.

Agenda

MORNING

9:00 Registration, Snacks/Coffee

9:15 Welcoming Remarks

Dr. Patricia Falcone
Deputy Director of Science & Technology, Lawrence Livermore National Laboratory
TLSI Co-Chair

Dr. Sally Morton
Executive Vice President—Knowledge Enterprise, Arizona State University
TLSI Co-Chair

Mr. Chad Evans
Executive Vice President, Council on Competitiveness

9:30 SESSION 1: Changing the Culture of Research and Innovation Ecosystems

Time matters—the need for speed. Leadership in many of the technologies transforming the economic, energy and national security landscape is in commercial firms, high-tech start-ups, universities, and national laboratories. But the commercial sector is moving so fast, the public sector finds it often cannot keep up. The inability to transition key technologies into key public sector partners in a timely manner is arguably one of the largest strategic threats to the United States today. We are innovating amazing technology across the whole ecosystem, but it can take years for it to have its intended impact for national and economic security.

The Federal defense, research, and acquisition culture creates barriers that inhibit engagement with commercial firms and bringing game-changing technologies to the public sector quickly. That culture has arisen from a complex of rules and regulations, policies, practices, controls, metrics, and incentives—a bureaucracy focused on low cost, risk avoidance, and fear of failure. Embedded in the organizational DNA, they drive the culture to which people respond in the course of their work. Similarly, university faculty incentives, including promotion and tenure criteria, revolve around publications and recognition from peers, and technology transition is often not treated as a priority.

At a recent meeting of the Council's National Commission on Innovation and Competitiveness Frontiers, a U.S. national laboratory director discussed how, despite enormous investments in modeling, simulation, and computation, the time it takes to move a new nuclear weapon from idea to first production has doubled since the 1980s' Cold War speed. They found red tape, bureaucracy, and death by a thousand cuts had slowed the process down. Employees were responding to an expectation of perfection, as opposed to excellence, because excellence involves risk taking, and learning from things that do not work.

Contracting officers, program managers, and university faculty are responding to the culture created by tangible rules, regulations, policies, procedures, metrics, and incentives.

Discussion Questions and Possible Guidance for TLSI Action:

- Can the culture be changed? If not, what are the alternatives?
- Are there regulations, rules, policies, or procedures that could be changed or modified to reduce barriers to speed and flexibility, while still maintaining the integrity of the system?
- Could training help? What new training content could help, and offered to which professionals in the ecosystem?
- What could significant Federal research funders do to change the culture?
- How can the United States prioritize and allocate resources to support culture change – and the development of an adaptive and agile industrial base that can quickly respond to evolving economic, national security, energy, and sustainability needs?

Moderator

Dr. Patricia Falcone
Deputy Director of Science & Technology, Lawrence Livermore National Laboratory
TLSI Co-Chair

10:15 SET UP FOR SESSIONS 2 & 3

Over the course of the past year several critical developments have emerged – each of which, on their own, merit attention by TLSI:

Implementation of CHIPS and IRA: Both CHIPS and IRA celebrated their one-year anniversary this August, with both bills firmly in the implementation phase. Capitalizing on investments in commercialization and critical technologies will be key to promoting the innovation ecosystem.

Congressional Focus on China: Congress continues to focus on China, particularly around technology and innovation, as evidenced by the growing interest in a "China 2.0" bill to address competitiveness issues in critical technologies.

Push for Technology Regulation: In recent months, momentum has been growing for expanded technology regulation, particularly of artificial intelligence. Careful policy design will be critical to ensuring that federal action boosts, rather than diminishes, innovation in critical technologies.

Critical Talent Shortages: Talent shortages in critical areas (e.g., semiconductors and cybersecurity) continue to pose a significant barrier to innovation and leadership in key tech.

In this context, Sessions 2 and 3 will touch on several key points:

10:15 SESSION 2: Enhancing the Innovation Workforce in Critical Technologies and Industries

Discussion Questions and Possible Guidance for TLSI Action:

- What technologies and industries are facing the most critical talent shortages? Do these differ in the short run and long run?
- Are there opportunities for the public and private sector to collaborate on addressing talent shortages? Do we need new partnerships or new models of education and workforce training?
- What role does high-skill immigration play in filling talent gaps in critical technologies? Does the current immigration system need any reforms to support this goal?

Moderator

Dr. Sally Morton
Executive Vice President—Knowledge Enterprise, Arizona State University
TLSI Co-Chair

11:00 SESSION 3: Building Innovation Ecosystems through National Domestic Strategies

- How can the United States leverage or reconfigure existing governance structures to create a coordinated national approach to innovation competitiveness?
- How can communication and collaboration between the public and private sector on key innovation challenges be strengthened?
- How can state and regional leadership capitalize on local resources to build innovation ecosystems? What role do these localized efforts play in an integrated, national innovation ecosystem?

Moderator

Mr. Chad Evans
Executive Vice President, Council on Competitiveness

11:45 Lunch

AFTERNOON

1:00 NIF Tour

2:15 High Performance Computing Tour

3:15 Bus transport back to the Livermore Valley Open Campus

3:25 Summary Remarks/Reflections—Next Steps for TLSI in 2023 and 2024

Dr. Patricia Falcone
Deputy Director of Science & Technology, Lawrence Livermore National Laboratory
TLSI Co-Chair

Dr. Sally Morton
Executive Vice President—Knowledge Enterprise, Arizona State University
TLSI Co-Chair

Mr. Chad Evans
Executive Vice President, Council on Competitiveness

4:00 Dialogue Adjourns

Participants

TLSI CO-CHAIRS & COUNCIL LEADERSHIP

The Hon. Patricia Falcone
Deputy Director for Science and Technology
Lawrence Livermore National Laboratory

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

Mr. Chad Evans
Executive Vice President &
Board Secretary & Treasurer
Council on Competitiveness

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Lockheed Martin

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Associate Vice President for Research
Natural Sciences and Engineering
University of Michigan

Dr. Eric Smith
Director, Artificial Intelligence
Lockheed Martin

Dr. Timothy Stemmler
Interim Vice President for Research, and Professor of Pharmaceutical Sciences
Wayne State University

Dr. Marianne Walck
Deputy Laoratory Director for Science and Technology and Chief Research Officer
Idaho National Laboratory

COUNCIL TEAM

Mr. Mike Nelson
Director of Interactive
Subject Matter+Kivvit

Mr. Dhruva Someshwar
Senior Research Assistant
Keybridge

TLSI Dialogue 28 participants at the National Ignition Facility, Lawrence Livermore National Laboratory.


NATIONAL
IGNITION
FACILITY
U.S. DEPARTMENT OF ENERGY
NNSA
National Nuclear Security Administration
Lawrence Livermore National Laboratory

Key Takeaways

U.S. research institutions need to shift toward more use-inspired research, and prioritize the speed of technology development and deployment. The culture at many U.S. research institutions is out of sync with today's highly competitive global economy being reshaped by rapid technological change, posing a risk to U.S. economic and national security. Typically, research universities favor basic exploratory research, and faculty incentives—such as decision criteria for promotion and tenure—focus on research grants received, peer recognition, and publication, rather than rapid translation of research to practical application, useful technology, and innovation. In the Federal R&D enterprise, bureaucracy, contracting and acquisition rules, and many current R&D models inhibit speed and discourage risk-taking, slowing-down technology development and deployment.

Incentives and support should encourage and help university faculty commercialize their research, including providing opportunities for business training and matchmaking with executives and entrepreneurs. To provide compelling reasons for increased state investment in universities, they should develop stronger narratives around the importance of academic research and technology translation to local and regional economic development, jobs, and global competitiveness.

Community engagement can help drive innovation, speed its development and deployment, and nurture potential innovators. Universities and the broader innovation ecosystem should engage with local and regional communities through programs such as cooperative extension. These programs offer channels for disseminating research findings and new technology at the local and regional level, and for gathering public and business input on research priorities and gaps. Community organizations, industry partners, and local government agencies can also identify where infrastructure investments as well as education and skill building efforts are needed.

As technology drives the global economy, underpins business, and is integral to the workplace, positive narratives about and building education capacity to support technology and innovation in the community are essential to developing entrepreneurs and the 21st century workforce. Engagement at the earliest ages through media such as television and film can nurture positive attitudes and interest in STEM and innovation as exciting careers.

Partnerships are critical across the entire innovation process. From research to technology development to building the workforce, partnerships play a crucial role in enabling and accelerating innovation. Partnerships come in many forms, for example, programs that promote research translation to application and use, Federal programs that support the development of pre-competitive commercially-promising emerging technologies, and workforce development programs that identify skill gaps and provide needed training. Organizations should not define their role narrowly, but rather recognize the diverse roles they could play and potential contributions they could make to support the development, commercialization, and scaling of new technology and spurring innovation. These could include public-private partnerships, university-industry partnerships, and efforts that transcend state and international borders.

An evolving definition of "place" opens doors for increased innovative capacity. "Place" has been a concept referring to one geographic location where innovation assets are concentrated. However, with the scaling of the Internet, digital tools for work and collaboration, and the pandemic-induced migration of labor across geographies, "place" is taking on a new meaning. Talent can be sourced from a wide variety of locations, opening access to new pools of workers. Smaller communities with a concentration of remote workers (e.g., workers at satellite campuses) can gain some of the benefits of place-based innovation without needing every asset that larger cities have.

This new view of "place" also opened the door to new collaborations and resource-sharing programs. Often, concentrations of assets no longer need to be physically proximal when accessible by Internet or other remote technologies. For example, the sharing of computing facilities can enable a wide variety of institutions to access technology regardless of location. In addition, collaborations and partnerships can be formed with institutions on the other side of the region, country, or world.

Setting the Stage for the TLSI Fall Dialogue

Chad Evans
Executive Vice President
Council on Competitiveness

Council on Competitiveness Executive Vice President Chad Evans welcomed participants, and outlined the TLSI mission as a "think tank" to provide thought leadership on critical issues affecting the U.S. technology and innovation ecosystem. To expand its scope of engagement, the TLSI summer and fall dialogues will help provide the intellectual foundation for a series of TLSI recommendations presented to policymakers across the country, and to inform the Nation's technology and innovation policies.

The summer dialogue, held at Lockheed Martin's Advanced Technology Center in Palo Alto, focused on developing a more agile industrial base that could meet new challenges in national security, sustainability, and energy. A robust conversation explored how to optimize our innovation systems as U.S. national security increasingly relies on new knowledge and technology developed in the commercial sector and universities. Some specific issues explored include: how to open the aperture for defense innovation; how to more fully engage the private sector and universities to help meet national security needs and defense missions; reducing barriers to small businesses and start-ups to engaging in defense-related projects; access to data, including for AI training; finance and investment issues; and engaging with international allies in technology and innovation.

At both the TLSI dialogue at Lockheed Martin and the summer meeting of the Council's National Commission on Innovation and Competitiveness Frontiers, the need for a cultural shift in the U.S. research enterprise was identified as a key issue to address and on the fall TLSI dialogue agenda along with enhancing the innovation workforce. Finally, the fall dialogue agenda called for participants to explore placed-based innovation, and how to strengthen and better leverage innovation assets in different places around the country.

Mr. Evans mentioned additional efforts taking place under the umbrella of the Council and its National Commission on Innovation and Competitiveness Frontiers:

- National Competitiveness Forum in Washington, D.C., on December 14-15, 2023.
- National Commission virtual working groups focused on four themes:
  - The Future of Sustainability;
  - The Future of Technology: Developing and Deploying Disruptive Technology at Speed and Scale;
  - The Future of Work: Developing, Supporting and Expanding the Modern Innovation Workforce in an Era of Creative Destruction;
  - The Future of Placed-Based Innovation: Broadening and Deepening the U.S. Innovation Ecosystem.
- Developing a Call to Action to present to the next Administration, a policy statement informed by the four Commission working groups and TLSI.
- A new, multi-year engagement platform—"Competitiveness Conversations Across America" carried out through large regional innovation summits hosted by National Commissioners and other Council members with the goal of exploring innovation opportunities and challenges, and to develop a series of best practices and potential recommendations for the next Administration.

  The first regional summit will be held in Nashville, Tennessee on April 25-26, 2024, hosted by the Chancellors of Vanderbilt University and the University of Tennessee-Knoxville—bolstered by a Steering Committee including the Director of Oak Ridge National Laboratory, the Chair of Nissan America, the CEO of Bridgestone, et al. The Tennessee conversation will focus on the future of mobility, including electric vehicle production and the development of next generation batteries. Potential states for convening other conversations on a variety of themes include Indiana, Illinois, Idaho, South Carolina, Alabama, the Massachusetts-Vermont-Maine corridor, the DC-Maryland-Northern Virginia region, Texas, New Mexico, Colorado, and California.

Mr. Evans also pointed to several international engagements including a Global Innovation Summit to be convened in November by the Council's sister organization, the Global Federation of Competitiveness Councils; and a Council "Innovation Arena" held in Dubai in connection with COP28, involving a series of keynote addresses, panels, and fireside chats. COP reached out to the Council in the hope it could bring greater participation from academia and research institutions into the process.

This international agenda sparked a discussion on balancing global engagement with U.S. competitiveness, including the need for international collaboration on solving global grand challenges, friend-shoring, and the benefits of collaborating with allies, while recognizing and managing and mitigating risks to U.S. competitiveness and national security.

Dr. Patricia Falcone
Deputy Director of Science and Technology
Lawrence Livermore National Laboratory
TLSI Co-Chair

Dr. Falcone welcomed participants to Lawrence Livermore National Laboratory (LLNL), one of three U.S. Department of Energy (DOE) national security labs. She provided a brief overview of LLNL's history, its place in the 17 national laboratory system, its management model, workforce, flagship facilities, and mission areas of science and technology.

Nuclear deterrence and nuclear weapons stockpile management is a prime mission at LLNL. A range of science and technology is required to fulfill that mission including lasers, directed energy, and optoelectronics to underpin nuclear deterrence in areas such as countermeasures, access to space, and secure communications.

LLNL is home to the National Ignition Facility, the world's premiere facility for creating extraordinarily high-pressure and high temperature conditions on Earth, the type of conditions in the center of planets and stars.

LLNL is working to nurture science, technology, and innovation for national security through domestic and international partnerships, deepening relationships with universities, and encouraging student interest. Working with industry is critical for deploying technology, and LLNL generates some money out of patent licensing and royalty payments.

She emphasized that, in solving national security challenges, "high walls" can create artificial and unnecessary barriers and secrecy that can lead to bad science outcomes. Also, there is a need for international engagement because U.S. R&D investments are not sufficient to stay on the leading edge of every area. However, in partnering, consideration must be given to: ensuring partners follow the same norms of transparency, integrity, and repeatability in their research; conflicts of interest; and ways to form partnerships quickly.

Dr. Falcone described how LLNL is approaching open innovation and engagement with partners. For example, modeled after research parks, the Livermore Valley Open Campus provides a site where the

private sector and academic communities can collaborate with lab personnel on unclassified R&D. Also, LLNL opened Uclick, the University of California Livermore Collaboration Center with meeting rooms, and where students and visiting faculty can have offices.

Dr. Falcone also discussed the new LLNL Quantum Information Science Center aimed at engaging the quantum community and applying quantum capabilities to the laboratory's existing work, and to support the work of all of the DOE Office of Science in specialty applications.

U.S. Department of Energy (DOE)
Lawrence Livermore National Laboratory (LLNL)

- Established in 1952; created out of the Manhattan Project
- One of 17 DOE national laboratories; one of three designated as a national security laboratory
- FFRDC, part of DOE's National Nuclear Security Administration
- GOCO model operated by the Lawrence Livermore National Security Corporation, LLC with management team from the University of California and industry partners led by Bechtel
- 8,500 employees; 2,000 Ph.D. scientists
- About $3 billion annual budget
- Home to the National Ignition Facility
- Home to 30 of the world's TOP500 high-performance computers
- Science and technology mission areas: nuclear deterrence, lasers, directed energy, nuclear weapons stockpile management, explosives, optoelectronics, photonics, high-performance computing, simulation, data science, earth and atmospheric science, climate modeling, quantum, artificial intelligence, high-energy density science, materials, advanced manufacturing, bioscience and bioengineering, as well as nuclear, chemical, and isotopic science and technology

SESSION 1

Changing the Culture of Research and Innovation Ecosystems

Time matters—the need for speed. Leadership in many of the technologies transforming the economic, energy, and national security landscape is in commercial firms, high-tech start-ups, universities, and national laboratories. But the commercial sector is moving so fast, the public sector often cannot keep up. The inability to transition key technologies from the commercial sector, academia, and national labs into public sector partners in a timely manner is one of the largest strategic threats to the United States today. We are innovating amazing technology across the whole ecosystem, but it can take years for it to have its intended impact for national and economic security.

The Federal defense, research, and acquisition culture creates barriers that inhibit engagement with commercial firms and bringing game-changing technologies to the public sector quickly. That culture has arisen from a complex of rules and regulations, policies, practices, controls, metrics, and incentives—a bureaucracy focused on low cost, risk avoidance, and fear of failure. Embedded in the organizational DNA, they drive the culture to which people respond in the course of their work. Similarly, university faculty incentives, including promotion and tenure criteria, revolve around publications and recognition from peers, and technology transition is often not treated as a priority.

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Contracting officers, program managers, and university faculty are responding to the culture created by tangible rules, regulations, policies, procedures, metrics, and incentives.

Discussion Questions

- Can the culture be changed? If not, what are the alternatives?
- Are there regulations, rules, policies, or procedures that could be changed or modified to reduce barriers to speed and flexibility, while still maintaining the integrity of the system?
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Dr. Patricia Falcone, Deputy Director of Science & Technology, Lawrence Livermore National Laboratory, and TLSI Co-Chair.

- What could significant Federal research funders do to change the culture?
- How can the United States prioritize and allocate resources to support culture change – and the development of an adaptive and agile industrial base that can quickly respond to evolving economic, national security, energy, and sustainability needs?

Points of Discussion among Dialogue Participants

1. Roles of government, industry, and universities in the innovation ecosystem.

The roles of government, industry, and universities are mostly siloed in the U.S. innovation system. Universities are viewed as fundamental research drivers, the commercial sector is focused on winning markets, and the government is generally confined to mission and national security related research and technology development. This model may be antiquated for a broadening view of "national interest."

Dialogue participants suggested:

- We may need new models. R&D is important to solve problems even at the deployment stage. Federal investments should anticipate research expenditures at the deployment stage rather than just at universities doing basic research.

2. Roles of government and the private sector in de-risking and scaling technology.

The Federal government is increasingly engaged in pilots and demonstration projects to de-risk technologies. The national environment is increasingly focused on deployment at scale, with pilots viewed as a phase one to demonstrate feasibility, capability, and economics, and to move toward adoption for those technologies that have demonstrated promise. But we often do not go ahead.

After a Federally-supported pilot or demonstration, the private sector may not see a commercial market large enough or a technology that can be commercialized fast enough to generate an adequate return on the investment needed to bring the technology to market and scale, for example, when the technology is developed to meet a government or national security mission. Similarly, venture capitalists lack patience and want to see returns quicker.

Unlike in China, the Federal government is reluctant to make command decisions, determining where technology investments are allocated, and undertaking concerted efforts to develop an infant industry or emerging technology. This heavier hand may have the benefit of speedy deployment and scaling, but can lead to failures. A robust market is required for the private sector to commercialize and scale new technology developed to address Federal priorities and the national interest. For example, to help meet the national need for clean energy, the Federal government has invested heavily in advancing solar energy technology, but China holds the competitive advantage across the solar supply chain. Countering this requires a focus on scalable markets from the outset, as well as public-private partnerships aimed at commercialization.

We need to look at China and other nations not only as competitors but also collaborators, especially in an era where science and technology cooperation between the United States and China has become politically controversial. But, in some areas of science and technology, at least by some measures, China is leading the United States. We need to consider whether we want to work with the global leader or not.

The U.S. system of research and technology development is relatively decentralized. There are a lot of smaller projects going on at the same time, leading to smaller failures. But there is trouble scaling and a lack of speed, and hoped for benefits may not materialize. While the United States should not adopt a centralized planning and command approach, we do need a framework for collaboration that allows us to be more competitive with countries whose governments make unilateral decisions on investments in technology, innovation, and industry development.

In the Federal government, there is a bias toward avoiding risk and a reluctance to make big bets to drive innovation quickly. Technical requirements may be set lower than the state-of-the-art in favor of the least risky and least expensive technology or solution. Processes are extraordinarily slow. This is one reason why the United States fell behind in hypersonics—we had failed hypersonics tests and could not live with that, even though doing anything well requires a lot of experiments.

Dialogue participants suggested several potential actions to lower these barriers to speed and scaling:

- The Council could advocate for the key role pilot, demonstration, and deployment acceleration programs play toward moving new technology towards adoption at scale.
- Establish partnerships between government, researchers, industry, and other non-governmental partners at the beginning to get some buy-in in pilot programs. For example, industry might be motivated to support a pilot of a technology that could be important to the industry. Also, early engagement can help researchers better understand industry problems and needs, identify potential applications and industry uses early, provide mechanisms for cost-sharing the de-risking of precompetitive technologies, while industry partners can plan for commercialization and deployment.
- Although technology development and translation are key to national and economic security, this narrative is not prevalent. The narrative must change to emphasize the value of investments for security and global competitiveness. Universities, the government, and the private sector must all play a role in articulating the need for these investments.

3. Emphasizing both use-inspired and mission-driven research and development

Understanding the need for a technology underpins decisions about investment. This helps identify the potential for a robust market for the private sector and to address significant government mission, and national economic and security needs. However, many current technology investments and projects are "push" rather than "pull"—prioritizing basic wide-ranging research, developing technologies, and determining use cases and the market landscape afterwards. This approach extends the time it takes to address needs, for example urgent national security needs, as additional work and investment are needed to translate research or further develop emerging technology for application to a specific need, problem, or market opportunity. Instead, we should define a pressing problem or need, mobilize a community of people to solve it, and align R&D and program investment.

However, government, universities, nor the private sector should be expected to define the agenda or priorities for the innovation process end-to-end. Each sector can contribute to advancing technology at different points in its development, maturation, commercialization, and deployment, but collaboration between these contributors can ease and accelerate the process.

A use-inspired approach does not exclude performing foundational research. Basic research is critical for creating the new knowledge needed in the long run to solve problems and meet future national needs, but should be connected to the innovation ecosystem to maximize its impact. For example, Pittsburgh and Carnegie Mellon have become the place to go in the field of robotics. They have the whole spectrum of research and faculty researchers, including connections to people working on foundational aspects, building out an end-to-end robotics ecosystem where you can have conversations on the most pressing challenges but not be completely disconnected from driving innovation and the technology. Similarly, faculty may indicate they perform only Federal 6.1 and 6.2 research. However, sometimes it is important to have a classified or proprietary conversation, or controlled information around that research, and academia has a hard time with that.

What works is defining a problem and having people work towards solving it. If there is a national security need, you can compartmentalize and chop it up into things that people can work on. We do this in software, and not everybody understands every line of code.

Moreover, research can go from fundamental to commercially applicable very quickly (e.g., gene editing and CRISPR) with the thought that it is ready to deploy and, therefore, no research is needed at the national level. However, as the research or technology is deployed, additional research, problem solving, and troubleshooting may be needed.

Dialogue participants suggested several approaches for injecting use considerations in research programming:

- University faculty performing foundational research should be open to pre-competitive conversations about their research with potential users, especially those developing technologies and solutions for national security.
- International collaboration can play a valuable role in accelerating the research process, commercialization, and scaling. The United States should identify specific areas of science and technology in which collaboration with allies would bring critical knowledge, expertise, and investment to the table. Collaborations between universities and institutions in partner countries can help build U.S. and key ally capacity and capabilities in certain fields critical for the future. The TLSI could reignite some U.S.-Australia engagement involving U.S. universities, U.S. companies, and labs and a relatively small investment to accelerate advancements in three or four areas.

4. Supporting pathways to research translation, technology transfer, and deployment in industry and the wider community of potential users.

Translating research into technology, solutions to problems, and impact does not necessarily need to come in the form of traditional commercialization. Non-commercial, community pathways can also be a valuable way to translate and deploy research and new technology.

Cooperative extensions are a proven model serving both commercial and non-commercial pathways to move new knowledge and technology into the broader innovation ecosystem and community of users. They have long been key for translation in sectors such as agriculture, and could be considered for other sectors and problems. For example, George Mason University is looking at an extension model to move ideas on climate resilience from the university into the community, and not thinking about intellectual property and spin-outs.

Dialogue participants offered insights and suggestions on supporting pathways to translation:

- Cooperative extensions should be expanded across other industry sectors and potential user communities. They can help connect faculty members to local businesses, community organizations, interest groups, and citizens,

disseminating new knowledge and technology, providing practical education, and translating research results into language appropriate for targeted audiences. Research faculty can hear from businesses and the community of potential users on how to improve research and future research priorities, enhancing researchers understanding of the industries locally and the needs of other communities.

5. Transforming university models and incentives to promote research translation

Current university culture and incentives are not well aligned with research translation, technology transfer, or collaboration with business for commercialization. Historically, university researchers and their incentives have focused on performing fundamental and bleeding-edge research that gets the papers, tenure, and peer recognition. There has been much less reward in turning research into things that impact society. Often, industry engages in the innovation process on a proprietary basis once promising research reaches the competitive stage. In some cases, Federal research is conducted on a classified basis, and some universities are reluctant to engage in classified research. As a result, many university faculty operate in a relatively narrow lane.

Increasingly, young researchers seek to carry their research through to the deployment stage, for example, by leaving universities to run a start-up company or have graduate students do it on their behalf, circumventing the existing system to do what we want them to do. Many other faculty view themselves as strictly researchers, separate from the private sector or applications of their research. University research faculty may not have the skills or desire to start a business. Moreover, industry is changing so rapidly, many universities cannot keep up because the timescale at which they change is much slower.

Some university administrators see the university is out of sync with how academics see themselves and even with some Federal funders because there is a lot of money for applied projects going to universities. There is interest in societal impact, and that also may be disconnected from the research culture. Faculty members may show no interest in commercial translation. However, faculty does not have to focus on commercialization, but rather translating their ideas and sharing their discoveries with the outside community.

Dialogue participants identified several approaches to changing the culture at universities:

- Federal research funders can play a pivotal role in changing university culture by promoting translation as a priority for gaining grant awards and other support. Several Federal programs are starting this process, including the National Science Foundation TIP Directorate, DARPA, ARPA-H, and others.
- The promotion and tenure process should incentivize different kinds of activity, including translation and commercialization.
- Matchmaking systems could pair researchers interested in translating and commercializing their research with MBAs and business professionals. For example, one participant mentioned a venture capital arm within their laboratory system that aids company creation by finding an executive team for commercial-ready research.
- The university should provide opportunities for interested faculty to learn start-up skills and the basics of business and markets. Both training and matchmaking opportunities should not be limited to young people, but also include mid- and late career researchers and potential entrepreneurs.
- Reframing the translation narrative to a broader concept and changing incentive structures could encourage faculty to engage in more translational activities.

SESSION 2

Enhancing the Innovation Workforce in Critical Technologies and Industries

"Innovation at scales requires workforce at scale."

Discussion Questions

- What technologies and industries are facing the most critical talent shortages? Do these differ in the short run and long run?
- Are there opportunities for the public and private sector to collaborate on addressing talent shortages? Do we need new partnerships or new models of education and workforce training?
- What role does high-skill immigration play in filling talent gaps in critical technologies? Does the current immigration system need any reforms to support this goal?

Participants discussed the lack of talent in advanced and emerging technologies such as semiconductors, cybersecurity, and quantum computing, posing a significant barrier to innovation and leadership in critical technologies. Demand for technology-related talent will grow in the years ahead, and scaling the supply of talent will be required to scale emerging technologies.

Ensuring the United States has the workforce it needs to develop and deploy emerging technologies at scale with speed requires strengthening the talent pipeline across the entire education and training continuum—from children in kindergarten to training of scientists and engineering to developing skilled labor to keeping late-career professionals on the cutting edge of technology.

Points of Discussion among Dialogue Participants

1. Strengthening a culture of lifelong learning

As technology advances rapidly, and new scientific and technical possibilities are unleashed, workers need to continue learning throughout their lives and careers. From technical workers to executives, continuing education and training are required to maintain our position as the most skilled innovation workforce in the world.

Dialogue participants identified several areas for improvement:

- Current and future workers need a strong baseline of scientific and technical knowledge. STEM education, particularly at the K-12 level, is critically important to provide the foundation of knowledge needed, and to nurture engaged students capable of progressing through higher education and their careers.
- In both the public and private sectors, leaders and decision-makers are often unable to keep up with the pace of technological change. Knowledge around technical aspects and capabilities of new technologies often becomes separated from the people who are overseeing and making decisions about programs. Executive education programs may be needed to arm leaders across government agencies, universities, industry, and other organizations with the information necessary

to understand emerging technology-related issues and make good decisions. This is an area where universities and their faculty can be invaluable.

- Not all people will attend college. Institutions of higher learning should find alternative pathways to boost community engagement and share knowledge. Universities could play a role beyond their typical students through community college partnerships, certification programs, or grassroots engagement.

2. Enabling the workforce at scale

Looking across the innovation economy, almost every sector faces the challenge of meeting workforce needs. In addition, the population in many communities and regions of the Nation are disconnected from the broader innovation ecosystem, and the wealth and opportunities it generates.

Dialogue participants offered several thoughts on improving the workforce at scale:

- Ensuring an adequate supply of workers across the technology-driven economy is a challenge that will require national, regional, and local efforts.
- Building a highly skilled workforce can help revitalize physical communities, strengthen the innovation ecosystem, and build new opportunities for workers.
- Many workers fear and are antagonistic of the potential impacts of new technologies such as artificial intelligence. There are many change forces out there that are, in many cases, showing growing disconnects between the workforce of the future at all levels, including a workforce that can be retained, retrained, and energized. Universities and regional communities can play a large role in a positive reframing of the role of technology in the economy and engaging workers in exciting new career areas being driven by it.
- There are opportunities to improve workforce development through targeted investment in critical workforce areas. For example, the National Science Foundation's Established Program to Stimulate Competitive Research (EPSCoR) aims to enhance research competitiveness of targeted jurisdictions, and it could be leveraged to catalyze workforce development in critical areas of technology and innovation.

3. Igniting interest in STEM careers

In the United States, there is a negative public perception about science and engineering, especially among youth. Often, popular culture does not portray scientists and engineers as aspirational, but rather as characters to laugh at on TV. Young people do not commonly view STEM careers as a positive social status indicator; they want to be social media influencers. Changing the narrative to promote science and engineering, especially among children, will be critical to maintaining a high technology and innovation workforce for the future.

Discussants offered avenues to address this issue:

- The Nation needs media images and content that portray scientists and engineers as heroes to inspire children, especially at a young age. For example, Tom Cruise and Top Gun led to children wanting to be pilots, and the Hunt for Red October did the same for submariners. In Korea, there is a nursing shortage, so the media created several television shows centered around positive depictions of nurses. Taiwan launched a similar campaign for manufacturing.
- Immigration is another important lever for strengthening the workforce. Immigrants can change their economic and social status by working in STEM-related careers.

- At education institutions—from K-12 to post-graduate programs—science and engineering are often taught in a mystical, non-enjoyable manner, focusing on the jargon, mathematics, and complex theories. Few teachers are armed with the skills and experience to teach practical, exciting, and enjoyable science and engineering courses that can inspire and engage students to delve further into the fields. Changing the culture to emphasize inclusion and arming instructors with the skills to better engage their students will be key to encouraging more people to pursue STEM careers.

4. Re-engaging workers post-pandemic

The COVID-19 pandemic had profound effects on the workforce and the general public's attitude towards work. A recent HP study reported that nearly three-quarters of knowledge workers have an unhealthy relationship with work and, of those, about three-quarters contemplate leaving their companies. Seventy percent say they are willing to take a salary cut to work somewhere that lets them work where they want.

Discussants offered insights and suggestions to address this issue:

- The pandemic made many people reevaluate their lives, and think more about their preferences and desires in a career. In addition, the vast majority of workers are disengaged from work and the organizational mission. Solving this problem starts with meeting workers where they are. Employers will need to allow more flexibility and be more attentive to workers' needs to maintain a positive and engaged workforce.
- Tying one's identity to a job or career has been a mindset prevalent in recent decades. During the pandemic, many people concluded that this mindset is not healthy and careers can fit into a greater life purpose. Accordingly, work needs to be fun, exciting, and fulfilling to satisfy workers' needs. This requires an intentional cultural shift, championed by organizational leadership.

TLSI Dialogue 28.

SESSION 3

Building Innovation Ecosystems Through National Domestic Strategies

"We have a lot of advantages compared to the rest of the world. So why aren't we optimizing those?"

Discussion Questions

- How can the United States leverage or reconfigure existing governance structures to create a coordinated national approach to innovation competitiveness?
- How can communication and collaboration between the public and private sector on key innovation challenges be strengthened?
- How can state and regional leadership capitalize on local resources to build innovation ecosystems? What role do these localized efforts play in an integrated, national innovation ecosystem?

Vibrant and dynamic local and regional innovation ecosystems are an essential component of a strong national innovation environment. However, many communities and regions are under tapped or not part of an innovation ecosystem, lowering the U.S. capacity for innovation and leaving large swaths of the country behind. Bringing these communities into the innovation economy presents a massive opportunity for new specializations, increased national capacity, and a more agile national system. However, capturing this opportunity brings many challenges, including building strong local workforces, securing and sustaining funding, and building supporting infrastructure.

Points of Discussion among Dialogue Participants

1. Driving strategic investment

Communities need funding for research, to build infrastructure, and attract workers. However, obtaining funding is often difficult and resource-intensive, and maintaining the steady stream of funding necessary for innovation ecosystem development is even harder. Although many funding streams exist, especially following the place-based investments in the IRA, IIJA, and CHIPS bills, more support is needed to ensure that resources are allocated strategically across communities.

Discussants identified several areas of challenge that need to be addressed:

- The Nation lacks tax structures and financial incentives that encourage investment in certain technology areas. While the government should not pick individual winners and losers, it can play more of a role in strategically targeting technology areas. Also, more investment could be directed to areas of technological convergence, and technologies that lend themselves to physical objects and physical ecosystems, with local ecosystem development a next step. For example, as part of the Federal strategy for advancing quantum information science, the National Institute of Standards and Technology supported the establishment of the Quantum Economic

Development Consortium, aiming to enable and grow the quantum industry. More than 100 companies are talking and working together, along with dozens of university and Federal government partners. However, the model has some mixed reviews.

- In another area of technology, there are companies that want to do new nuclear. There are some loan guarantees, but the regulatory structure and inability of government to pick winners is a hurdle for getting it over the finish line with speed and scale. There is interest in Eastern Idaho in creating a nuclear corridor, but there is a lack of infrastructure, uncertainty about what is going to be the winning technology, and inadequate local capital and workforce.
- Investment from state and local governments is crucial for building R&D excellence, for example, in higher education institutions, and regional and local innovation ecosystems. However, many state and local governments lack a compelling narrative about the value of the research university. Universities can play a critical role in developing and promoting the narrative around research, helping constituents understand that these taxpayer investments are going to drive economic development.
- Strategic coordination is essential for both capital investments and the allocation of resources, particularly in areas critical for economic and national security. For example, cybersecurity is a large and critical national and cross-sector challenge requiring collaboration among Federal agencies, national laboratories, and industry. CISA, ONCD, and other organizations are working together, coordinating investments, and sharing information to stop cyber threats. Similar collaborations involving the public and private sectors are needed for other critical technology areas.

2. Building local ecosystems through concentration and proximity

A concentration of innovation assets—talent, research capabilities, educational capacity, and economic opportunities—is crucial for building local innovation ecosystems. When these factors come together in the same geography, funding and further opportunities often follow.

Dialogue participants raised several important areas to explore and examples to learn from:

- Bringing multidisciplinary talent together within the same region or community can increase random encounters and foster new collaborations. Building innovation districts within communities to encourage physical co-location can help spur further innovation. Also, there is often an increased level of trust and collaboration with in-person work.
- Teaming efforts among universities, governments at all levels, and venture capital were critical for Pittsburgh's economic renaissance rising from the development of a geographic concentration of assets on robotics. This concentration of assets enabled Pittsburgh to attract top talent and develop a globally-leading specialization in robotics, spurring further investment and development. However, this ecosystem, and many others like it, are fragile. Sustained government support and steady funding are necessary for Pittsburgh to continue growing its innovation ecosystem, including building out the regional supply chain and attracting further talent.
- The Center for Space, High-Performance, and Resilient Computing (SHREC), an NSF-supported Industry-University Cooperative Research Center, is advancing capacity-building efforts in space computing, high-performance computing, and computing for harsh or critical environments. Building and operating satellites requires large investments in infrastructure and computing. While different organizations can develop these resources independently, that approach siloes technical capabilities and infrastructure, and results in duplicative investments. Through

SHREC, several universities and industry partners share access to satellite-enabling infrastructure, saving resources and democratizing innovation assets. This resource-sharing approach can be a useful model to apply across different sectors and areas of technology.

3. Engaging workforces across new "places"

Even when research is occurring at national laboratories or universities in a region, a lack of local capital and workforce can be a significant barrier to place-based innovation. Building a workforce is critical for capitalizing on innovation assets such as research universities and encouraging further ecosystem development.

Dialogue participants suggested several workforce development solutions:

- The pandemic resulted in a more diffuse workforce, especially among highly-skilled and technology workers. Even as the "return to work" movement begins, workers are more diffuse than pre-pandemic. For example, at Amazon, employees are being directed to return to the office, but can now choose to go to several disparate regional locations. This more distributed model could shape the future of place-based innovation; smaller talent concentrations can become seedlings to create new innovation districts and ecosystems.
- Addressing infrastructure problems such as broadband connectivity, especially in rural communities, will enable new people to join the innovation workforce. New sources of talent can be tapped through remote work or as enterprises move into areas with newly-built infrastructure. Even small investments can have a large impact given effective communication.
- Increasing engagements with local communities and the people who surround research enterprises can help build trust and motivate them to join the innovation workforce, bringing in new ideas and perspectives in the process.
- Branding can be an issue. Despite its many attractive features, the Midwest has been branded the "Rust Belt" or "flyover country," making it hard to attract people. In reframing the conversion, the story cannot be just about qubits or molecules. There is some rebranding of the Midwest to "The Heartland," and efforts to share stories about what is happening in these communities. Pittsburgh has also struggled with an image issue. For example, as students consider attending Carnegie-Mellon University, they have a negative perception of Pittsburgh.

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