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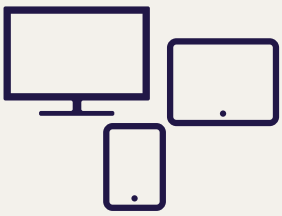
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NATIONAL ACADEMIES Sciences Engineering Medicine

Proceedings of a Workshop—in Brief

Convened June 24, 2026

National Conversation on Reimagining the U.S. Research Enterprise

Cross-Sector Perspectives and Emerging Opportunities (Conversation 2): Proceedings of a Workshop—in Brief

INTRODUCTION

The United States' research enterprise remains a global leader in discovery, talent development, and institutional capacity, yet its ability to translate scientific strength into sustained economic, workforce, and societal outcomes has weakened over time. Multiple national assessments have concluded that the core challenge is not a lack of scientific excellence, but fragmented governance, misaligned incentives, and insufficient coordination across research, workforce, and innovation systems. Public funding, private investment, and philanthropic support often operate on different timelines and risk assumptions, leading to gaps in mid-stage research, scale-up, and workforce preparation. These structural frictions reduce returns on research investment and slow the diffusion of innovation into the economy. Workforce challenges further compound these issues.

The Government-University-Industry-Philanthropy Research Roundtable (GUIPRR) of the National Academies of Science, Engineering, and Medicine is committed to improving the research enterprise of the United States by identifying cross-sectoral issues that prevent it from reaching its full potential. On June 24, 2026, GUIPRR convened the second workshop in a series of three in Washington, DC, to explore cross-sector opportunities for strengthening human capital and workforce development and to examine system-level structures and funding mechanisms that can effectively drive innovation. The workshop highlighted innovative models and promising approaches while surfacing considerations for their implementation, scalability, and sustainability, as well as opportunities for cross-sector partnerships.

The first workshop in a series of three, *The U.S. Research Enterprise and the Nation's Economic Future*,[1] held March 31–April 1, 2026, examined how the nation's research capabilities contribute to economic growth, job creation, and competitiveness through a robust innovation ecosystem. Discussions explored innovative funding models and partnerships, including the roles of government, industry, academia, and philanthropy in supporting research and innovation. Participants also considered the metrics used to measure the value of research and development and the role of artificial intelligence in shaping the research enterprise. Building on these discussions, the second workshop focused more specifically on workforce development, institutional structures, and approaches to strengthening collaboration across sectors. A third workshop, scheduled for December 2026, will explore themes emerging from the first two conversations and provide opportunities to examine potential strategic approaches

[1] For more information, see https://www.nationalacademies.org/projects/CAST-STPL-25-03/publication/29415.

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and inform possible future National Academies activities related to the U.S. research enterprise.

"Today's workshop brings together leaders from industry, philanthropy, government, and academia," said GUIPRR co-chair **Darryll Pines** (University of Maryland), noting GUIPRR's focus on increasing collaboration across these sectors. He described the workshop as being organized around two themes: the science of science and what works for driving innovation and strengthening human capital and workforce development. Expert panels addressing these themes were interspersed with facilitated tabletop discussions that provided workshop participants with opportunities to respond to critical questions, share perspectives, and consider promising approaches and implementation challenges.

PANEL 1: THE SCIENCE OF INNOVATION

Morgan Weidow (Shadow Ridge Analytics) moderated the first panel focused on the science of innovation. Panelists from higher education and the private sector shared insights from their work to inform how to strengthen the U.S. research and innovation enterprise.

Building a Campus-wide Innovation Ecosystem and Culture of Innovation—Early Stages

Dean Chang (University of Maryland [UMD]) covered the early stages of creating campus-wide innovation ecosystems, recognizing a full progression that ranges from introducing concepts of innovation through courses and workshops to starting companies and investing in these companies with university funds. Chang pointed to UMD's awards and high national rankings in entrepreneurial achievements as one indication of the university's return on investment (ROI) in innovation over the past 15 years.[2] He described UMD's approach to innovation across three dimensions: students, faculty, and strategic focus.

UMD's business and engineering schools have offered strong entrepreneurship programs for several decades, but Chang described the year 2012 as an inflection point marked by the launch of several initiatives. The Academy for Innovation and Entrepreneurship was created out of the provost's and president's offices with the goal of engaging students in innovation and design thinking across all 12 of UMD's colleges. Chang said this support helped cultivate a campus-wide culture of innovation and entrepreneurship, with about half of all UMD students now taking at least one course in the area. The Do Good Institute was created to support start-ups for social good. The Southern Management Leadership Program offers scholarships to community college transfer students in all majors who minor in technology entrepreneurship. The Startup Shell also was created in 2012 as a student-run and -led incubator and has led to the creation of 300 start-ups to date.

In 2012, the National Science Foundation (NSF) selected UMD to create the National Innovation Network, which has evolved to serving as the lead university for the I-Corps Mid-Atlantic region hub.[3] From 2022 to 2026, training and other support has resulted in 344 start-ups, raised $200 million, and created 940 jobs. Chang described the program as transformative for faculty, graduate students, and post-docs.

Chang also discussed UMD's strategic focus on quantum science and technology, tracing the development of the region's quantum ecosystem to investments the university began making more than two decades ago in collaboration with partners such as the National Institute of Standards and Technology (NIST). Chang described IonQ's growth as part of the context for subsequent public and private investments in the region. In January 2025, Maryland's governor committed $1 billion to scale the state's quantum innovation ecosystem, followed by a $100 million Defense Advanced Research Projects Agency (DARPA) initiative centered at UMD to advance quantum technologies for national security. Chang also noted Microsoft's announcement that it would locate its quantum headquarters next to UMD's campus. He used these developments to illustrate the role of government, universities, and industry in building a regional innovation strategy around a long-term area of research investment.

Building a Campus-wide Innovation Ecosystem and Culture of Innovation—Later Stages

Building on Chang's discussion of the early stages of developing an innovation ecosystem, **Bryn Rees** (University of Colorado [CU] Boulder) discussed his institution's

[2] For more information, see innovate.umd.edu.

[3] For more information, see https://www.midatlanticicorps.com.

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experience with later stage commercialization and creation. Rees said the university's generation of spin-out companies compares favorably with the venture capital (VC) hubs of Boston and the San Francisco Bay Area. He cited a 5-year study showing that CU Boulder's commercialization activities translated to almost $9 billion in economic impact and 31,000 jobs.[4] He stressed the value of using economic impact data to demonstrate the outcomes associated with federally supported activities instead of using anecdotes.

Rees framed these outcomes in the context of what he described as a challenge faced by every ecosystem: closing the gap between invention and commercialization. He said that this gap is unlikely to be traversed without intentional efforts to support commercialization. To address challenges related to mindset, mentorship, and funding, CU Boulder created resources, drawing on an approach developed at Babson College. Rees distinguished this model from traditional tech transfer, noting that it is an intentional effort in venture creation, acceleration, and funding. He also discussed CU Boulder's adoption of the Boulder Thesis, developed by entrepreneur Brad Feld, and its four principles for a successful ecosystem: (1) center entrepreneurs as leaders, (2) offer a steady, year-round series of opportunities and supports, (3) make the ecosystem accessible and open to all participants, and (4) is long-term perspective and commitment.[5]

As one example, Rees described the Embark Deep Tech Startup Creator, which pairs experienced serial entrepreneurs with top university innovations.[6] He explained that this program responds to a challenge he has observed in commercialization in which many investors are not interested in technologies at an early stage of development, while many innovators are not interested in forming and leading companies themselves. From hundreds of applicants, about 10 start-ups are spun out per year, according to Rees. He also highlighted Destination Startup—a program focused on access to capital through a showcase that attracts in-state and out-of-state investors.[7]

Building a Translation Infrastructure

Ashwith Chilvery (Future Use of Energy in Louisiana [FUEL]) discussed FUEL as a place-based innovation ecosystem funded through NSF's Regional Innovation Engine programs.[8] As context, he characterized the United States as having a robust discovery infrastructure while lacking a developed infrastructure for translating discoveries into applications. He described innovation as national in ambition but regional in execution, explaining that FUEL focus on innovators, intellectual property (IP), investors, and infrastructure within regional ecosystems. Chilvery identified a few key sources of friction that can affect the translation of discoveries: misaligned incentives, as different sectors optimize for different outcomes; fragmented accountability, as no single institution oversees the journey from discovery to deployment; and mismatched timelines, as technology maturation exceeds grant, political, and investment outcomes.

Chilvery described FUEL's approach to reducing these frictions through activities that include scouting and validating technologies, operating a talent lab, and ensuring that ventures are investable and scalable within Louisiana's carbon innovation sectors. He said FUEL also is building an evidence-based innovation system to measure impact through outcomes using key metrics such as industry participation, start-up formation, and economic impact for Louisiana. Chilvery characterized innovation as the product of system design that can support the movement of discoveries from the lab toward applications that create jobs and lead to economic resilience. "In the 21st century, competitiveness belongs not to just the countries that generate the most ideas but to those that translate the most ideas into impact too," Chilvery concluded.

Industry's Role in Innovation Ecosystems

Sara Scharf (BAE Systems) noted how her experience in government, start-up, and corporate settings has shaped her perspective on innovation. Now involved in external innovation and partnership scouting, she seeks entities

[4] For more information, see https://www.colorado.edu/venturepartners/media/3578.
[5] For more information, see https://newsletter.ecosystementrepreneur.com/p/the-boulder-thesis-by-brad-feld.
[6] For more information, see https://www.colorado.edu/venturepartners/opportunities-and-events/embark-deep-tech-startup-creator.
[7] For more information, see https://www.colorado.edu/venturepartners/opportunities-and-events/destination-startup.
[8] For more information, see https://www.nsf.gov/funding/initiatives/regional-innovation-engines.

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that might have technologies of interest to BAE Systems in aerospace, platforms and services, intelligence and security, and electronic systems. She explained that the research and development (R&D) groups to whom she reports are looking for next-generation technologies versus suppliers that can already produce at scale. BAE Systems identifies potential start-up and university partners through several channels, she said, including setting up accelerators, partnering with other accelerators, holding open calls, and interacting with venture capital firms and universities. For example, in one accelerator effort, BAE Systems reached out to performers funded by DARPA. Scharf said selected applicants receive mentorship and other forms of support.

Drawing on these experiences, Scharf shared observations on how industry, academia, and government can better work together. She emphasized the value of understanding differences in terminology across sectors to facilitate communication, pointed to capstone projects and research consortia as ways industry can engage with universities, and urged forming local connections between companies and regional universities. Scharf also noted the need for alignment in contracting and legal arrangements, as well as incentives for tenure-track faculty to work on issues pertaining to national security.

As her biggest takeaway, Scharf emphasized the value of universities understanding the research and technology interests of potential industry partners. She explained that, from her perspective, industry will not fund research at universities for its own sake but rather will seek to fill gaps and needs. She has found that the best partnerships occur when a potential partner has done their homework to understand BAE Systems' activities and can identify areas where their capabilities and the company's interests align.

Learning from Success

Christina Yancey (American Institutes for Research [AIR]) discussed her background in talent development and incentivizing evidence-building ecosystems to grow and expand innovation. She posed that this entails "how we learn from successes to scale effective innovation that results in economic growth and expands human potential." Yancey suggested that one approach is to integrate talent pipeline development with innovation.

As an example, Yancey said, most of the resources from the American Recovery and Reinvestment Act of 2009 and the CHIPS and Science Act of 2022 went to the Department of Commerce and NSF, but an interagency agreement allowed the Department of Labor to help design requirements around quality jobs to be attached to funds.[9] Yancy pointed to conditions established at the outset of projects, including evidence-based conditions, such as paying individuals higher than the prevailing or minimum wage and providing benefits.

Yancey also discussed the amount of workforce data, particularly microdata, that is collected and described the need to collect workforce data more systematically to better use it. She highlighted two areas being studied: the establishment of metascience offices and applying R&D frames to the social and behavioral sciences. Yancey pointed to the approach utilized by DARPA, which offers a model to incentivize speed, iteration, and scale. She identified other models of funding that also exist and can be applied to talent development, such as milestone payments, rapid reviews, and tax incentives.

Discussion

Chang and Rees were asked how their universities launched campaigns to support innovation, in terms of initial capital and whether university funds are expected to be repaid or recovered. Rees responded that rather than present university leadership with a grand plan that required a large up-front investment, CU Boulder followed an entrepreneurial path by piloting programs before making subsequent investments. Rees said it was a slower process but also was financially conservative. He said that moving step-by-step allowed the university to demonstrate engagement, impact, and traction while minimizing risk. He contrasted this approach with other countries where, he said, large influxes of government capital had not produced the intended results.

Rees also discussed university-dedicated venture funds, which can take an equity interest, but he said this should be a secondary goal. In his view, a major problem that stops universities from being successful is over-correction on ROI maximization on start-up deals, which limits deal flow. Chang agreed and noted that added costs go up

[9] For more information see, https://www.fcc.gov/general/american-recovery-and-reinvestment-act-2009 and https://www.congress.gov/bill/117th-congress/house-bill/4346.

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exponentially along the discovery-to-innovation pathway. He said it is easier to invest in the early stages of innovation, such as training. He added that UMD now has its first venture capital fund, which has met a unique need by focusing on job creation in the county where it is located.

Asked whether universities, nonprofits, or other entities should lead NSF Regional Innovation Engines, Chilvery noted that Louisiana State University leads FUEL, but that this is an exception nationwide. In his view, the right lead organization depends on who can manage relationships and demonstrate the ability to conduct activities at scale. Rees noted that he serves as a co-principal investigator of the Colorado and Wyoming ASCEND Engine, which is led by Innosphere Ventures.[10] Rather than a gross characterization of which type of organization should take the lead, Rees said it is a more nuanced decision based on what is needed in a particular situation.

The panelists continued to discuss venture philanthropy as a source of funding. Rees said CU Boulder explored this funding but found greater interest in ROI-based venture funding in their ecosystem. He noted venture philanthropy efforts at the University of Michigan and Indiana University, among others, who have launched such funds, and said factors such as a powerful donor base can affect the feasibility of this approach. Rees estimated that approximately 5 percent of university-affiliated venture funds use a philanthropic model. Chilvery said FUEL is exploring venture philanthropy as a part of its capital stacking strategy.

A participant asked whether the use of specialized nonprofits at universities can facilitate contracting processes or provide alternatives to existing contracting processes. Scharf said she welcomed more flexibility in contracting and that nonprofits are a way to offer creative alternatives. Yancey highlighted the work of the Institute for Progress, which has aggregated incentive structures around funding and recently released the Atlas of Innovation.[11]

Reflecting on the panel's theme of reducing friction within innovation, a participant agreed that institutional processes create friction in an innovation ecosystem. As an alternative to traditional contracting, the participant noted DARPA's use of "Other Transaction Authority [OTA]," which has accelerated procurement over the past 25 years.[12] The participant identified another point of friction in which faculty are not incentivized to engage in start-ups in the current promotion and tenure structure. The participant noted that of the more than 360,000 utility patents issued annually, only 4 percent come from universities, in part because of these friction points.

Scharf recounted difficulties related to tech transfer agreements, finances, and other arrangements when she worked with a professor on a start-up. Chang similarly recalled some of the points of friction at UMD when setting up its first venture fund. Because the fund involved taxpayer money, he said, it required state attorney general approval, as well as setting up processes for payments. Yancey identified another friction point related to research production and use. Drawing on her experience overseeing the Clearinghouse on Labor Evaluation and Research,[13] she noted the challenges of determining what evidence can appropriately inform discretionary grant making. She emphasized that applying evidence to inform innovation in the field often requires balancing the most rigorous evidence available with the most relevant to field context, raising important questions about how to integrate and assess knowledge generated outside traditional peer-review processes.

Chilvery pointed to NSF's support of Promotion & Tenure-Innovation & Entrepreneurship (PTIE), an initiative that includes innovation and entrepreneurship as part of promotion considerations.[14] A participant concurred that PTIE is a possible way to reduce the friction point related to incentivizing faculty. This participant also pointed out that entrepreneurship is high risk, but most institutions are risk-intolerant, and that effective partnerships depend on understanding what organizations are positioned to assume different types of risk and contribute their respective capabilities.

[10] For more information, see https://www.nsf.gov/funding/initiatives/regional-innovation-engines/portfolio/colorado-wyoming-ascend-engine.
[11] For more information, see https://atlasofinnovation.org.
[12] For more information, see https://acquisitioninnovation.darpa.mil/docs/Articles/Contract%20Management%20Dobriansky%20OTA.pdf.
[13] For more information, see https://beta.dol.gov/research-data/clear.
[14] For more information, see https://www.ptie.org.

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TABLETOP DISCUSSION 1: SUCCESSFUL INNOVATION

In the first of two tabletop sessions, participants joined panelists in a facilitated discussion and considered characteristics of successful innovation ecosystems; promising models that seem most scalable or transferable across sectors; structural approaches or pilot models that could significantly improve coordination; and outcomes that are currently undervalued or under-measured. After sharing perspectives, a member of each group reported out in a brief plenary session. Several themes emerged from the various tabletop sessions, including the importance participants placed on the people and places that comprise innovation ecosystems; connections across stages of innovation; structures that facilitate coordination; and approaches to measuring and sustaining innovation.

People, Purpose, Place, and Culture in the Ecosystem

Several groups discussed the characteristics that shape innovation ecosystems. **Coleen Burrus** (Princeton University) summarized her table's discussion as "three Ps and a C" to strengthen research ecosystems: *people, place, purpose,* and *culture*. A *place* and its unique qualities should be embraced, *people* and communities mobilized, and a common *purpose* developed. A shared *culture* is built on long-term vision, with participation, persistence, and a sense of public good. The group also included a "D" for an ecosystem that is *data-driven*. She also noted breaking down barriers among different parts of an ecosystem. The group used quantum as an example, where different clusters are talking to each other, such as community colleges and 4-year institutions.

Patricia Falcone (Lawrence Livermore National Laboratory) similarly reported that her table focused on the "system" within an innovation ecosystem. Participants discussed the value for a systems perspective that is open to different processes, connectedness, and teaming based on shared purpose. She reported a discussion on the elements of good participation, which include agility and utilizing a systems perspective. Falcone said the group also considered the bifurcation of priorities, in which institutions have a regional focus on jobs as well as a broader focus on innovation activities. The group pointed out several programs within the NSF Regional Innovation Engines that are undertaking this work.

Connections Across the Innovation Pathway

Other groups focused on connections between different stages of innovation. **Keivan Stassun** (Vanderbilt University) referred to Rees's earlier presentation on the many components involved in moving from innovation to commercialization. As the group discussed, the relationship between discovery, innovation, and commercialization can operate in both directions. For example, exposure to the commercialization process can help faculty and graduate students better understand pathways for translating discoveries and the range of options available to them. The group also considered movement in the opposite direction, from commercialization back to discovery, including the role companies can play in supporting earlier-stage research. The group referenced Bell Labs as a historical example of industry investment in discovery-oriented research.[15]

Structures and Models for Coordination

Several report outs addressed structures for connecting organizations and resources within innovation ecosystems. **Julianne McCall** (California Council on Science and Technology) quoted author James Clear, who said, "You do not rise to the level of your goals. You fall to the level of your systems."[16] Her table discussed successful multipronged approaches, including the Georgia Research Alliance in which members can use the core facilities of other alliance members; the shared funding model employed by the University of Texas at Austin; and coordination taking place in the publishing world.[17]

Morgan Weidow (Shadow Ridge Analytics) reported that systems alignment was underlying the conversations at her table. Participants discussed areas where industry and universities may have common goals, for example, in workforce development, including where their practices

[15] For more information, see https://www.nytimes.com/interactive/2026/02/18/technology/bell-labs-history.html and https://www.wsj.com/tech/bell-labs-research-development-018dd8ea.
[16] For more information, see https://jamesclear.com/3-2-1/january-2-2020.
[17] For more information, see https://gra.org/page/1074/core_exchange_categories.html and https://research.utexas.edu/resources/grant-management-services/budgeting/cost-sharing.

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may differ. One example was related to IP. The group discussed perceptions that universities are slow to share IP and considered models for agreements and approaches that could facilitate IP transfer and reduce friction in the innovation process.

The issue of governance models arose in **Taylor Eighmy's** (University of Texas at San Antonio) report out. The participants considered initiatives that can create and sustain an innovation ecosystem, for example, through the National Science and Technology Council.

Measuring and Sustaining Innovation

Questions of measurement and sustainability appeared across several table discussions. **Burrus's** group identified being data-driven as an additional characteristic of an innovation ecosystem, while other groups considered how systems and institutions can maintain innovation activities over time.

Eighmy reported that his table recognized the importance of a national innovation enterprise that can withstand the test of time and changes in political leadership, be connected to national security, and seek to improve people's lives. They noted several large-scale efforts where this has worked well, including the Human Genome Project, advanced manufacturing, and elements of the Genesis Mission. The group also discussed the role of continued federal support for basic science alongside efforts to move research discoveries toward commercialization.

McCall's group raised the issue concerning the availability and dissemination of information about seminal reports. Participants observed that reports and other resources describing previous efforts may not be widely known and discussed approaches for making information about such efforts more accessible.

PANEL 2: STRENGTHENING HUMAN CAPITAL THROUGH CROSS-SECTOR PARTNERSHIP

JB Holston (Colorado Department of Higher Education) facilitated a panel focused on preparing the workforce for innovation and other emerging challenges. All sectors benefit from being a part of the conversation, he said, and welcomed representation from different sectors on the panel.

Strengthen & Modernize Initiative

Tony Boccanfuso (UIDP) explained UIDP's work in developing pilots and approaches to increase the impact of partnerships between universities and industry. In 2024, UIDP launched the Strengthen and Modernize Initiative (SAMI) to seek better approaches for engagement in the global research ecosystem. SAMI focuses on three idea clusters: (1) reimagining IP management to accelerate research translation; (2) industry-driven models for collaborative research; and (3) new approaches for maximizing how talent is developed and works.

Focusing on the talent cluster, Boccanfuso discussed the Industry-Integrated Ph.D. Scholars Program,[18] which was developed in response to feedback from industry leaders who questioned the ROI associated with supporting the costs of traditional Ph.D. students. Launched as a project in 2025 and created as a pilot in August 2026 with funding from universities, industry, and the NSF TIP directorate, the program supports students who will work in industry as well as the faculty who will train and mentor them. The model includes formal university-industry Ph.D. partnerships, jointly defined dissertation research topics, structured industry research experience, and other components designed to connect doctoral training with industry. Boccanfuso said approximately 40 universities and companies are part of the initial cohort.

Data, Planning, and Funding

Heather McKay (Strada Education Foundation) offered three policy and practice ideas with on-the-ground impact based on her experience in state government in the Commonwealth of Virginia and at Strada. She noted that a 2024 Strada report found that 50 percent of students with higher education degrees are underemployed.[19]

McKay's first idea was to use data to look at the relationship between workforce supply and demand more carefully. She noted that beyond a first-destination survey, higher education institutions often have limited information about the occupations entered by their graduates. McKay described Strada's proposal to expand data collection by adding questions about occupation,

[18] For more information, see https://uidp.org/strengthen-and-modernize-initiative/uidp-launches-nsf-funded-initiative-to-expand-stem-ph-d-funding-streams/.
[19] To review the Talent Disrupted report, see https://www.strada.org/reports/talent-disrupted.

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location, and hourly wages to the unemployment insurance surveys that employers submit quarterly. She also pointed to the analysis of social media profiles to gather valuable information about career pathways. When she used this method in Virginia, she learned that one in nine liberal arts majors entered a computer occupation. She suggested that changes could be made to equip more liberal arts majors to work in these fields, such as through a college minor or work-study opportunities.

McKay's second idea concerned the use of targeted funding to respond to regional workforce needs. She cited a Strada study on talent migration showing that approximately 70 percent of students work or live within 1 hour of where they attended school. McKay said this finding illustrates the need to get students prepared for the labor market where they live. She suggested states could consider these workforce patterns when making funding decisions for universities, including the types of education and training programs offered in high-demand areas.

Third, McKay discussed opportunities for states to coordinate workforce, economic development, and education plans to increase impacts. She described Richmond, Virginia's, long-term goal of becoming a biosciences center. After 10 years of cultivation and planning, three major pharmaceutical companies decided to locate their manufacturing plants in Richmond in 2025.

Community Colleges as Talent Operating Systems

To **Mordecai Brownlee** (Community College of Aurora), the United States does not need more credentials but rather needs a Talent Operating System consisting of an ecosystem that can identify, develop, connect, reskill, and advance workers.[20] Brownlee described this concept as a way to remove the silos in which higher education continues to operate, often as competitors and not as partners. He said that without such a system, learners, and particularly first-generation learners, lose the most. Brownlee pointed to the new Workforce Pell Grant program, which provides funding for short-term educational programs, as one reason to look at novel systems and processes.

A Talent Operating System could enable AI-accelerated workforce adaptation, continuous skill-based alignment, and iterative progress, he suggested. The traditional educational model is linear, but learners today take different routes in their education and careers, due in part to disruption in the labor market. He said some states have mandated changes to engage students early in their training pathways. In Texas, for example, he said engagement with industry has informed educational opportunities beginning in middle school. Rather than repackage what is already offered, Brownlee advocated for starting with the skills sought by employers and working backward to develop shorter educational pathways providing these skills. He also described community colleges as great connectors to support skill placement, transferability, and economic mobility, citing a partnership between his institution and the Colorado School of Mines as an example of co-development.[21]

New Models for Ph.D. Training

Anand Jagota (Lehigh University) built on the earlier discussion of doctoral education for students going into industry. Jagota was a co-organizer of the 2025 National Workshop on the Formation of Industry-University Partnerships for Doctoral Training, funded by NSF and his institution.[22] Drawing on this experience, he underscored the disconnect between the current training of science, technology, engineering, and mathematics (STEM) Ph.D.s and the needs of employers outside of academia. The traditional model is faculty-centric and does not adequately prepare students for non-academic careers, he posited.

As an alternative model, Jagota described Lehigh's Pasteur Partners Ph.D. (P3) Program, which he characterized as student-centered.[23] In addition to technical excellence, the program instills five essential competencies that Jagota identified as important to doctoral training: effective communication; people skills, teamwork; critical, independent thinking; learning agility, openness to collaboration, cross-disciplinary interest, broad perspectives; and ethics, research integrity. He noted that differences among graduate programs can present challenges when implementing this type of model. As a

[20] Brownlee noted his presentation was based on a recent article he authored, available at https://www.ccdaily.com/2026/06/america-doesnt-need-more-credentials-it-needs-a-talent-operating-system.

[21] For more information, see https://ccaurora.edu/admission-aid/financial-aid/special-pathway-partnerships/mines-academy.

[22] For more information, see https://sites.google.com/lehigh.edu/pasteur-partners-phd-program/national-workshop-2025.

[23] For more information, see https://sites.google.com/lehigh.edu/pasteur-partners-phd-program/home.

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solution, Jagota suggested a hub-and-spoke model which identifies shared interests across departments (the hub) while recognizing individual departments' specific needs (the spokes). Jagota described other challenges requiring resolution related to IP, time scale for research, and resources for corporations to commit resources. He said P3 has developed several participation models to accommodate different levels and types of industry engagement, including a fellowship model with IP agreements and more of a sponsored research program.

Leveraging the Resources of Large Companies

Lydia Logan (IBM) underscored the value of coordinating education, employers, and government planning within workforce ecosystems to support current and future economic needs. She said IBM is building platforms that take publicly available data to create AI-enabled predictive analytics to provide policy makers and other key parties with information that could inform workforce planning needs and subsequently keep the innovation ecosystem strong.

When looking for solutions, big corporations are seen as the primary source of solutions, but they have limited research divisions, Logan cautioned. However, she pointed out, large companies like IBM have pipelines that also need to develop talent, including vendors, clients, and other smaller entities. Logan emphasized the value of creating pathways that allow workers to build skills and advance into more senior roles. She also shared feedback from industry colleagues in senior leadership roles who perceive a gap in entrepreneurship training and amplified the need for such training so that people are agile no matter their academic degree. As one example, Logan said IBM is exploring how concepts from its consulting and sales expertise can be applied to the company's STEM programs.

Logan also described several ways that companies can contribute to university-industry partnerships beyond providing direct financial support. In working with universities, IBM and other employers can be leveraged to co-develop courses and projects, offer guest lecturers and mentors, and otherwise create a talent pipeline responsive to industry needs. Rather than having a university request a large amount of money from IBM for its own program, she suggested taking advantage of the resources that IBM or other large companies already possess related to teaching, learning, administration, and operations, so that funds can be freed up to strengthen student experiences.

Logan also noted the broad range of teams required so that the United States can stay on top of innovation. She noted that approximately 50 percent of the American workforce needs 2 years of post-high school education and emphasized that it is not enough to focus on Ph.D.s at the very top to keep the local economy and university systems going. Finally, she said students need practical experience while still in school because this is what employers expect. She pointed to internships, apprenticeships, and other learning opportunities as means through which students can gain and demonstrate experience before they enter the workforce.

Discussion

In response to a question about how students can gain industry experience, Jagota shared that the P3 Program at Lehigh requires internships, which he described as providing students with exposure to research areas that are both interesting and useful. Holston commented that academic programs in Colorado are exploring workplace learning opportunities for their students but face challenges, as most employers have fewer than two hundred employees and do not have the human resource capacity to establish and maintain such programs. Holston raised the possibility that larger companies, such as IBM, could develop mechanisms to support smaller companies to engage students.

A participant commented that a Talent Operating System can provide support, funding, and a sense of purpose, and asked how to operationalize this. Brownlee pointed to existing models as one way to address the question. For example, in Alabama, he said that when Boeing approached state officials about its workforce needs, these individuals looked across the state's community colleges and universities to see which institutions and locations could address the company's needs. Brownlee also cited Dallas College, where individual community college presidents were assigned responsibility for being industry sector leads across the district.

McKay added that when communities work together, people can identify the roles they are positioned to play

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within the workforce ecosystem. In another example from Dallas, McKay described a unit that looked across institutions and employers to understand supply and demand and got them to start talking rather than competing. Logan acknowledged an unpopular aspect of this strategy, noting that institutions may have to reconsider some existing programs or activities. She said data can reveal areas where the number of graduates in particular fields exceed available employment opportunities, even when these degree programs remain popular. Holston said states are having difficulty in determining who makes these decisions in response to such information, the free market or another entity.

A participant closed the discussion by pointing to the National Defense Education Act (NDEA) of 1958, which played a role in developing STEM talent in response to national priorities at that time.[24] He posited the imagining of a modern-day NDEA, recognizing the changes since then. What would a NDEA 2.0 look like?

TABLETOP DISCUSSION 2: WORKFORCE CAPABILITIES

In the second of two tabletop sessions, participants and panelists engaged in a facilitated discussion and considered lessons from successful regional or sector-based workforce partnerships; workforce capabilities that will be the most critical over the next 5 to 10 years; the evolving role of higher education in preparing learners to meet workforce needs; and funding, structural, or policy changes that could significantly strengthen workforce development and talent alignment across sectors. Following the discussions, representatives from each table reported highlights to the full group. During the report-outs, participants discussed connections between education and regional workforce ecosystems, preparation for changing career pathways, experiential learning, and data and funding structures supporting workforce development.

Connecting Education with Regional Workforce Ecosystems

Several groups discussed connections among educational institutions, employers, and regional economies. **McCall's** table highlighted examples of universities working with industry to inform curricula and provide other experiential learning opportunities. Participants pointed to efforts at Virginia Tech, George Mason University, and University of Maryland.

Weidow said the group returned to the earlier observation that most people live and work in the same place where they are educated. The group considered what this pattern could mean for regionalized education and workforce development. Participants also considered the use of digital networks to connect rural and underserved communities with educational and workforce opportunities, particularly in areas without direct connections to major universities or research ecosystems.

Preparing Learners for Adaptability

Several discussions focused on the capabilities and skills students may utilize as career and labor markets change**. Jeffrey Alexander** (RTI) reported that his table acknowledged the importance of workforce development but posited that it is important to avoid making higher education purely vocational. The group discussed the value of preparing students to pivot and change directions over the course of their careers through the development of transferable skills rather than solely training for a specific job.

Weidow reported that her table discussed the broader role of higher education in developing capabilities and skills such as problem solving, confidence, networking, and continual learning. The group considered these to be foundational capabilities alongside preparation for specific occupations.

Stassun distilled the discussion at his table as a shift from thinking only about *whom* organizations need to hire toward also considering how they can *identify, develop, and acquire promising ideas.* Referring to the NDEA of 1958 and its focus on educating scientists and engineers, Stassun said the group considered how these shifts will change how STEM professionals are trained and prepared. Participants discussed acquiring entrepreneurial training so scientists and engineers can offer ideas in which they can get involved and contribute, in addition to subject-matter expertise.

Experiential Learning and Earlier Engagement

Experiential learning emerged across several of the table discussions. **McCall** highlighted several programs in which participants are involved, which could offer

[24] For more information, see https://www.congress.gov/bill/85th-congress/house-bill/13247/text/pl.

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inspiration beyond their campuses. The group pointed to examples of project-based and experiential learning at Worcester Polytechnic Institute (WPI) and Northeastern University, respectively.[25] McCall's table also considered challenges with hiring and the education pipeline from high school to college. She relayed the group's question about whether students are inspired early enough in their education to pursue these pathways.

Weidow's group viewed experiential learning as one way students can distinguish themselves, while recognizing that such opportunities can be expensive to provide. To this end, participants considered ways to reinvent or share the cost burden. The group also discussed the importance of reinvesting in K–12 STEM education. Alexander said his table discussed opportunities for students to engage in public service and gain experience in corporate settings. Recognizing that smaller organizations cannot subsidize these experiences, they suggested that companies participating in federal grant programs such as the Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs could support students in industry settings through internships.

DATA, FUNDING, AND STRUCTURAL SUPPORTS

Participants also considered structures that might support connections between education and workforce development. **Alexander's** table discussed a policy suggestion to develop better data infrastructure to collect data that can inform educational and institutional planning, with better linkages to discussions of economic development, workforce development, and education. He also pointed out that having data across multiple regions is critical for tailoring local needs such as workforce development.

In addition to considering whether the SBIR and STTR programs could support training opportunities, **Stassun** used these programs to highlight existing mechanisms to navigate the gap between ideas and federal acquisition. While Phases I and II support the development of ideas with commercialization potential, he explained that Phase III provides a pathway through which products or technologies developed through SBIR or STTR funding may be eligible for sole-source, noncompetitive acquisition by the federal government. Stassun said this connection between developing and acquiring ideas offered another way to consider the capabilities and skills for which scientists and engineers are being prepared.

CLOSING REMARKS

In closing, Pines thanked participants and staff and returned to the workshop theme of reimagining the research enterprise. Reflecting on the discussions, he encouraged participants to "find a way to say yes" to working together and described cross-sector collaboration as central to continued innovation. "This is what GUIPRR is all about—bringing this really incredible community together to talk about how to improve the ecosystem that is so valuable to our lives and to the national competitiveness of the country," he said.

Pines identified reducing friction within the research and innovation ecosystem as a key theme he took from the first panel. He pointed to contractual and procurement processes, joint appointments, differences in institutional cultures, intellectual property, and funding as areas where friction can arise. He also reflected on the panel's discussion of university innovation ecosystems and industry partnerships, noting both the progress that has been made and opportunities to better understand how different sectors work together.

Turning to the second panel on workforce development, Pines highlighted the importance participants placed on collaboration across sectors. Drawing on McKay's remarks, he summarized the discussion with the phrase "think together, plan together, and grow together," connecting it to the workshop's broader consideration of how government, universities, industry, and other partners can contribute to the future of the research enterprise.

[25] For more information, see https://www.wpi.edu/project-based-learning/project-based-education and https://www.northeastern.edu/co-op.

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REVIEWERS To ensure that it meets institutional standards for quality and objectivity, this Proceedings of a Workshop—in Brief was reviewed by **Walter G. Copan**, Colorado School of Mines (Emeritus); **Charles Johnson-Bey**, Morgan State University; and **Theresa Kotanchek**, Evolved Analytics LLC. **Kirsten Sampson Snyder**, National Academies of Sciences, Engineering, and Medicine, served as the review coordinator.

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FOR ADDITIONAL INFORMATION

For additional information regarding the workshop, visit https://www.nationalacademies.org/projects/CAST-STPL-26-04.

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