PROJECT TITLE:

Dissemination of ASEE Industry 4.0 Webinars and Summit Findings

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INTRODUCTION

The Workforce Summit for Industry 4.0 was a two-year project of the Corporate Member Council of the American Society for Engineering Education. It began with a series of webinars delivered from 2020 to 2022 that highlighted the challenge facing American industry: the technologies that enable Industry 4.0 are rapidly coming online, but we lack the workforce to take full advantage of them.

The Summit project culminated in a two-day gathering in April 2022, convening representatives for industry, academia, and the policy sphere to formulate novel approaches to building the skilled technical workforce that America needs in the 21st century. After that event, the Summit received funding from NSF's Advanced Technical Education (ATE) program to summarize and broadcast the Summit's findings and identify "lighthouse projects" that exemplify promising, scalable models for more efficiently and robustly producing a larger and more effective skilled technical workforce. This report summarizes the key goals and themes of the Summit and articulates its principal findings. The report concludes by profiling a handful of initiatives that demonstrate potentially scalable models of how those findings can be realized.

SUMMIT GOALS

The Summit brought together stakeholders and leaders from the policy, industry, and academic sectors to spotlight lighthouse examples of innovation and new models and partnerships in pursuit of two intertwined goals:

Make the education of engineering professionals less exclusive and expensive, and more efficiently equip learners with 21st century skills, knowledge, and abilities.

- Develop a more robust system of skilled technical education that efficiently connects the abilities of learners and the capabilities of education providers to the needs of employers.

SUMMIT THEMES

The Summit made clear that the silos and hierarchies that dominated the past century of post-secondary technical education need to be rethought, redesigned, or removed. Three overarching trends illustrate why:

1. Today, a technical career is a **helix, not an arc**.
   For much of the 20th century, technical workers could expect their career to follow a single sequence of steps: Learn, then Earn, then Retire. Today's technical careers are helical, a series of recurring cycles: acquiring skills, applying those skills, and assessing new skills needs. Learners take these steps repeatedly and at times concurrently.

2. Learners in this environment require **multiple on-ramps and off-ramps** at each juncture between learning, earning, and assessing.
   Employers and educators need to be far more flexible in onboarding and offboarding individuals who progress through their institutions. Learners need to be able to transition smoothly from one step to the next and from one institution to the next.

3. The relationship between an institution and its employees or students is **no longer one to many. It is now many to one.**
   Workers will change employers, career fields and industries several times during their career. Students will attend multiple institutions while completing a variety of courses, programs, certificates, or degrees.

None of these trends is new. In fact, NSF's ATE program has been supporting the development of hundreds of projects designed to navigate these trends for the past thirty years.

What is new is this moment?
The glacial pace of institutional change in companies and colleges is confronting the inexorable logic of Moore's law. Technology advances at an accelerating rate, requiring ever-shorter cycles for preparing and reskilling technical professionals. Companies and colleges adapt much more slowly, as does the policy framework in which they operate. We have reached a tipping point, in which the design and operation of the entire system that prepares people for skilled technical work – from the trades to advanced research – need to be reconceived.

What does this moment require?
It would be comforting to think that we could solve this problem with a single, massive-scale solution. Just as the National Interstate Highway System laid down a high-speed, high-efficiency system on top of an existing patchwork of federal, state, and local roads, surely, we could build an education superhighway to transform learners into workers in overwhelming numbers and at blazing speed, couldn't we? Perhaps. But it is hard to imagine that we could summon the will, resources, and alignment to even begin to try. And there is too much inertia, and too much continuing value, embedded in the American system of education which remains, despite its weaknesses and challenges, the envy of the world in many respects.

Most of our formal STEM educational system, and our system of skills education for industry and business, was built over a century ago to support the factory model of industry. It has been tremendously successful, but it no longer meets the moment. In fact, the problem we face now is a consequence of the systemic design choices made over the course of the past century. The sequential structure of education -- primary, secondary, postsecondary, graduate, postgraduate – still delivers substantial value, but it no longer aligns with the needs of many technical learners.

One of the consequences of the Great Disruption of the COVID pandemic is that it revealed that many learners are ill-served by the current system. One's capacity and desire to acquire technical skills can develop at a different pace than the lock-step march of grade levels. And employers' needs to upskill and reskill employees are evolving faster than the speed with which colleges can develop and deploy new programs. Moreover, the policymaking process lags far behind the pace of technological change in its ability to fund, assess, validate, and regulate both industry and academia.

The existing education system is optimized to deliver **standardization at scale**. But our technology now permits, and our culture increasingly demands, **customization at scale**—the ability to adapt the modality and content of instruction to meet an individual's learning style, learning goals, and baseline knowledge. Information technologies now exist to assess learners' individualized needs and goals, and to deliver individualized programs and assessments to help them reach them. The means exists to maintain an individual's personalized record of credentials achieved and skills demonstrated and deliver them to employers and educators at the learner's direction.

The automotive industry provides a useful analogy for the path before us. The transition from fossil-fuel vehicles to electric vehicles is accelerating, but we still live in an era in which gasoline, electric, and gas-electric hybrid vehicles share the road, and we can expect to do so for many years to come.

Similarly, the Workforce Summit has demonstrated the urgent need for alternatives to traditional diploma and degree programs to speed up the production of workforce-ready technical professionals at all levels. But it remains true that the existing system for delivering degrees and other credentials can and should remain in place alongside these options. It is both impractical and unnecessary to attempt wholesale change of primary, secondary, and higher education. We need to accelerate experimentation into a range of additional models and modalities, so that we may more rapidly discover those that merit being taken to scale. The future needs to include traditional programs that grant diplomas and degrees along established timelines; alternative programs that confer credentials for the demonstration of competencies outside of existing frameworks; and hybrids of the two.

SUMMARY OF FINDINGS

Historians have identified four Industrial Revolutions, periods in which transformations in the dominant technologies driving industrial systems created a fundamental reordering of the economy, and with it, society. Previous revolutions occurred in the 18th, 19th, and 20th centuries, driven by the harnessing of productive power through steam, fossil fuels and electrification, and digital computing, successively. We are now in a fourth industrial revolution—often called Industry 4.0—powered by the massive scaling of data processing power, characterized by disruptive trends including the rise of data and connectivity, analytics, human-machine interaction, and improvements in robotics. As with the previous revolutions, the very nature and structure of work through nearly every sector of the economy has been altered. This transformation in the way in which wealth is created and work is performed requires a similarly broad-based transformation in the education that prepares people for that work.

The institutions that educate and train the technical workforce for Industry 4.0 have largely continued to operate in segregated silos that were developed during the Second and Third Industrial Revolutions. Academic programs and curricula still follow traditional engineering and technical disciplines (such as mechanical, electrical, and chemical) associated with the previous eras. For industries and businesses to succeed and remain competitive in this new age, their workforce must be educated and trained in a new way. Educational institutions need to redesign their academic programs to meet the needs of industry and a rapidly changing society.

The Corporate Member Council of the American Society for Engineering Education (ASEE) launched the Workforce Summit for Industry 4.0 to develop consensus recommendations for changes and improvements needed in curricula, work-based experiences, policies, and practices in preparing the technical and engineering workforce. The initiative's objective was to create closer collaboration between industry, academia, and policymakers to strengthen the Industry 4.0 talent pipeline and bolster U.S. competitiveness. This work was carried out through a series of webinars followed by a culminating Industry 4.0 Summit of a select group of industry experts, academic leaders, and other community stakeholders. to discuss creating new models, methods, and collaborations to develop a workforce better prepared to lead and win in an Industry 4.0 environment.

WEBINARS: SUMMARY AND KEY FINDINGS

New Industry 4.0 Technologies impacting Industrial Processes

Many webinar panelists cited that the ability to apply Artificial Intelligence tools has emerged as a critical competency for business success in just the past few years. According to the Boeing representative, Micro-credentials, Scalable Education, and Certification of Knowledge will have to become the norm to enable workers to stay current and to allow employers to keep track. At Boeing, changes in the skills and knowledge necessary for a successful digital life and workflow are now impacting the organization's cultural systems. These changes promise rapid innovation due to the need for a highly educated adaptive workforce but also give the company new opportunities to measure the flow and quality of information, including key competency and agility measures.

In another webinar, Jeff Wilcox of Lockheed Martin shared that emerging operations technologies are being put to use in manufacturing facilities such as Human Augmentation, Transformative Computing, Intelligent Machines, Advanced Design Synthesis, Designer Materials, and Cognitive Assistants. According to Jeff Wilcox, a new paradigm of engineering and technical operations, engineering and the enterprise, and engineering and partnerships will drive successful manufacturing enterprises in the future.

What Must Change in Engineering Education to Provide Industry 4.0 Skills

Quoting an article from *The Atlantic,* Michael Arenas, VP of Talent & Development at Amazon Web Services, said: "Like the entertainment industry, colleges will need to embrace digital services in order to survive." Again, quoting Tomas Chamorro-Premuzic, Chief Innovation Officer at ManpowerGroup, Arenas warned that "Employers need skills, not degrees; Students want jobs, not theory; Students are paying more and more ... to get less and less; Universities prioritize research...over teaching."

Jeff Wilcox of Lockheed emphasized that engineering colleges need to teach systems thinking, foster engineering leadership, promote communications for engineers, and embrace work-integrated learning.

In another webinar, Irene Patrick, Senior Director of Industrial Innovation at Intel, presented Intel's longitudinal study of manufacturing, delineating the strategies and tactics that will accelerate Artificial Intelligence and the Internet of Things (IoT). Their study found that Digital Transformation is a holistic problem. Seventy-three percent of participants identified the holistic complexity of advanced technologies as a significant barrier to digital transformation and suggested a "systems of systems" approach to attain sustainability. The technical Skills Gap and Data Sensitivity were identified as the biggest challenges to Digital Transformation.

Intel's study also identified the top five digital skills of the future: Deep understanding of modern programming or software techniques, Digital dexterity, Data Science, Connectivity, and Cybersecurity.

Challenges and Opportunities for Industry and Academia to Work Together

Jorge Puente, VP of Engineering at Kelly Engineering, presented an engineer's perspective on preparing the Engineers of Tomorrow. His call to students, academics, and businesspeople is that "the single-industry career is dead, but the engineers of tomorrow have a huge number of career opportunities." Engineering students must be given greater insight into the variety of potential career paths. He emphasized that academia and industry must work together to strengthen the engineer's skillsets. Their research also shows that 63% of CEOs are concerned with their inability to find engineering staff with the right skills. University programs need to provide more real-life engineering experiences. Over 60% of employers now consider the emerging digital skills sets of Industry 4.0 as baseline requirements for employment.

Career and Job Opportunities for Future Engineering Graduates

Jorge Puente of Kelly Engineering shared research that shows that jobs currently open for individuals with engineering degrees consistently exceed the pool of engineers seeking jobs. Lack of diversity is partly to blame: Puente noted that only 16% of engineers in the workforce are women. He emphasized that engineers of tomorrow have a vast number of career opportunities, but there is a constant and growing mismatch between the skills that are most in demand and the skills that new graduates possess. Mid-career engineering job seekers also frequently lack the skills that open engineering jobs demand.

While the traditional route to engineering jobs used to be from single disciplines such as Electrical, Mechanical, or Industrial, Puente indicated that modern engineering jobs demand a multidisciplinary or interdisciplinary perspective, such as Electrical and Design, Industrial and Procurement, Mechanical and Systems. Engineering schools need to adapt the way they design their programs so that their graduates have a greater ability to work across disciplines.

Industry Initiatives to Bridge the Skills Gap and Meet the Desired Workforce

Jason Tyszko, VP of Center for Education and Workforce at the U.S. Chamber of Commerce Foundation identified several long-term trends and challenges in the economy affecting the skilled technical workforce. Demographics, especially the retirement wave of Baby Boomers, is driving structural changes in the labor market, which is becoming more dynamic, not less. The half-life of skills is shortening, which means that skill obsolescence is a reality for every mid-career professional and new graduate.

The Chamber has developed a program, Talent Pipeline Management (TPM)®, to enable educators and employers to collaborate on designing and maintaining a supply chain for talent, in the same way that companies execute long-term strategies to manage their other essential supply chains. TPM is described in more detail below as a Lighthouse Example.

Implementing these changes will come at a cost. Tyszko recommended a more public-private approach for financing talent development. To reduce barriers to entry and to provide greater access to the skilled technical workforce, education, training, and credentialing need to be more affordable and generate less debt. Employers, educators, and policymakers also need to consider the risk to employment and income inherent in the shorter cycle times of employability and address the costs that workers face if they have to more frequently engage in retraining and reskilling.

What Stakeholders are Already Doing to Meet Workforce Challenges

Jane Oates, President of Working Nations, advised that to address the chronic shortage of people entering the technical talent pipeline, employers and educators need to communicate the value and attractiveness of technical career pathways to students of all ages. Their messaging needs to emphasize that these careers are centered in problem-solving and creativity and highlight the exciting fields that are open to new learners in green jobs, space travel, healthcare, and more.

Ms. Oates further suggested that policymakers provide more targeted funding for specific engineering career navigation, mentoring, and work-based learning. To foster deeper understanding of industrial practice within the academic community, she called for colleges to invest more in specialized engineering work-study experiences, engineering co-ops, business incubators and do-tanks. She recommended providing more incentives for businesses to work with faculty and students on applied research, fewer restrictions for faculty to take leaves to work in industry, and greater rewards and incentives for time spent by engineering faculty within organizations that employ their graduates.

Jenna Carpenter, Campbell University's Dean of Engineering, described how Campbell is already working to make engineering attractive to more, and more diverse, students. Campbell offer design-based, hands-on, team-based and project-based courses in all four years of a baccalaureate program. Students have frequent exposure to industry-sponsored projects and design competitions judged by industry professionals. Students engage with industry in professional development and career preparation services, internships, student organizations and tours. Campbell's open admission policy aims to weave students in, rather than weeding them out. To that end, Campbell has established benchmark goals to attract and train a diverse cohort of job-ready engineers; align curricular and co-curricular educational offerings with industry needs; create teaching and learning spaces to support innovative approaches to engineering education; and create industry partnerships that prepare & connect students with employment opportunities.

WORKFORCE SUMMIT: SUMMARY AND KEY FINDINGS

University as a Service (UaaS)

The transformation to Software as a Service (SaaS) revolutionized what and how technology companies serve the market. A similar transition is needed in education. JB Holston of the Greater Washington Partnership, a civic alliance of regional employers, articulated the potential for UaaS—referencing models such as Guild. Siemens USA CEO Barbara Humpton envisioned universities of the future serving lifelong learning needs through a membership model. Gregory Washington, president of George Mason University and former engineering dean, made the case that the US has evolved from a national, analog, industrial economy to a global, digital, knowledge economy, and universities must transform how they operate to meet new talent needs.

Diversity Is the Challenge; Diversity Is the Solution

Solving the US talent crisis requires creating pathways to opportunity for women and people of color who have been blocked from STEM careers by social, economic, and cultural barriers. University of the District of Columbia President Ronald Mason pointed to the roots of the talent shortage in wealth inequality, which strongly correlates to race. Jason Tyszko, of the US Chamber of Commerce Foundation, showed how to scale proven talent supply solutions using the Chamber's Talent Pipeline Management framework (described in detail as a lighthouse example below). The National Science Foundation's Broadening Participation programs can also help drive progress in connecting talent to opportunity, as will new financing structures for education funding and loan forgiveness. Celeste Carter, lead program director of NSF's Advanced Technological Education program, emphasized the critical role of community colleges in engaging diverse students in technical fields. Many states are working to foster greater collaboration between their state university systems and community college systems through stronger articulation agreements and enrollment coordination. State policymakers need to incentivize and prioritize these efforts.

Democratize Engineering

NSF's Acting Deputy Assistant Director of the Engineering Directorate, Don Millard, highlighted how the personalization revolution that has swept through industry is coming for education. Democratizing engineering requires shifting the model from one-to-many to many-to-one, he said. Programs like NSF's Revolutionizing Engineering Departments aim to drive organizational and cultural change. Lee Lambert, chancellor of Pima Community College, described how PimaFastTrack helps adult learners obtain industry-recognized skills in programs that can be tailored to specific employers. Coursera's Skills Transformation Advisor Juliana Guaqueta shared research indicating that learners have the greatest interest in jobs such as data scientist and machine learning engineer but lack preparation. Coursera can provide personalized programs to help close these gaps, she explained. States should consider adopting policies that lower barriers to entry to higher education, such as Maine's tuition-free community college program. Partnerships between community colleges and universities should also be encouraged. As one example, the ADVANCE partnership between Northern Virginia Community College (NOVA) and George Mason University (Mason) gives NOVA students targeted, personalized support to complete their bachelor's degrees at Mason more quickly and cost-effectively.

Adjacencies Are Key

Aligning the right partners is essential to scale and drive success. Adjacencies—within region, industries, and fields of knowledge—are where those partners will be found. Roger Tadajewski, executive director of the National Coalition of Certification Centers (NC3), spotlighted the organization's student engagement pathway to develop highly skilled, job-ready professionals through programs and certifications across industries. University of Maryland President and former Dean of Engineering Darryll Pines described how the Greater Washington Partnership brought together academia and industry to address the regional talent shortfall through initiatives such as the Capital Collaborative of Leaders in Academia and Business (CoLab).

Mentors Are Essential

Relationships are the key to changing systems and cultures, and mentors are needed in many areas. Martin Guay, vice president of business development for Stanley Black & Decker, pointed out that we do not learn to ride a bike from a book—we learn from experience and from one other. His company needs to upskill thousands of workers in the next decade, and he noted that this learning could be peer-to-peer. Ken Ball, dean of engineering at George Mason University, stressed that many faculty could use industry mentors to help better prepare students for the workplace. Chris Carlson, head of university relations at Northrop Grumman, emphasized that models such as the National Society of Black Engineers' mentoring program Summer Engineering Experience for Kids (SEEK) increase the diversity of future engineers.

THE PATH AHEAD

The following four lighthouse examples have been selected from dozens of similarly worthy candidates, to cast light on particularly promising models for how alternative and hybrid-alternative models can take shape.

Lighthouse Examples

1. A regional-scale integrated learning environment for K12 STEM skill development

The roots of the skilled technical workforce shortage run deep into the early years of elementary school. High school is far too late to attract students to technical career opportunities through hands-on STEM experiences, especially underrepresented and marginalized students who tend to opt out well before their high school years. Anecdotal evidence suggests that while girls in grades 1-3 participate in programs like Lego leagues in equal numbers to boys, their representation drops as low as 10% for robotics competitions and similar programs in high school.

Public schools struggle to assemble the resources needed to offer compelling hands-on STEM experiences throughout the K12 years, meaning that access to the most impactful programs like First Robotics is often skewed in favor of the socio-economically privileged. Local talent pools of mentors, advisors and volunteers are also often unevenly distributed among school districts and typically fail to include professionals with the full range of talents and experiences that students wish to access. And K12 faculty are already stretched extremely thin, with limited bandwidth to add more extracurricular programs and enrichment curricula to their overfilled plates.

A regional approach can help overcome these resource and talent constraints, and that is the approach taken by the STEM Coliseum and Learning Center of Maine[1] in South Portland. The Coliseum is a 501(c)3 established to create a continuum connecting STEM education to workforce readiness to serve the growing skilled technical industries of southern Maine. Located in nearly 25,000 square feet of space in a popular regional shopping mall, the Coliseum sits within an hour's drive or less for more than half the population of this largely rural state. In addition to a First Robotics competition track and pit spaces for local FR teams to service their robots, the Coliseum offers competition space for Lego League and VEX competitions – serving the needs for hands-on STEM experiences for students from first through twelfth grades.

Beyond competition space, the Coliseum houses facilities for the full range of STEM experiential learning – labs for coding, AI, and electronics, plus a fabrication lab, machine shop, and maker spaces for woodworking and metal working.

The Coliseum also teaches entrepreneurship and professional skills, giving team members a share of responsibility for program development and execution, and for fundraising for competitions and programs. The regional approach enables school districts to access a high-capacity facility with far more resources than individual schools could assemble. Moreover, the regional approach activates a far more diverse talent pool of advisors, mentors, instructors, and donors, giving students access to a much richer source of expertise in a range of industries and professional specializations.

Corporate partnerships fund most of the Coliseum's operation, ensuring close alignment between industry's needs for talent and the design of the learning programs that prepare that pool of future talent. Coliseum programs are closely tailored to priority areas of the state's economic development strategy: defense and aerospace, the blue economy, precision manufacturing, and biomedical devices, among others. The Coliseum is also entering into articulation agreements with area high schools and universities, so that students earn appropriate credit for their hands-on learning.

Another notable benefit of developing a regional-scale facility like the Coliseum is that it can serve the growing ranks of home-schooled students and students engaged in Extended Learning Opportunities. ELOs are hands-on, credit-bearing experiences (for elective or core credit) outside of the traditional classroom with an emphasis on community-based career exploration. These programs include paid work experiences, expanding educational opportunities in rural Maine, work skills development, and increasing engagement of otherwise disengaged youth. The State of Maine used more than $5.6 million in ARP funds (Coronavirus State and Local Fiscal Recovery Funds) to provide grants to 26 ELO programs across thirteen of the state's sixteen counties. The Coliseum has played a key role both in connecting students with opportunities for career exploration and providing the facility in which to complete that work. More students demand and deserve opportunities for career exploration and hands-on technical learning through the entirety of their K12 careers. Regional centers like Maine's Coliseum offer a promising model for amassing the talent and facilities needed to make rich experiences a reality.

1 *https://stem-coliseum.odoo.com/about-us#vision*

2. An academic-Business-Policy collaboration to develop accredited microcredentials.

The 2023 World Economic Forum future of Jobs report listed "skills gap in the local labor market" as the top barrier to business transformation and workforce strategies. It was named by 60% of the companies surveyed -- far more frequently than other commonly cited barriers, such as limited access to capital or outdated or inflexible regulatory frameworks.

A new program launched by Siemens Digital Industries Software[2] demonstrates the power of companies and universities working in collaboration with a policy-setting body (ABET, the engineering program accreditor for universities) to build micro-credential programs that target specific skills gaps that impede companies' ability to grow and transform their businesses.

The ABET pilot of a quality review process for these credentials means that they will meet defined standards of quality, and that employers can trust these credentials will demonstrate that learners have gained valuable real-world knowledge and skills

Through a strategic collaboration with the University of Colorado Boulder (CU Boulder), Siemens' first credential pilot for ABET recognition will offer a graduate credential program consisting of nine courses that will be globally available through Coursera. The first four courses, focused on applied sustainability , are live, with additional courses set to launch later this year. Topics will include leading the circular business, sustainable supply chains and operations management, product, and packaging design for the circular economy, and leveraging consumer demand for sustainable business practice, among others.

Penn State has launched a series of four credential courses for engineering career preparation covering automation, project management, business fundamentals and inclusive teamworking. This blend of technical and interpersonal skills will play a critical role in preparing students to be able to translate theory into results on the job. Additional credentials offered by Siemens will focus on developing digital mindsets and skillsets.

This program promises to accelerate learners' achievement of skills genuinely valued by industry by combining the speed and flexibility of microcredentials with the trust and reliability of ABET recognition.

3. A graduate program blending business and engineering skills for mid-career professionals.

The state of Washington lies on the opposite coast from the state of Maine. Likewise, its tech industry occupies the opposite end of the spectrum from Maine's in terms of size, sophistication, and role in the state's economy. Two of the "magnificent seven" tech companies that are leading America's economy are headquartered in the Seattle metro area (Microsoft and Amazon). Two others have major corporate campuses there (Meta and Google). The University of Washington thus finds itself at the heart of one of the world's largest markets for skilled technical professionals.

The University of Washington is therefore particularly well situated to respond to the demands of the tech industry. And it was in response to input – and generous funding – from Microsoft that the University of Washington launched the Global Innovation Exchange (GIX)[3] in 2017 as an engineering-and-business institute for emerging and established technology leaders. GIX is built around the insight that tech enterprises require professionals who possess a mix of business and technical skills – domains that universities have long kept separate. GIX is jointly supported by the University of Washington's College of Engineering and Foster School of Business. GIX partners with corporate, government and non-profit organizations to deliver transformational learning through graduate education, global experiences, and professional development programs.

Graduate students at GIX tackle six-month challenges proposed by GIX partners, culminating in an immersive, interdisciplinary experience in technology innovation. The GIX program is designed to help learners advance from implementation roles to leadership by equipping them with a more complete and balanced set of technical and management skills than an engineering or business degree can provide on its own. It also focuses on closing the skills gap from both ends. Learners enjoy access to the Seattle area's dynamic innovation ecosystem and its unparalleled quality of projects, experts, and mentors from firms and institutions at the forefront of technology innovation. GIX also gives firms and institutions priority access to this uniquely prepared talent pool by offering membership in the GIX consortium. Consortium members can submit unlimited proposals for the 6-month student capstone projects. As project partners, they have ongoing access to top UW faculty engaged with each graduate team. They enjoy deep engagement with student teams on member-led initiatives or projects and access to the GIX prototyping and other lab spaces, enabling rapid iteration of hardware and software with the added support from a dedicated team of experts.

GIX represents an emerging model of graduate program built from and for the demonstrated needs of industry for a new type of technical talent, produced through industry-provided project-based experiences that break down the traditional silos of business and engineering schools, and build learners' management and technical skills concurrently.

2 *https://blogs.sw.siemens.com/academic/how-siemens-supplementing-traditional-engineering-programs-new-abet-accredited-credential-program/*

3 *https://gix.uw.edu/*

4. Corporate Talent pipeline management

The pace of technological innovation far exceeds the speed with which educational institutions can adapt their programs, and this speed gap will only accelerate. This means that the onus to drive innovation in talent development falls increasingly on the organizations that hire that talent. If companies wish to avoid being constrained by talent bottlenecks, they need to be more proactive. Just as they implement strategies to secure their material supply chains for decades into the future, companies need to develop similarly long-range strategies to secure sustainable sources of skilled talent.

But they do not have to do this alone. The US Chamber of Commerce Foundation has developed a program that prepares companies to implement Talent Pipeline Management®.[4] Built by business, for business, TPM provides employers and their education and workforce development partners with strategies and tools to co-design talent supply chains that connect learners and workers to jobs and career advancement opportunities. Supported by the TPM framework and delivered through the TPM Academy®, TPM facilitates change management to achieve better outcomes for all partners.

TPM was designed to augment the traditional channel available to companies for providing input to higher education programs: the industry advisory board. Rather than keeping companies in a reactive, advisory posture relative to their academic partners, TPM provides a framework and toolkit that allows companies and educational institutions to set common goals and establish shared metrics for return on investment (ROI). The TPM Academy trains business, workforce, economic development, and education leaders on the TPM framework, a demand-driven strategy to create career pathways for students and workers with talent pipelines aligned to dynamic business needs. The TPM Academy is an in-person or virtual training, facilitated by the U.S. Chamber of Commerce Foundation, for state and local chambers, business association and economic development agency leaders, as well as employers, to learn to drive partnerships with their education and training providers based on industry need.

Not only does TPM give companies the opportunity to drive the development of programs that will feed their workforce needs, but it also helps build a shared culture of skilled technical workforce development across educational institutions and companies alike. Graduates of the TPM Academy become members of a national network of workforce development leaders and TPM practitioners, creating a national community of innovators who can help scale a coherent national strategy.

4 *https://www.uschamberfoundation.org/solutions/workforce-development-and-training/talent-pipeline-management*