EXECUTIVE SUMMARY/POLICYMAKER'S BRIEFING

PROJECT TITLE:

Dissemination of ASEE Industry 4.0 Webinars and Summit Findings
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SUMMIT BACKGROUND

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 has been altered. This transformation requires a similarly broad-based transformation in the education that prepares people for that work.

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 how this transformation should take shape. This work was carried out through a series of webinars followed by a convening of a select group of industry experts, academic leaders, and other community stakeholders.

SUMMIT GOALS

The Summit focused on two intertwined goals:

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

2. 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 identified three overarching trends:

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.

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.

SUMMARY OF FINDINGS

WEBINARS: SUMMARY AND KEY FINDINGS

New Industry 4.0 Technologies impacting Industrial Processes
The ability to apply Artificial Intelligence tools has become a critical competency for business success. 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 of the capabilities of their workforce.

Workers need to be skilled in the new operations technologies that run manufacturing facilities such as Human Augmentation, Transformative Computing, Intelligent Machines, Advanced Design Synthesis, Designer Materials, and Cognitive Assistants.

What Must Change in Engineering Education to Provide Industry 4.0 Skills
Quoting Tomas Chamorro-Premuzic, Chief Innovation Officer at ManpowerGroup, Michael Arenas, VP of Talent & Development at Amazon Web Services 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.

Irene Patrick, Senior Director of Industrial Innovation at Intel, identified the top five digital skills of the future:

1. Deep understanding of modern programming or software techniques
2. Digital dexterity
3. Data Science
4. Connectivity
5. Cybersecurity

Challenges and Opportunities for Industry and Academia to Work Together
Jorge Puente, VP of Engineering at Kelly Engineering advised that we need to accept that "the single-industry career is dead." New digital skills are essential for long-term employability. Over 60% of employers now consider the emerging digital skills sets of Industry 4.0 as baseline requirements for employment.

Modern engineering jobs also demand a multidisciplinary or interdisciplinary perspective. 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 noted that the half-life of skills is shortening. Skills obsolescence is a reality for every mid-career professional and new graduate.

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. Implementing these changes will come at a cost. Tyszko recommended a more public-private approach for financing talent development.

What Stakeholders are Already Doing to Meet Workforce Challenges
Better outreach is needed to attract learners to technical careers. Jane Oates, President of Working Nations, advised that employers and educators need to communicate the value and attractiveness of technical career pathways to students of all ages, emphasizing that these careers feature in problem-solving and creativity.

Ms. Oates further suggested that policymakers provide more targeted funding for specific engineering career navigation, mentoring, and work-based learning experiences.

Colleges need to invest more in specialized engineering work-study experiences, engineering co-ops, business incubators and provide fewer restrictions and better incentives for faculty to spend time within organizations that employ their graduates.

Jenna Carpenter, Campbell University's Dean of Engineering, described Campbell's approach to making 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.

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. Siemens USA CEO Barbara Humpton envisioned universities of the future serving lifelong learning needs through a membership model.

Diversity Is the Challenge; Diversity Is the Solution
Solving the US talent crisis requires creating pathways 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. Educators and employers need to remain steadfast in providing equal access and delivering equitable outcomes.

State policymakers need to incentivize and prioritize greater collaboration between public university systems and community college systems through stronger articulation agreements and enrollment coordination.

Democratize Engineering
Don Millard, NSF's Acting Deputy Assistant Director of the Engineering Directorate, asserted that democratizing engineering requires shifting the model from one-to-many to many-to-one. 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, such as the ADVANCE partnership between Northern Virginia Community College (NOVA) and George Mason University (Mason) that gives NOVA students targeted, personalized support to complete their degrees at Mason.

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. University of Maryland President and former Dean of Engineering Darryll Pines described how the Greater Washington Partnership convenes academic and industry leaders to address the regional talent shortfall.

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, described how peer-to-peer education can help his company upskill the thousands of new workers needed in the next decade. Ken Ball, dean of engineering at George Mason University, stressed the value of industry mentors for faculty and students alike. Chris Carlson, head of university relations at Northrop Grumman, emphasized that models such as the National Society of Black Engineers' Summer Engineering Experience for Kids (SEEK) increase the diversity of future engineers.

THE PATH AHEAD

These four lighthouse examples offer particularly promising models:

Lighthouse Examples

1. A regional-scale integrated learning environment for K12 STEM skill development
Regional centers like The STEM Coliseum and Learning Center of Maine[1] offer a promising model for concentrating a scale of talent and resources that individual school districts would struggle to afford individually. The Coliseum aims to grow the STEM workforce for the growing skilled technical industries of southern Maine. It offers competition space for First Robotics, Lego League and VEX competitions – providing hands-on STEM experiences for students from first through twelfth grades. It also 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.

2. An Academic-Business-Policy collaboration to develop accredited microcredentials.
Siemens Digital Industries Software[1] is partnered with universities and ABET (the engineering program accreditor for universities) to build recognized micro-credential programs that target specific skills gaps that impede companies' ability to grow and transform their businesses.

Working with Siemens, the University of Colorado Boulder (CU Boulder) will offer nine courses that will be globally available through Coursera and go through the ABET recognition review process.

The collaboration with Penn State will include four credential courses covering automation, project management, business fundamentals and inclusive teamworking.

Siemens credential program promises to accelerate learners' achievement of skills genuinely valued by industry by combining the speed and flexibility of microcredentials with the quality assurance of ABET recognition.

3. A graduate program blending business and engineering skills for mid-career professionals.
In response to input and funding from Microsoft, 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 represents an emerging model of graduate program that breaks down the traditional silos of business and engineering schools and builds learners' management and technical skills concurrently.

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

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 US Chamber of Commerce Foundation's program, Talent Pipeline Management®,[4] 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.

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).

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.

CONCLUSION

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 the existing system cannot be discarded. Innovation needs to take root alongside and within established modalities. 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.

The four lighthouse examples cited offer models of alternative or hybrid programs. Each addresses the four key themes that the Summit identified: serving learners and workers along the helical pathways of their careers; smoothing their transitions through on-ramps and off-ramps of education and employment; facilitating the many-to-one relationship between institutions and individuals and beginning to offer customization at scale.

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