

Building Bridges to Success

REGIONAL BUSINESS-HIGHER EDUCATION PARTNERSHIPS
TO GROW AND DIVERSIFY THE STEM WORKFORCE



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ABOUT THE BUSINESS-HIGHER EDUCATION FORUM

The Business-Higher Education Forum (BHEF) is a private, nonprofit membership organization of leading C-Suite business executives and university presidents who employ the latest market intelligence to inform strategic partnerships that create innovative talent solutions in high-demand emerging fields. Members provide leadership by encouraging their peers to act on critical talent needs. For more information about BHEF, visit www.bhef.com.

ACKNOWLEDGEMENTS

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Lead BHEF staff members for this publication include Steve Barkanic, Stephanie Blochinger, Janet Chen, Brian Fitzgerald, and Jennifer Thornton.

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We hope that this report will give its readers a sense of the impact of NSF's grant in demonstrating the power of business-higher education partnerships to create new kinds of STEM pathways that provide educational opportunity and economic mobility for underrepresented students. We also hope that it can inform NSF's strategic plans for innovative, pro-active solutions for U.S. STEM education.

LETTER FROM THE BUSINESS-HIGHER EDUCATION FORUM

THE BUSINESS-HIGHER EDUCATION FORUM (BHEF) was excited and energized when the National Science Foundation (NSF) announced a major, bold initiative in 2017 to push the boundaries of scientific research and education. Those “10 Big Ideas” touch on critical questions regarding the future of work, convergence of research disciplines, research infrastructure, need for data-capable professionals across sectors, and other areas. NSF has made important investments in these areas that further the its mission of promoting the progress of science, securing national defense, and advancing national health, prosperity, and welfare.

Soon after this announcement, the National Science Board (NSB) released the report, *Our Nation’s Future Competitiveness Relies on Building a STEM-Capable Workforce: A Policy Companion to Science and Engineering Indicators 2018*, which noted that the number of jobs in the United States requiring “substantial science, technology, engineering, and mathematics (STEM) expertise” has increased 34 percent over the past decade. Additionally, a 2019 NSB report, *The Skilled Technical Workforce: Crafting America’s Science & Engineering Enterprise*, stated:

...the need for a STEM capable U.S. workforce at all educational levels has become more apparent—and urgent. Technologically, we are on the cusp of revolutions in data and artificial intelligence, developments that will continue to accelerate changes in the workplace and intensify our need for citizens who excel at using data, information, and technology in their work.

34%

INCREASE IN THE PAST DECADE IN THE NUMBER
OF JOBS REQUIRING SUBSTANTIAL SCIENCE, TECHNOLOGY,
ENGINEERING, AND MATHEMATICS (STEM) EXPERTISE
IN THE UNITED STATES

In 2014, NSF awarded a five-year grant to BHEF to build a network of regional partnerships that demonstrate the impact of deep engagement by STEM-driven businesses in facilitating the transfer of students, particularly veterans, women, and members of groups underrepresented in STEM fields.

Among the report's recommendations were calls for synergies among K-12 schools, two- and four-year colleges and universities, and businesses in building educational pathways for students leading to careers in high-demand fields, as well as for federal agencies to increase their support of such partnerships. The report advocated for flexibility in developing pathways that respond to regional workforce needs, and it cautioned that a one-size-fits-all approach will not produce the kind of diverse, highly skilled STEM professional needed in the digital economy.

BHEF has been pleased to have been a partner with NSF during this pivotal period in the agency's strategic transition. In 2014, NSF awarded a five-year grant to BHEF to build a network of regional partnerships that demonstrate the impact of deep engagement by STEM-driven businesses in facilitating the transfer of students, particularly veterans, women, and members of groups underrepresented in STEM fields. That effort has touched on several of the themes of the 10 Big Ideas initiative and provided NSF with a lens on innovative approaches to connect college success and career readiness in emerging STEM fields.

As a nonprofit membership organization composed of the nation's leading business executives and university presidents, BHEF is well-positioned to lead a project to explore the roles business can play in connecting classrooms and careers in STEM disciplines. BHEF's use of market intelligence to create business-higher education partnerships and innovative talent solutions in high-demand and emerging fields serves as a foundation for building sustainable student pathways that directly

address the workforce needs of today's and tomorrow's economy. Moreover, BHEF provides avenues for sharing learning through national and regional convenings, learning network reports, and other dissemination vehicles.

For example, in 2018 BHEF and NSF organized and implemented a two-day workshop titled *Reskilling America's Workforce: Exploring the Nation's Future STEM Workforce Needs* that brought together about 150 leaders from business, higher education, government, and the nonprofit sector to better understand evolving needs of the nation's workforce and explore critical issues related to employers' highest-demand workforce needs. (BHEF published the proceedings of this workshop, available on BHEF.com).

We hope that this report will give its readers a sense of the impact of NSF's grant in demonstrating the power of business-higher education partnerships to create new kinds of STEM pathways that provide educational opportunity and economic mobility for underrepresented students. We also hope that it can inform NSF's strategic plans for innovative, pro-active solutions for U.S. STEM education.

Sincerely,



A handwritten signature in dark ink, appearing to read "Brian K. Fitzgerald".

Brian K. Fitzgerald
CEO, Business-Higher Education Forum
Principal Investigator, USI² Consortium Grant

INTRODUCTION

FOR MORE THAN A DECADE, the Business-Higher Education Forum (BHEF), a membership organization of leading business executives and university presidents, has dedicated itself to increasing the supply and diversity of talent with technical and scientific knowledge and skills for the business, government, and nonprofit sectors. BHEF launched its STEM Initiative in 2006 to improve STEM P-16 outcomes and, after the release of the 2007 National Academies report *Rising Above the Gathering Storm*, adopted the goal of increasing the number of STEM degrees and the diversity of STEM graduates through research, modeling, and active collaboration between its business and academic members. In particular, the initiative challenged BHEF's academic members to form partnerships with business members to improve STEM undergraduate persistence and completion rates on member campuses.

Under the leadership of the STEM Initiative's co-chair Bill Swanson, then chairman and CEO of Raytheon Company, BHEF also initiated a multiyear research and system dynamics modeling project in partnership with ACT to better understand the interplay of STEM interest and proficiency in mathematics among P-12 students, as well as STEM enrollment, persistence, and degree completion in postsecondary education. Aided by a unique longitudinal dataset of 700,000 student-unit records from ACT's student assessments, BHEF collaborated with systems engineers and scientists from Raytheon, Northrop Grumman, Boeing, and other companies, as well as STEM faculty from member academic institutions and outside experts. Together, we created one of the first systems dynamics simulation models—the BHEF STEM Education Model®—that has enabled the simulation of policy and programmatic interventions in the STEM P-16 “system.”

That modeling demonstrated the need for mutually reinforcing P-12 and postsecondary policy and practices. For example, decreasing attrition among highly effective mathematics and science middle school teachers produced significant downstream impacts on student proficiency. At the same time, increasing the persistence and completion of STEM undergraduate students had the most immediate impacts on graduates entering the STEM workforce. Additionally, modeling several high-impact practices, such as cohort learning experiences, in the first two years of enrollment proved significantly effective in improving year-to-year persistence for all STEM students (BHEF, 2010).

Support from the United States Department of the Navy's Office of Naval Research permitted BHEF to build the U.S. STEM Undergraduate Model®, which expanded the research and modeling of high-impact practices in STEM undergraduate education and, in particular, their impact on women and underrepresented minorities—who together, make up the majority of STEM undergraduate attrition (BHEF 2013 a, b). The modeling demonstrated

that multidimensional interventions that provide academic, social, and career/work-based learning supports provide the greatest impact on STEM outcomes. However, the research and modeling also uncovered the fact that high-impact practices, while effective, were deployed less frequently at two-year than four-year colleges, thus creating a persistent drag on STEM degree production and diversity: a low transfer rate of two-year STEM students into STEM majors on four-year campuses.

In an effort to harness this learning and practice for greater impact, BHEF launched its signature initiative, the National Higher Education and Workforce Initiative (HEWI), in 2012 to formalize and expand business-higher education partners and focus these partnerships on addressing emerging workforce challenges in an increasingly digital economy. At the initiative's launch event on Capitol Hill in June 2012, Wes Bush, then chairman and CEO of the Northrop Grumman Corporation, announced a grant to the University of Maryland College Park to create the nation's first undergraduate honors program in cybersecurity: the Advanced Cybersecurity Experience for Students (ACES). He also awarded a grant to the University of Maryland, Baltimore County to fund a Cyber Scholars Program, an extension of the highly successful Meyerhoff Scholars Program, focused on women in cybersecurity. The momentum created by these two grants accelerated the formation of partnerships by other BHEF business and academic members. Initial research identified a number of emerging fields in high demand across many sectors, including cybersecurity and data science, around which the initiative's early partnerships formed. Five of these BHEF-member partnerships focused on providing high-impact practices to students at community colleges to help those students transfer to four-year institutions and pursue STEM baccalaureate programs—thereby increasing the number of STEM degrees and the diversity of STEM graduates.

Developing evidence-based models for implementing strategic and sustainable engagement by business with higher education to increase the persistence of STEM students, particularly women and underrepresented minorities.

IN 2014, WITH MAJOR SUPPORT FROM NSF, BHEF launched a five-year project to demonstrate the efficacy of regional ecosystems of community colleges, four-year higher education institutions, and STEM-driven business in facilitating the retention and persistence of students in STEM fields. BHEF proposed to advance knowledge in a largely unexplored area of four-year undergraduate STEM education: developing evidence-based models for implementing strategic and sustainable engagement by business with higher education to increase the persistence of STEM students, particularly women and underrepresented minorities. The project identified the transfer of students from two-year to four-year institutions as a key juncture that, if addressed, could significantly increase both the diversity and overall STEM degree attainment at the baccalaureate level.

In order to achieve such outcomes, BHEF proposed to build an Undergraduate STEM Interventions with Industry (USI²) consortium that served as a learning community for the project sites. With NORC at the University of Chicago serving as the project evaluator, five individual BHEF-member sites engaged businesses in implementing combinations of evidence-based interventions—high impact practices—designed to increase STEM student persistence, transfer, and completion to determine whether business engagement in partnerships using such practices increase community college student transfer to baccalaureate STEM programs and such students' success in STEM majors.

To address this focus, BHEF developed a theory of action in Figure 1. Students begin at a two-year college and transfer to a four-year program—with the support of industry-engaged interventions facilitated by BHEF's Strategic Business Engagement Model—and then persist to bachelor's degrees and careers in high-demand STEM fields. The result is improved student success, student acquisition of STEM skills, and increased diversity in STEM fields. BHEF will share insights and learning from the project with its members, national partners, and the wider business and higher education communities, shaping the way

FIG. 1 BHEF's THEORY OF ACTION

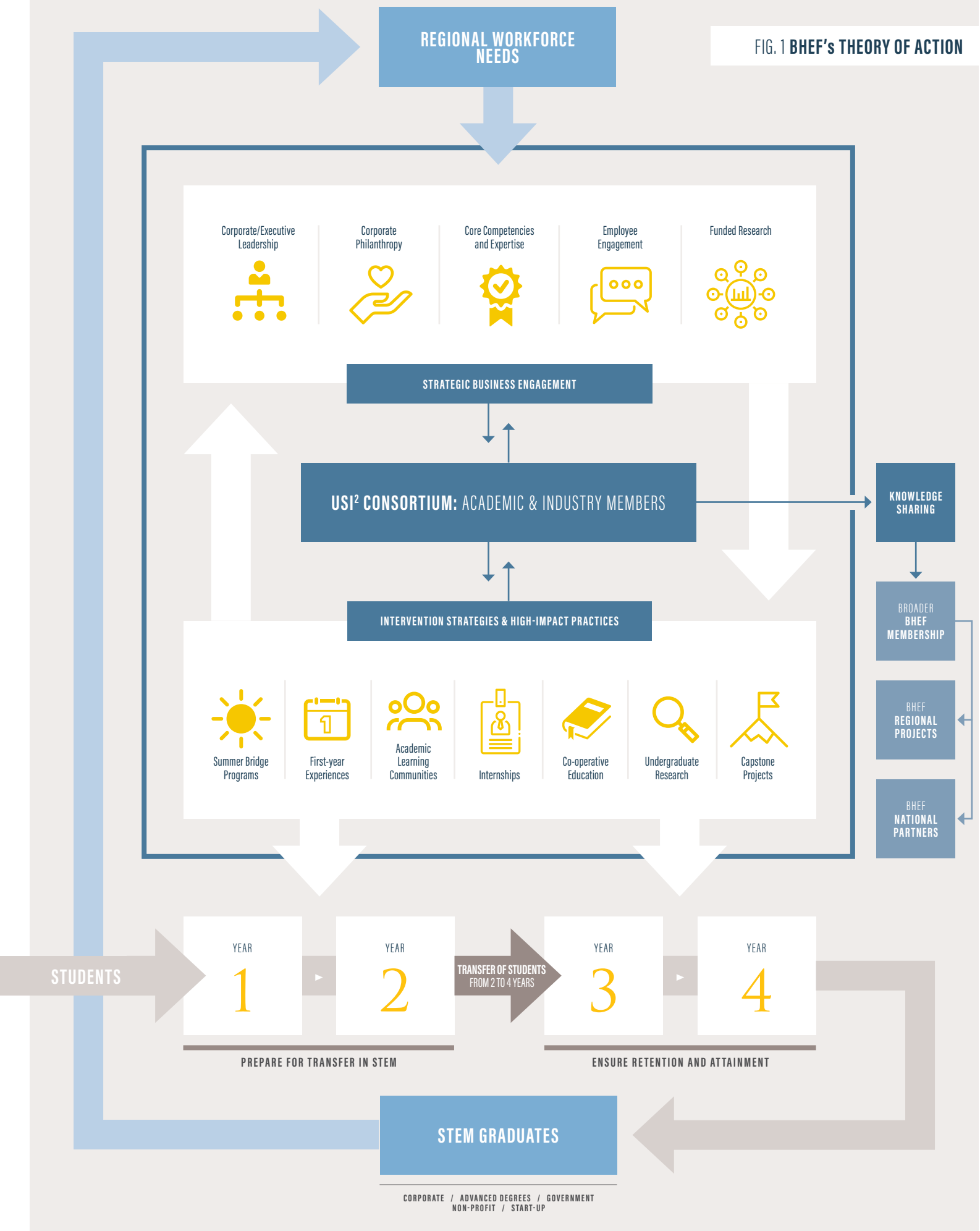
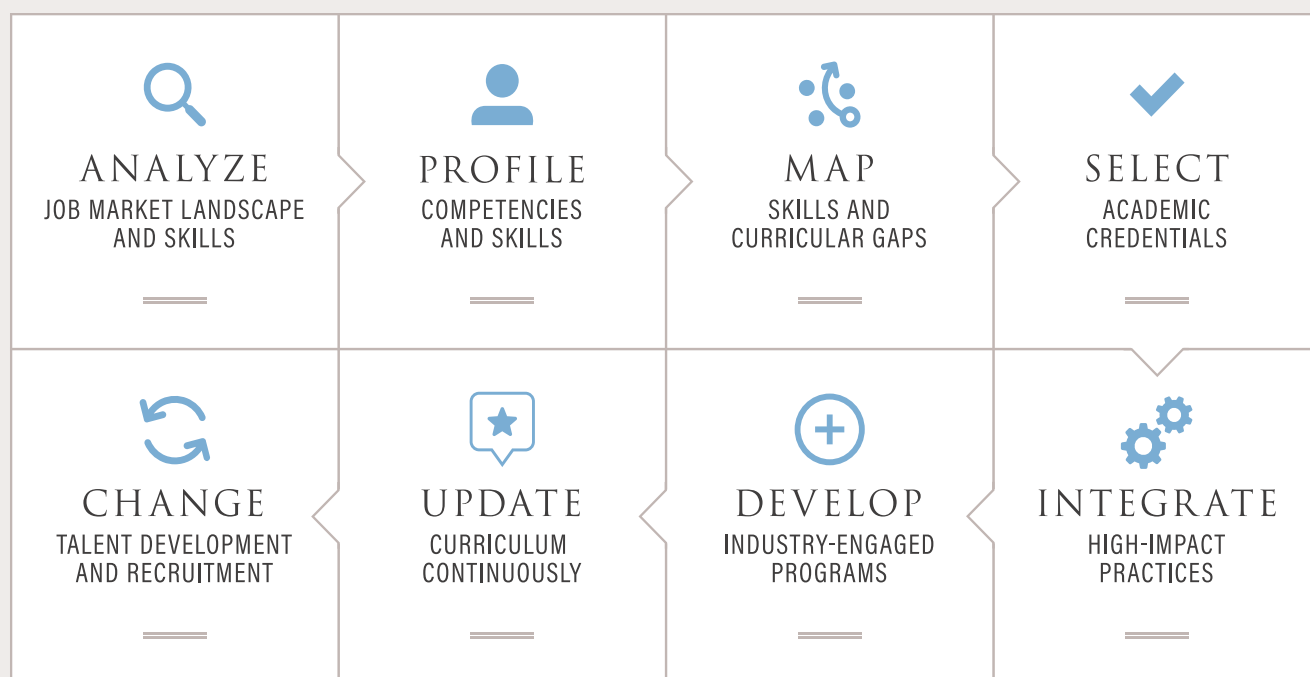


FIG.2 BHEF STRATEGIC ENGAGEMENT MODEL PARTNERSHIP IMPLEMENTATION PROCESS



those organizations engage in strategic STEM undergraduate/workforce partnerships.

To advance these partnerships and ensure alignment of knowledge and skills with employers' needs, BHEF developed a rigorous methodology—the Partnership Implementation Process—outlining a series of steps and milestones to guide the development of business-led engagement with higher education in the creation of new academic programs and student pathways. Given the variety of differentiating factors that exist within each partnership engagement—including specific industry sectors, companies, and student subpopulations—the process serves as a common text for not only facilitating change but also sharing outcomes. The project demonstrated that the methodology is replicable and scalable across a wide range of geographic settings, types of institutions, economic sectors, and disciplinary foci in a mosaic of pathways to college success and career readiness. The Partnership Implementation Process also provides a blueprint for moving partnerships from initial workforce analysis and competency mapping to revised employer hiring practices—all of which was managed by a third-party intermediary playing a coordinating and oversight role that is essential for rapid success.

The eight-step methodology is outlined in Figure 2. The first step in the Partnership Implementation Process is to analyze the workforce requirements of geographic regions under consideration. Partners then identify the skills required of the ideal job candidate and design a competency map. Institutions map their

curricula to business needs, work with companies to determine the best academic vehicle for an industry-recognized credential, build in ongoing applied learning for students with relevant business engagement opportunities, and formally launch the new program or pathway. Finally, partners continuously update the curriculum, and business partners revise and adapt their talent recruitment models based on their engagement with their academic partner.

BHEF's 2019 publication, *Creating Purposeful Partnerships: Business and Higher Education Working Together to Build Regional Talent Ecosystems for the Digital Economy*, describes the process in more detail. It builds upon the work supported by the NSF grant and offers insights into business-led regional talent ecosystems that facilitate the development of a prepared workforce (BHEF, 2019a). The findings serve as a playbook for CEOs and their executive teams for establishing purposeful and strategic partnerships with higher education leaders to meet the need for diverse talent that has the required skills for companies' long-term success.

This report, *Building Bridges to Success: Regional Business-Higher Education Partnerships to Grow and Diversify the STEM Workforce*, captures the learning from the NSF-funded project, highlights the partnerships and institutional contexts in which these STEM pathways were designed and implemented, and conveys the impact and sustainability of business engagement on developing a diverse, highly skilled workforce.

This project identified the transfer of students from two-year to four-year institutions as a key juncture that, if addressed, could significantly increase both the diversity and overall STEM degree attainment at the baccalaureate level.

In order to achieve such outcomes, BHEF proposed to build an Undergraduate STEM Interventions with Industry (USI²) consortium that served as a learning community for the project sites. With NORC at the University of Chicago serving as the project evaluator, five individual BHEF-member sites engaged businesses in implementing combinations of evidence-based interventions—high impact practices—designed to increase STEM student persistence, transfer, and completion to determine whether business engagement in partnerships using such practices increase community college student transfer to baccalaureate STEM programs and such students' success in STEM majors.



IMPACT

GRANT IMPACT AMONG THE SITES

Five partnerships formed the foundation for the USI² Consortium. The following sections identify the challenge they addressed, the solution they created, the outcomes of the work, and the broader impacts beyond the project's original scope.

THE SITES

- I. **The City University of New York and IBM** PG. 12
Capitalizing on Existing Infrastructure to Support Transfer Students in Data Science and Analytics and Urban Sustainability
—
- II. **Miami Dade College and NextEra Energy** PG. 16
Developing Stackable Credentials in Data Science and Analytics
—
- III. **Northeastern University, Raytheon, IBM, and Others** PG. 20
Integrating Work and Learning in Industry-Informed IT and Cybersecurity Curriculum
—
- IV. **University of Wisconsin-Milwaukee and The Water Council** PG. 24
Pioneering a New Work-Based Learning Model in Water Science Program
—
- V. **Washington University in St. Louis and Boeing** PG. 28
Providing an Alternative Engineering Pathway for Nontraditional Students

SITE I.

The City University of New York and IBM

Capitalizing on Existing Infrastructure to Support
Transfer Students in Data Science and Analytics and
Urban Sustainability

THE CHALLENGE

A Burning Glass market analysis that BHEF and IBM commissioned in 2017 forecast that annual job openings for data science and analytics (DSA) roles will rise steadily to 2.72 million postings in 2020. And according to BHEF's Financial Services Workforce project, the financial services industry in New York City, in particular, is increasingly demanding DSA skills.

The campuses of the City University of New York (CUNY) do not, however, currently offer an undergraduate degree program in data science or the equivalent. Simultaneously, CUNY faculty members identified a lack of scientific computing skills as a major barrier for STEM transfer students. Those students often do not receive introductory training in scientific computing in their freshman courses, leaving them unprepared for higher-level STEM courses.

Those facts, taken together, created an opportunity to meet the needs of business while also harnessing and focusing the untapped talent at community colleges.

2.72M

FORECASTED ANNUAL JOB OPENINGS FOR DATA SCIENCE AND
ANALYTICS (DSA) ROLES POSTED IN 2020

CUNY CURRENTLY DOES NOT OFFER AN UNDERGRADATE DEGREE
PROGRAM IN DATA SCIENCE OR THE EQUIVALENT

CUNY's TRELLIS Summer Bridge Program uniquely blends technology-based instruction with in-person experiential learning while capitalizing on its state-of-the-art facilities for scientific computing, remote sensing, and in-situ environmental monitoring.

THE SOLUTION

With a long-term vision to implement the program broadly throughout its system, CUNY developed extracurricular data science programming for undergraduates to support the development of a pathway from community college to the City College of New York (CCNY) and on to the high-skill STEM workforce. Facilitated by BHEF, CUNY engaged faculty and IBM staff members in identifying both site-level and industry-wide barriers to success for students at community colleges. The resulting CUNY TRELLIS (TRansformational Experiential Learning for Leadership in STEM) program developed two high-impact practices:

1. a summer bridge program for students transferring from community college to STEM baccalaureate-degree programs and
2. capstone data science projects for senior students who have successfully transferred.

The TRELLIS Summer Bridge Program recruited from the system's seven community colleges to train cohorts of 10 students in the fundamentals of data analytics and scientific computing through work on guided analysis projects. Launched in the summer of 2016, it used real data on climate change resilience in New York City. Capitalizing on the CUNY Advanced Science

Research Center's state-of-the-art facilities for scientific computing, remote sensing, and in-situ environmental monitoring, the TRELLIS Summer Bridge Program was unique in its blend of technology-based instruction with in-person experiential learning. Web-based learning resources supported self-paced, technical learning for participating students, who entered the program with diverse academic backgrounds. At the same time, in-person, collaborative activities helped students develop other key workforce competencies, including problem-solving, communicating with diverse audiences, collaborating on interdisciplinary teams, and gaining familiarity with ethics and privacy issues in data science.

After three years, CUNY faculty members mentored cohorts of five students who had successfully transferred from a community college to CCNY, supporting them in conducting capstone environmental data science projects. Participating students worked on a diverse range of projects, including an evaluation of socio-spatial data to understand the economic impacts of buying out flood-zone properties, the development of a web platform to provide access to integrated weather data products, and an analysis of municipal-service-request data to quantify the impact of extreme weather. Students conducting capstone projects served as peer mentors for students in subsequent bridge-program cohorts in order to foster the development of student communities and strengthen the environment of extracurricular programming.

PARTNERS

IBM served as the lead business partner, providing insight on industry demand for workplace competencies, guidance on the development of training activities, and expert staff members to present at career development workshops and events for CUNY students. Along with IBM, CUNY hosted an industry roundtable with BHEF in summer 2018, engaging staff from IBM, Arcadis, Deloitte, Bloomberg, Wiley, and General Assembly.

In September 2019, CUNY also held a half-day Climate Week NYC event, attended by more than 50 CUNY faculty members and students, as well as representatives from a variety of regional industries—including investment/financial services, environmental monitoring, and engineering consulting. The event provided the opportunity to highlight undergraduate training programs, discuss the role of business-higher education partnerships in supporting near-term urban sustainability, and brainstorm the development of new partnerships.

Business partners:

IBM,* Arcadis, Deloitte, Bloomberg, Wiley, and General Assembly

Higher Education partners:

The City University of New York,* City College of New York, Borough of Manhattan Community College, Bronx Community College, Guttman Community College, Hostos Community College, Kingsborough Community College, LaGuardia Community College, Queensborough Community College

(asterisk indicates original partner)

OUTCOMES

Through the CUNY TRELLIS program, 38 students participated in high-impact practices. Thirty-seven percent of those students were women, and 42 percent were underrepresented minorities in STEM. Nearly all participating students were able to successfully transfer to bachelor's degree programs at CUNY, with the first cohort of students graduating in spring 2019. Participating students have also received competitive fellowships, including the National Science Foundation Research Experience for Undergraduates Fellowship, the National Oceanic and Atmospheric Administration CREST Fellowship, and the National Centers for Environmental Prediction Summer Student Internship. Beyond those impacts, the project has served as a supportive programming model for students transferring from community college to CUNY four-year colleges, and it is now being replicated on other CUNY campuses.

BROADER IMPACTS

While TRELLIS began as a summer bridge program, it played a significant role in the larger New York City talent ecosystem. For example, the CUNY Environmental Sciences Initiative investigated the role of business-higher education partnerships in building the workforce needed to support sustainable, smart cities. CUNY's efforts informed BHEF's New York City Data Science Task Force, supported by the Alfred P. Sloan Foundation and composed of more than 50 subject-matter experts in data science and analytics. This group developed a competency map and built partnerships and programs to meet workforce needs.

In addition, BHEF's Financial Services Workforce Project—in partnership with Business Roundtable members and other companies, as well as the university system's Baruch College Zicklin School of Business—focused on developing the DSA, cybersecurity, and risk competencies that financial services organizations increasingly need.



PARTNERSHIP CHECKLIST

- ☒ **Select Field or Sector:**
DSA and Urban Sustainability Science
- ☒ **Select Geographic Region:**
Northeast (New York)
- ☒ **Select Academic Vehicle:**
Undergraduate Credential
- ☒ **Develop Industry Engagement Strategy with High-Impact Practices:**
Presentations, Real-World Datasets, Co-Developed Curriculum, Outreach and Networking Events, Summer Bridge Program, Internships, Capstone Projects
- ☒ **Evaluate Company Signaling Mechanisms:**
Ongoing

AS A HIGH SCHOOL STUDENT IN QUEENS, Shivron Sugrim lacked direction. No one in his family had attended college, and he couldn't envision a potential career. As high school graduation approached, he didn't feel prepared for a traditional, four-year college, so he worked in retail with no opportunity for advancement. During this time, Shivron saw a video about the European Space Agency's Rosetta spacecraft. He became fascinated by aerospace and, for the first time, had a vision for a career. To explore this new interest, Shivron enrolled in classes at the Borough of Manhattan Community College (BMCC), a CUNY open-access institution.

Shivron thrived at BMCC. He conducted materials-science research with a faculty member and performed well in his science and math courses. After completing the major courses in BMCC's engineering science program, Shivron applied to the Grove School of Engineering at CCNY as a transfer student and was accepted for the fall 2017 semester.

The summer before transferring, Shivron participated in the TRELIS summer bridge program. The enhanced programming skills he gained through the summer bridge program played a major role in his successful transfer to upper-level courses at CCNY. He felt well prepared for his courses, even though he had limited formal training in programming prior to the bridge program. He used the new skills he gained regularly in his course assignments and was prepared to take additional programming courses using Matlab, Python, and C++.

CCNY's Grove School of Engineering is both figuratively and literally far from Shivron's neighborhood in Queens. He travelled over an hour by motorcycle, as his neighborhood is at the edge of New York City with limited access to public transit. But participation in the bridge program helped Shivron feel like he was part of his new campus community. He made friends with other incoming transfer students through his collaboration on team projects and participation in networking events. He was then able to begin his studies at CCNY with student and faculty contacts in a variety of programs throughout the campus.

After completing his first year of classes, Shivron worked on a capstone project under the mentorship of Ricardo Toledo-Crow, the director of the Environmental Sensing Laboratory at the CUNY Advanced Science Research Center. He collected, visualized, and analyzed local weather data, integrating data from roof mounted sensors with external remote sensing data sets. Through work on that project, Shivron has gained enhanced skills in C++, proficiency with HTML/CSS, and experience working with environmental sensing and communications protocols that will be particularly valuable for a career in the aerospace industry.

He has successfully passed the Fundamentals of Engineering exam, the qualifying examination for engineering licensure, and is an active student member of the National Society of Black Engineers and the Society of Asian Scientists and Engineers. Shivron graduated in fall 2019 with a bachelor of engineering and a minor in mathematics and is starting a job as an engineer-in-training in Pittsburgh.

SITE II.

Miami Dade College and NextEra Energy

Developing Stackable Credentials in Data Science and Analytics

THE CHALLENGE

Data analytics skills are a core workforce need across almost every industry sector, both private and public. Yet undergraduates are typically offered little to no coursework or experience directly related to the field, and they therefore enter industry woefully underprepared for high-performing work environments.

According to regional job market data, nearly 2,200 jobs openings related to data analytics are projected in South Florida during the next five years at an average salary of just over \$100,000. Additionally, a Gallup poll revealed that, by 2021, 69 percent of employers expect candidates with data science and analytic skills to get preference for jobs, yet only 23 percent of college and university leaders say their graduates will have those skills.

69%

OF EMPLOYERS EXPECT CANDIDATES WITH DATA SCIENCE AND ANALYTIC SKILLS TO GET PREFERENCE FOR JOBS BY 2021, ACCORDING TO A GALLOP POLL

Miami Dade College developed the only four-year bachelor's degree in data analytics in the state of Florida as part of its innovative stackable program.

THE SOLUTION

Miami Dade College (MDC) partnered with BHEF, NextEra Energy, and other local and national companies with the initial goal of creating the only four-year bachelor's degree in data analytics in the state of Florida. That goal matured into a set of three academic programs that stack into each other to provide students with the skills and competencies necessary for a job in data analysis:

- The College Credit Certificate (CCC) in Business Intelligence Professional is a one-year, 20-credit, accelerated program that prepares students with the workforce skills they need for immediate employment and career experience. Program areas of study include database concepts, Structured Query Language (SQL), data-mining algorithms, predictive methodologies, and data visualization techniques.
- The Associate in Science in Business Intelligence is a 60-credit, two-year degree that prepares students for employment as business intelligence analysts or related occupations or for upper-division studies in data analytics.
- The Bachelor of Science in Data Analytics is a four-year program that embeds the associate degree in business intelligence. Students can enter the degree

after completing any other associate degree and a set of five pre-requirement courses: database concepts design, statistical methods, SQL administration, SQL implementation, and introduction to business analytics. During the last two years of the program, students learn to apply data-mining methods and statistical tools to resolve business questions and make recommendations that effectively support tactical and strategic business objectives. Areas of study include statistical methods, regression analysis, and data visualization.

In the introductory programming course for the data analytics bachelor's degree, students join a learning community that fosters relationships with faculty members. Students also begin a two-semester undergraduate research experience, which they can continue over the summer semester. Miami Dade provides stipends for nontraditional and commuter students who choose to engage in that summer research.

The programs follow an interdisciplinary approach that combines data engineering, math, statistics, advanced computing, and the scientific method to train students to become data analysts, able to manipulate and analyze data across fields. Given the transdisciplinary nature of data science, students have gained a broad set of foundational skills, and regional partners have contextualized the program to meet their own sector-specific needs.

PARTNERS

With support from BHEF and the Business Roundtable, Miami Dade hosted a one-day industry focus group that included representatives from NextEra, Accenture, Miami Children's Hospital, Miami-Dade County's Information Technology Department, Oracle Corporation, SAS Institute, and Siemens Energy. As a result of this convening, a competency map outlining the major duties, tasks, knowledge, skills, traits, and software tools required for data analysts was created, and an interdisciplinary team of the college's faculty members and administrators then used that map to develop a new curriculum for a suite of industry-recognized stackable credentials. Professionals from NextEra, the lead business partner, brought intellectual resources, field experience, skills, and competencies to the program. They strengthened the education-to-workforce pipeline through efforts such as co-development of new courses focused on active learning, student research opportunities, relevant case studies, interdisciplinary solutions, the creation of an energy sector specialization, and a direct pathway to jobs. Additional industry partners have also engaged in industry roundtables co-hosted with BHEF, developed workshops to increase faculty capacity to conduct data analysis research and teach data analytics skills, and provided students access to case studies, speakers, and mentors.

Business partners:

NextEra Energy,* Accenture, Miami Children's Hospital, Miami-Dade County's Information Technology Department, Oracle Corporation, SAS Institute, Siemens Energy, Baptist Health of South Florida, Jackson Health System, Dell, Visa Inc., Univision Communications Inc., Florida Panthers, Miami-Dade County's Department of Transportation and Public Works, Mount Sinai Medical Center, Miami Heat, Nicklaus Children's Hospital, the Venture City, Assurant, United Data Technologies, Cognizant, Tech Mahindra, and Ryder System

Higher Education partners:

Miami Dade College*

(asterisk indicates original partner)

OUTCOMES

Since the implementation of the program in fall 2015, enrollment has almost doubled every year. Beginning with 20 students in the bachelor's degree in data analytics, as many as 161 students were pursuing one of the three different stackable credentials by spring 2019. In total, 165 underrepresented minority students and 58 female students have enrolled, and 31 students have graduated with a bachelor's degree, 33 with an associate degree, and 47 with a certificate. In addition, all the students who graduated in Miami Dade's first cohort, in 2018, gained job positions like business intelligence analyst, data warehousing specialist, and data analyst—positions with annual salaries averaging over \$75,000, according to the Bureau of Labor Statistics. Given Miami Dade's diversity (86 percent of students are minorities and 78 percent work while attending college), it is furthering equity of opportunity for its student population and pioneering connections between work and learning through modern apprenticeships and internships.

Most notably, a one-year college credit certificate in business intelligence allows more students to quickly gain valuable skills and a credential, even if those students are unable to complete the associate or bachelor's degrees. The overwhelming demand for such skills also motivated Florida International University to create a one-year master's program in the field, furthering the skills potential and overall stackable credential.

BROADER IMPACTS

Miami Dade's project began by addressing the many challenges of designing a new major in analytics in collaboration with business partners, including NextEra Energy. While the college successfully received approval for the only analytics major at a public institution in the state, its curriculum has evolved to a stackable credentials model. This serves as a distinct model for supporting students as they progress in their chosen pathways, allowing employers to match talent at all levels of development and meet the region's need for employees with skills in data science and analytics. Companies have given very positive feedback after hiring and validating the skillsets of the program's graduates, as well as opened new positions and referred MDC's program to other departments. In addition, Miami Dade continues to build on their programs, developing new courses and concentrations in areas such as healthcare analytics and artificial intelligence. It is in the process of creating an articulation agreement with Florida International University, which offers a master's program in data analytics.



PARTNERSHIP CHECKLIST

- ☒ **Select Field or Sector:**
DSA

- ☒ **Select Geographic Region:**
Southeast (Florida)

- ☒ **Select Academic Vehicle:**
Stackable Undergraduate and Graduate Degrees and Certificates

- ☒ **Develop Industry Engagement Strategy with High-Impact Practices:**
Guest Lectures, Mentorship, Real-World Datasets, Co-Developed Curriculum, Robust Industry Advisory Group, Personalized Industry Partnership Strategies, New Work-Based Learning Programs

- ☒ **Evaluate Company Signaling Mechanisms:**
Ongoing

WHEN ROBERTO CARLOS RODRIGUEZ-ANDREU discovered the magic of data, his life, goals, and expectations of the future changed. After researching careers, he realized that business intelligence and data science was a marketable profession with a bright future in a data-driven world. He started pursuing his bachelor's degree in science in data analytics at Miami Dade College. As an MRI technologist for 10 years, as well as a husband, dad, and student, Roberto faced an overwhelming challenge in undertaking this new degree. Nevertheless, the power of data, his family's support, and the professionalism of the college's educators sustained him and allowed him to develop a foundation for his career.

Every day in class was an exciting experience for him. He found that the faculty had built a remarkable program that opened a world of opportunities and knowledge for his career development. He was exposed to real data problems, algorithms, reports, and projects, and he used different tools and applications with new terminologies and vocabulary—all of which served to enhance his skills. Hired in 2019, he is now a clinical business technical analyst working for the Business Intelligence Team at Baptist Health of South Florida. He continues to work on his professional and educational goals and will attend Dakota State University for a master's in healthcare analytics.



SITE III.

Northeastern University, Raytheon, IBM, and Others

Integrating Work and Learning in Industry-Informed
IT and Cybersecurity Curriculum

THE CHALLENGE

According to the Advanced Cyber Security Center, a Boston-based consortium focused on the cybersecurity field, Massachusetts is one of the fastest growing hubs for cybersecurity in the United States. This growth has increased the demand for talent such that in the fiscal year ending August 2018, Massachusetts had over 9,000 cybersecurity job openings (source: cyberseek.org) and roughly one in 10 jobs in cyber in the Boston area were unfilled.

1 IN 10

JOBS IN CYBER IN THE BOSTON AREA WERE UNFILLED

MASSACHUSETTS HAD OVER 9,000 CYBERSECURITY JOB
OPENINGS AT THE END OF FISCAL YEAR 2018

Recognized as a leader in work-based learning,
Northeastern seamlessly integrated work and learning
to create an industry-informed IT and cybersecurity
curriculum.

THE SOLUTION

In partnership with Raytheon, IBM, and other industry leaders, the Lowell Institute School at Northeastern University developed a multifaceted solution to address the growing demand for cybersecurity talent in the Greater Boston and New England regions and improve student transfer, persistence, and career readiness. The three key elements of the project included:

1. Development of a new industry-aligned, five-course systems administration and cybersecurity concentration within the online bachelor's of science in information technology (BSIT) degree.
2. Integration of experiential learning opportunities to support engagement, persistence, and career readiness by redesigning the online BSIT curriculum using challenge-based learning and the incorporation of real-world, industry-sourced projects provided by the experiential network.
3. Implementation of a peer and industry mentoring program that matched learners with more-advanced students and industry professionals working in cybersecurity and information technology via an online mentoring platform.

Building on its history as a leader in work-based learning, Northeastern focused on connecting associate degree graduates as well as other working adults already in the IT field to the specialized cybersecurity skills needed to gain an entry-level role in cybersecurity. The principal goals of the project were to expand the talent pipeline, provide economic mobility to working adult learners through on-ramps into the high-demand fields, and broaden participation in those fields to include underrepresented minorities and women.

Northeastern's approach included STEM seminars and the use of cohorts and mentoring, which are particularly important for nontraditional students who may lack the residential, place-based connection that traditional students experience. Northeastern enhanced the experiential learning opportunities it provided to students by revising the BSIT curriculum using the challenge-based learning model and integrating opportunities for virtual internships via the Experiential Network.

A key project activity in aligning curriculum and pathways among community colleges, Northeastern, and industry, and in supporting student career exploration and discovery, was organizing cybersecurity events highlighting industry speakers, two of which Northeastern and BHEF co-hosted. Finally, in collaboration with Mentor Collective, Northeastern established a virtual mentoring platform to provide peer and industry mentoring, a recognized high-impact practice.

PARTNERS

Northeastern worked closely with its industry partners, Raytheon and IBM, to analyze the job market landscape and skills, profile competencies and skills, map skills and curricular gaps, update its curriculum, and develop industry-engaged programs and project-based learning opportunities. IBM provided access to virtual cybersecurity labs and software tools that were evaluated for inclusion in the new cybersecurity concentration. IBM also hosted Northeastern faculty members for a five-day professional development training session in Chicago to familiarize them with IBM's tools, curriculum, and certifications.

In addition, Northeastern and BHEF co-hosted two cybersecurity industry events with partners such as Beth Israel Deaconess Medical Center, Raytheon Company, State Street Corporation, Burning Glass Technologies, MassTech, Partners Healthcare, Spark Process, the MITRE Corporation, IBM, and GuidePoint Security. Finally, Northeastern collaborated with its community college partners to align its curriculum with business needs, incorporate high-impact practices, and develop its Experiential Network.

Business partners:

Beth Israel Deaconess Medical Center, Burning Glass Technologies, Raytheon Company,* State Street Corporation, MassTech, Partners Healthcare, Spark Process, The MITRE Corporation, IBM,* GuidePoint Security, and Raytheon

Higher Education partners:

Northeastern University,* North Shore Community College, Bunker Hill Community College, MassBay Community College, Quincy College, and Quinsigamond Community College

(asterisk indicates original partner)

OUTCOMES

In the past four years, the BSIT program has had a total of 870 enrollments and has graduated 112 students with their bachelor's degree. Northeastern has also attracted 62 internal transfers (students who switched into BSIT from another major or program), reflecting the appeal of the BSIT program. Of those enrolled, 21 to 24 percent have been female students and 28 to 30 percent have been underrepresented minorities in each of the four years. During this time, the virtual mentoring program provided peer and industry mentoring to 410 students. In the three years since the launch of the Experiential Network in the BSIT program, 32 students have participated in these virtual internships.

Additionally, in order to enhance transfer pathways, Northeastern signed 16 new articulation agreements with community colleges during the last four years, most of them including pathways into BSIT. The university is also launching a new program to give BSIT credits to students who have earned a Google IT Support Certificate.

BROADER IMPACTS

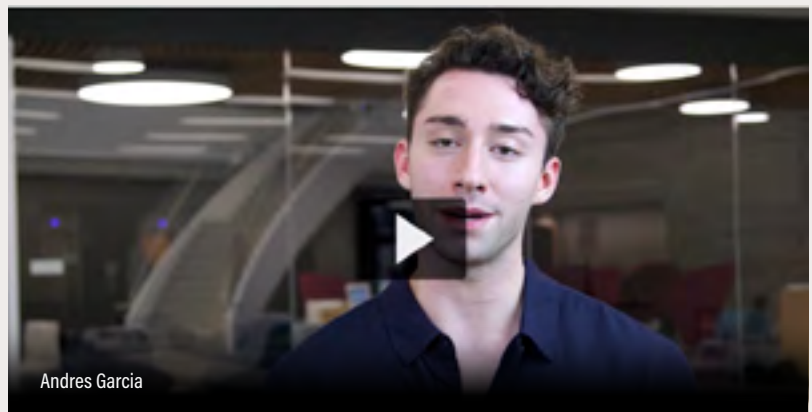
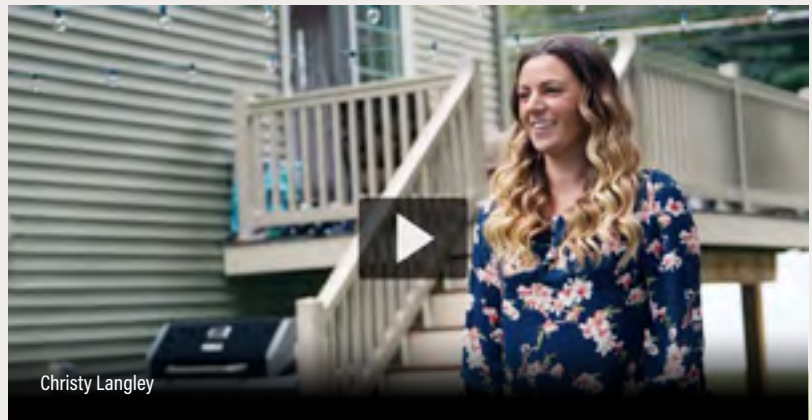
Northeastern's project began by focusing on the creation of a cybersecurity concentration within their BSIT degree. Building on the university's efforts to create new models for industry-recognized credentials, Northeastern collaborated with IBM to recognize IBM digital badge credentials as counting toward graduate degrees and partnered with General Electric to launch an accelerated bachelor's of science in advanced manufacturing systems degree program. In partnership with BHEF and based on a research report from NORC, Northeastern produced the report, *Designing and Implementing Work-Based Learning: A Call to Action for CHROs*, which sought to better understand how organizations are approaching work-based learning experiences as they pertain to talent identification—recruiting, training, and connecting work and learning (Gallagher et al., 2019; Knepler & Zapata-Gietl, 2019a). In addition, the university's work with its community college partners on the Experiential Network has provided a scalable and sustainable model for further industry engagement in experiential learning.



PARTNERSHIP CHECKLIST

- ☒ **Select Field or Sector:**
IT and cybersecurity
- ☒ **Select Geographic Region:**
Northeast (Massachusetts)
- ☒ **Select Academic Vehicle:**
Undergraduate Degree
- ☒ **Develop Industry Engagement Strategy with High-Impact Practices:**
Speaker Series, Mentoring Program, Co-Developed Curriculum, Industry Roundtable, Industry-recognized badges, New Work-Based Learning Programs
- ☒ **Evaluate Company Signaling Mechanisms:**
Ongoing

Northeastern provides bachelor's completion student video stories at <https://www.northeastern.edu/bachelors-completion/student-stories/>



SITE IV.

University of Wisconsin-Milwaukee and The Water Council

Pioneering a New Work-Based Learning Model
in Water Science

THE CHALLENGE

Water and wastewater technology in the Midwest, and the nation at large, suffers from an impending crisis of both an aging workforce and a dearth of qualified replacements. Nearly half of engineers and technicians at water distribution systems and municipal/commercial wastewater treatment plants are within five years of retirement. And, while technical college degrees are common, only 10 percent of employees in the current workforce have a bachelor's degree or higher. Nevertheless, rapidly advancing sensor technology is demanding an elevated level of technical training to modernize existing facilities.

~50%

OF ENGINEERS AND TECHNICIANS AT WATER DISTRIBUTION
SYSTEMS AND MUNICIPAL/COMMERCIAL WASTEWATER
TREATMENT PLANTS ARE WITHIN FIVE YEARS OF RETIREMENT

WATER SYS-STEM serves as a modern work-based learning program that is a hybrid of an apprenticeship, internship, and research experience combined.

THE SOLUTION

Building on Milwaukee's reputation as a water-centric city and its expertise in freshwater science, the University of Wisconsin-Milwaukee School of Freshwater Sciences (SFS) developed a partnership with The Water Council to bring together the region's freshwater public, private, and academic research community to create the WATER SYS-STEM: See Yourself Succeeding in STEM program. The partnership involved working with three local technical colleges—Gateway Technical College (GTC), one of the oldest AA-degree colleges in the United States, Milwaukee Area Technical College (MATC), and Waukesha County Technical College (WCTC)—to increase workforce diversity by recruiting first-generation, low-income, and under-represented-minority students interested in water applications.

During the 10-week summer program, each student is paired with a faculty member as well as an industry mentor. In the first week, students engage in an experiential component at SFS that involves a variety of experiences, including expeditions to Lake Michigan and discussions of professional decorum for internships. In the second through ninth week, students engage in a paid internship with one of several industry water partners. In the 10th week, they return to SFS for a week of expeditious water technology experience and debriefing from their industry internship. With industry mentors and representatives, they also make both oral and poster presentations on their internship

experiences to an audience of university scientists, faculty, and staff at a summer research symposium.

As a required part of the program, the paid internship ensures that the selected number of student participants can be matched with the available number of industry partners who can provide that intervention. The program's goal is to help students transfer to a four-year STEM degree while gaining both academic and industry experience.

The program's curriculum focuses on providing hands-on experience in real-world research and exposure to personal and professional development through seminars, discussions, and on-site visits. Through it, students have worked side-by-side with professional scientists, analyzing local and regional problems in water use and actively engaging in real-world sampling, quantitative interdisciplinary analysis, and experiential linkage of skills to existing technological functions. Students have been challenged to imagine new ways to approach common problems that have circumvented shortcomings, while making use of current efficiencies. The program has also had an element of peer mentorship, with students from previous years returning for lunch visits. Altogether, this program represents a modern work-based learning model that is a hybrid of an apprenticeship, internship, and research experience.

PARTNERS

In addition to partnering with The Water Council, the WATER SYS-STEM program has benefited from partnerships with at least 19 industry partners across diverse areas of the water technology sector—including start-ups as well as medium, large and international water companies—that provided paid internships. Those partners have also provided continued employment, tuition assistance, mentorship, diverse technologies, and career development, all while working with WATER SYS-STEM to identify needed skillsets and personal characteristics of desired employees. The partners have also served on an advisory committee that has met once each year to share best practices. In addition, The Water Council's annual meeting has provided networking opportunities for the program's students.

Business partners:

The Water Council,* Advanced Waste Management; A.O. Smith; Badger Meter; City of Milwaukee Department of Public Health; City of Racine Department of Public Health; Clearwater Industries LLC; Evoqua Water Technologies; Covanta; GRAEF Engineering, Planning, and Design; Great Lakes Aquaculture Center; Milwaukee Water Works; Milwaukee Metropolitan Sewerage District; Marlo, Inc.; Pentair Corporation, Rexnord and the Hunger Task Force-Aquaculture Center at UWM; Ruekert & Mielke, Inc.; Sage Water; Stonehouse Water Technologies; Stormwater Solutions LLC; Watertech of America, Inc.

Higher Education partners:

University of Wisconsin-Milwaukee,* Gateway Technical College, Milwaukee Area Technical College, Tuskegee University, and Waukesha County Technical College

(asterisk indicates original partner)

OUTCOMES

Thirty-four students have participated in the WATER SYS-STEM, 82 percent of whom have been first-generation and 44 percent of whom have been women. The program has resulted in several robust articulation agreements, which have included guaranteed admissions, a streamlined transfer process, and/or on-site advisors. WATER SYS-STEM has also served as a model to convene a Midwest Land-Grant Colleges workshop on nationwide STEM recruitment into water technology jobs. The program has helped define this transdisciplinary field by identifying and detailing its workforce needs and connecting those needs to university degrees. In return, WATER SYS-STEM has provided industry partners, including The Water Council, access to a vital source of diverse STEM talent that otherwise would not have been available. Furthermore, 29 percent of participants obtained employment with their internship provider.

BROADER IMPACTS

The NSF-supported partnership between the University of Wisconsin-Milwaukee and The Water Council has inspired a vision for an internationally recognized, multidisciplinary Connected Systems Institute (CSI). The Institute is a collaboration among the University of Wisconsin-Milwaukee, Rockwell Automation, Microsoft, Johnson Controls, and other industry leaders with an initial focus on Industrial Internet of Things (IIoT). It will be a testbed to provide education, conduct research, and offer programs to develop talent, expertise, and solutions to lead companies to greater productivity through IIoT technologies and applications. The CSI offers an integrated rather than siloed approach to education that prepares students for the future workforce while still ensuring that they have a solid grounding in traditional content and application.

Through its partnership with The Water Council, UWM has also been able to build and expand its new partnership model, attracting many more businesses to collaborate on talent development. In addition, UWM's program presented The Water Council with an opportunity to work with Tuskegee University, a historically black university in Alabama, to identify five engineering students to intern with three water technology employers in Wisconsin. That has not only expanded the company's diversity goals but also introduced engineering students to the field of water as a place to apply their skills.



PARTNERSHIP CHECKLIST

- ☒ **Select Field or Sector:**
Water Science

- ☒ **Select Geographic Region:**
Midwest (Wisconsin)

- ☒ **Select Academic Vehicle:**
Undergraduate Credential

- ☒ **Develop Industry Engagement Strategy with High-Impact Practices:**
Internships, Mentorship, On-Site Visits, Exposure to Diverse Technologies, New Models for Work-Based Learning

- ☒ **Evaluate Company Signaling Mechanisms:**
Ongoing

HMONG PEOPLE CURRENTLY HAVE NO COUNTRY. Hundreds of years ago, the Hmong ruled part of China but they were eventually driven out by force and migrated to the mountains of Laos. When the Vietnam War broke out, American CIA agents recruited Hmong men and children, as young as 10 years old, to fight against Communist Vietnam for them. As a result of their aid to the Americans, the Hmong people experienced genocide by the Lao government when the Vietnam War ended. This forced the Hmong to migrate to Thailand where there were refugee camps set up, mostly by swimming across the Mekong River where many people were swept away by the fast current.

Hmong Vang was born in one of these refugee camps in Thailand. When he was two months old, his family came to the United States with nothing but the clothes on their backs. They landed in Milwaukee and have lived there ever since. Growing up, Hmong did not have anyone to look up to in terms of being successful in America. None of his elder relatives had any formal education other than elementary education in Laos. Therefore, no one could really mentor him or give him guidance on how to be successful in America. For as long as he can remember, his mom always emphasized that he and his siblings should seek a successful and prosperous life through higher education.

Throughout grade school, Hmong was an A and B student and graduated in the top 10 percent of his class. He later attended University of Wisconsin-Madison but eventually dropped out because he did not know what field he wanted to pursue. After working for a year or two in Milwaukee, he decided that he needed to try higher education again. This time, he had a goal to obtain a degree in a promising field that would provide an adequate salary.

He applied to the Electrical Engineering Technologies program at Waukesha County Technical College. During his time at WCTC, the dean came into class one day and announced a STEM Internship Opportunity at UWM's School of Freshwater Sciences. In Hmong's first year in the program, he interned at Pentair as a Manufacturing Engineering Intern. In his second year, he interned at Watertech of America, as a result of a connection between Carmen Aguilar, associate scientist for UWM's School of Freshwater Sciences, and Joe Russell, president and CEO of Watertech of America. They were both connected to The Water Council organization. After Hmong's internship ended, Watertech decided to hire him full-time as an Applications Specialist.

Watertech has allowed Hmong to live life fully—and to help his family have more in life because he did not want anyone, especially his younger siblings, to go through the same struggles and financial obstacles that he experienced simply because they did not have a choice. He has been at Watertech for just over three years now. Currently, he works with vendors to get the best pricing on water treatment equipment, provides support to the salesmen regarding the technologies they use in water treatment, and works with customers to provide solutions to problems that they have. His proudest moments at Watertech are working with partners to develop a secure and financially sensible platform that they can use to have remote communications with the water treatment controllers that they have out in the field. Eventually, he wants to obtain a bachelor's degree in electrical engineering at either UWM or the Milwaukee School of Engineering, with financial support from Watertech of America.

SITE V.

Washington University in St. Louis and Boeing

Providing an Alternative Engineering Pathway for Nontraditional Students

THE CHALLENGE

In the St. Louis region, businesses needed additional engineers to meet high demand, but many individuals from St. Louis and surrounding communities had no clear pathway for entering the profession. The only accredited engineering bachelor's programs in the region were offered out of state or through private universities whose high tuition costs and selective admission process effectively excluded prospective students with financial need. Several public universities in Missouri offered more-affordable engineering programs, but their locations in other parts of the state rendered them out of reach for nontraditional students with personal or professional obligations in St. Louis. Furthermore, many prospective students were unable to meet the basic admissions requirements for bachelor's programs in engineering because some public high schools in the St. Louis region did not offer a critical prerequisite: calculus. Due to those barriers in the educational pathway for the engineering profession, businesses were unable to tap into the diverse pool of local talent with the interest—but not the opportunity—to become engineers.

The Joint Engineering Leadership Development Program (JELDP) was created to help students construct their goals and personal identities; prepare them for engineering careers; and provide additional resources through scholarships, internships, and mentorship through its industry partner, Boeing.

200

POTENTIAL EMPLOYERS IN THE ST. LOUIS REGION
THAT WILL BENEFIT FROM JOINT ENGINEERING LEADERSHIP
DEVELOPMENT PROGRAM'S (JELDP) PART-TIME INTERNSHIP
PROGRAM

THE SOLUTION

The University of Missouri-St. Louis/Washington University Joint Engineering Program (JEP) was founded in 1993. It is the only program in the St. Louis region that offers bachelor's degrees in civil, electrical, and mechanical engineering at the cost of a public university tuition. The program has been instrumental in educating students who could not otherwise afford private university tuition or meet the admissions standards to become engineers.

Lower-division classes are taken at the University of Missouri-St. Louis (UMSL) or a local community college, such as St. Louis Community College, and upper-division engineering courses are offered in the evenings and on Saturdays on the Washington University (WUSTL) campus and are taught by its faculty. This schedule is designed for nontraditional students, including not only those who start in the community colleges system but also those who have significant family obligations, are changing careers, or are veterans.

Launched in fall 2015, the Joint Engineering Leadership Development Program (JELDP) was created to help students construct their goals and personal identities; prepare them for engineering careers; and provide additional resources through scholarships, internships, and mentorship through its industry partner, Boeing. The program features the following components:

- **Creation of an Engineering Studio.** A one-credit studio serves as a “first-year” experience for students beginning their engineering coursework on the Washington University campus to accommodate the different experience and preparation levels at which students might enter the program. The course helps students explore their own personal identity and how that relates to the engineering profession. The studio is composed of modules that feature topics such as ethics, leadership, and diversity and allows students to engage with a practicing engineer—either the course lecturer or a visiting expert—on those topics.
- **Student/Alumni Mentorship.** A mentorship program utilizing Mentor Collective was added in 2017 to bridge the curricular interventions between the engineering studio and the senior seminar courses. It’s common for students, especially nontraditional ones, to struggle when they take upper-division courses. Many have families, full-time jobs, and other pressures that make it more challenging to persist in the program. Students are required to register for the mentorship program while taking the engineering studio course, but participation is optional. Students are matched with a mentor who is an alumnus of the JEP, and Mentor Collective tracks the mentorships to make sure they meet roughly once per month.
- **Part-Time Internship Program.** A part-time internship program enables students to gain work experience during the day and continue with their coursework in the evenings. The JEP also created a position focused on students’ internship experiences that is closely integrated into the advising process. Mechanisms are being developed to manage relationships between the program, its students, and approximately 200 potential employers in the St. Louis region.
- **Student Makerspace.** A student makerspace, solely dedicated to students in the JEP, was equipped in 2019. The new space will give students a place to meet, innovate, and gain hands-on experience.
- **Senior Seminar Courses.** Washington University has also incorporated upper-division seminars focused on developing career goals and professional skills in each of their three engineering majors—civil, electrical, and mechanical—to deepen the holistic, real-world connections in a student’s chosen field of study.
- **Capstone Projects.** Capstone projects informed by industry challenge students to engage in applied problem-solving and to practice working in teams.

Students enter the upper level of the program with a wide variety of backgrounds and life experiences, including prior work, military service, and volunteer activities. There is also tremendous socioeconomic and ethnic diversity among the students, and the flexibility of the program makes it attractive for those with outside family obligations. The program’s guiding philosophy is to help students identify how they are unique and to view their uniqueness as a strength. By building on individual uniqueness, a student working closely with advisors and mentors can develop a strategy and implementation plan for a successful career. This student-centered approach is the cornerstone of the program’s curricular enhancements, industry engagement, and career development.

PARTNERSHIP CHECKLIST

- ☒ **Select Field or Sector:**
Engineering
- ☒ **Select Geographic Region:**
Midwest (Missouri)
- ☒ **Select Academic Vehicle:**
Undergraduate Degrees
- ☒ **Develop Industry Engagement Strategy with High-Impact Practices:**
Adjunct Faculty, Internships, Mentorship, Co-Developed Curriculum, Scholarships, Aligned Partnership Strategy that Coordinates Investments, Capstone Projects
- ☒ **Evaluate Company Signaling Mechanisms:**
Ongoing

PARTNERS

With its corporate resources and the program's academic partners, Boeing supports JELDP students through recruitment, transition, preparation, and employment readiness. Boeing has made three key contributions:

1. part-time, year-round internships exclusive to students in the program,
2. a mentorship program, and
3. tuition scholarship funds for students it selects.

It has also made a seven-figure financial gift over five years, including \$100,000 per year in scholarship funds for those select students. In addition, Boeing's engineering professionals have collaborated on the design of the new curriculum, developed capstone projects, and served as adjunct faculty for the engineering studio and senior seminar courses. Upon completion, students may be considered for Boeing's Graduate Residency Program, which gives graduate students the opportunity to work at Boeing while earning their advanced engineering degree.

Business partners:

The Boeing Company,* Ameren Corporation, Nidec, Emerson, Power Engineering, Metropolitan St. Louis Sewer District, the Army Corps of Engineers, Burns and McDonnell, Gross Mechanical, Leonardo DRS Land Systems, and Guarantee Electric

Higher Education partners:

Washington University in St. Louis,* University of Missouri-St. Louis,* St. Charles Community College, Jefferson College, Southwestern Illinois College, and St. Louis Community College's four campuses (Florissant Valley, Forest Park, Meramec, and Wildwood)*

(asterisk indicates original partner)

OUTCOMES

The Joint Engineering Leadership Development Program has proved to be very successful. Students have received more scholarships, mentorship opportunities, internships, and full-time job offers from Boeing. In addition, approximately 76 alumni of the Joint Engineering Program have volunteered to be mentors. All 280 students have participated in the Engineering Studio class, approximately 75 percent of students in the upper level graduate within three years of entering, and all the program's graduates are employed. Seventeen percent of students are female, 12 percent are underrepresented minorities, and 40 percent are Pell-grant eligible.

Boeing's partnership in the leadership development program has changed the company internally, expanding its recruitment to include two-year colleges and accelerating hiring initiatives. As a result, the program has created career pathways for a previously untapped source of diverse talent, positioned Boeing as a regional leader in cultivating local engineering expertise, and built the foundation for a regional engineering talent ecosystem that other employers can leverage. This successful partnership with Boeing has also provided Washington University with proof points to encourage other local companies to join the program and scale it up, thus creating even more opportunities for students.

BROADER IMPACTS

While their partnership began with the development of the JELDP program, project leaders at Washington University and Boeing have developed a national model for how a major research university can partner with a leading global company and two regional academic institutions to develop engineering talent from a diverse, highly disadvantaged community. The partnership of a four-year public university, four-year private university, community college, and employer, which are all focused on developing a regional talent ecosystem with support from state and federal government, is unique. Each partner aligned on key objectives to address a regional need for diverse talent and focused on big-picture results.

The program has also identified around 200 companies in the St. Louis region with whom the JEP has some relationship; approximately 40 of these engage directly with the program on an annual basis, and many more have alumni working for them. These other companies include Ameren Corporation, Nidec, Emerson, Power Engineering, Metropolitan St. Louis Sewer District, the Army Corps of Engineers, Burns and McDonnell, Gross Mechanical, Leonardo DRS Land Systems, and Guarantee Electric.

Building a pool of local engineering talent will not only benefit existing companies, but it also has the potential to attract new firms to the St. Louis area, creating a positive feedback loop that will increase demand for engineers and other technical professionals. Further insights are captured in a BHEF case study funded by Washington University on the development of the JELDP program (BHEF, 2018b).

ERIC'EL JOHNSON GREW UP IN A FAMILY THAT STRUGGLED to make ends meet but never lost hope that a better life was possible. Johnson's mother worked long shifts to support her three daughters yet also made time to attend college classes and inspired her daughters to dream big about their futures. Johnson was determined to earn a college degree of her own, and she promised that her mother would not have to pay for it. She was initially drawn to the Joint Undergraduate Engineering Program by her long-standing interests in math and science. Studying in St. Louis meant that she could live on campus and be immersed in college life but still be just a short drive away from her tight-knit family. Johnson's mind was made up when she learned that she would also be awarded a full scholarship, which would enable her to keep her promise to her mother.

When Johnson entered the Joint Undergraduate Engineering Program at the University of Missouri-St. Louis in fall 2012, she was matched with a peer mentor who helped connect her to an internship opportunity at Boeing. That internship, during the summer after her freshman year, would become her first of three internships at Boeing. Through careful planning and hard work, Johnson transitioned to Washington University ahead of schedule, in the spring semester of her sophomore year. She was excited to be at an elite engineering school, where the classes were small and challenging and where she had opportunities to work with advanced technology and to learn from adjunct faculty who were practicing engineers. Attending all her courses in the evenings allowed Johnson to spend her days taking advantage of the many internship and research opportunities available through Washington University. She also made time to share her experiences with more than 150 freshmen in the engineering program by the time she graduated. When Johnson earned her degree in May 2016, Boeing hired her as an electrical engineer.

Since joining Boeing full-time, Johnson has continued to pursue her passion for mentoring others. She volunteers with the company's outreach efforts in the local public schools, helping create opportunities for young people in the community to discover engineering. Johnson has also maintained a strong connection to the Joint Undergraduate Engineering Program. She plans to serve as a mentor for future program cohorts—sharing her experience as a Boeing employee to help prepare students for life after college—and she aspires to eventually serve as an adjunct instructor in the program. Johnson also feels deeply connected to Boeing and hopes to continue working for the company over the long term. She is currently studying for her master's degree in electrical engineering with financial support from Boeing.

3

KEY CONTRIBUTIONS MADE BY BOEING:

1

PART-TIME, YEAR-ROUND INTERNSHIPS EXCLUSIVE TO STUDENTS IN THE PROGRAM

2

A MENTORSHIP PROGRAM

3

TUITION SCHOLARSHIP FUNDS FOR STUDENTS THEY SELECT

BOEING HAS ALSO MADE A SEVEN-FIGURE FINANCIAL GIFT OVER FIVE YEARS, INCLUDING

\$100K

PER YEAR IN SCHOLARSHIP FUNDS FOR THOSE SELECT STUDENTS

While their partnership began with the development of the JELDP program, project leaders at Washington University and Boeing have developed a national model for how a major research university can partner with a leading global company and two regional academic institutions to develop engineering talent from a diverse, highly disadvantaged community. The partnership of a four-year public university, four-year private university, community college, and employer, which are all focused on developing a regional talent ecosystem with support from state and federal government, is unique. Each partner aligned on key objectives to address a regional need for diverse talent and focused on big-picture results.



INSIGHTS

FROM THE EVALUATION

The project's independent evaluator, conducted a mixed-method, multiyear evaluation of each site using design-based intervention research (DBIR) principles.

METRICS ACROSS THE SITES

METRIC	CUNY	MDC	NEU	UWM	WUSTL	TOTAL
Students Enrolled	38	192	870	34	280	1,414
Female Students						> 25%
Underrepresented Minority Students						> 40%

NORC AT THE UNIVERSITY OF CHICAGO (NORC), the project's independent evaluator, conducted a mixed-method, multiyear evaluation of each site using design-based intervention research (DBIR) principles. DBIR is a form of inquiry that intentionally engages researchers with practitioners during large, systemic educational change activities to integrate real-time adjustments and ultimately to better support successful implementation and scaling. The term *design-based* indicates that researchers are engaged simultaneously, iteratively, and collaboratively with practitioners in designing and studying systemic change efforts (Kelly, 2003) and that learning takes place within a broad ecology of institutions and organizations across time and space (Barron, 2010). Over the project period, NORC investigated how contextual effects shape the implementation process, the delivery of the intervention, and the intervention's sustainability over time—focusing particularly on persistent problems of practice that emerged over the five-year study period, from multiple stakeholder perspectives.

NORC's *Undergraduate STEM Interventions with Industry (USI²) Internal Evaluation Report* (Knepler & Zapata-Gietl, 2019b) for this project indicated that participating institutions were offering effective programs to support the interest of college transfer students in pursuing STEM degrees and careers, as well as students who move between stackable credentials (e.g., MDC's program). The time and level of commitment that their administrators and faculty members put into the academic program

were two of the key ingredients of success to date. The legacy of this project is its ability to provide lessons and key takeaways to scale and to study in the future. This project has seen exemplary programs emerge in areas such as data science, in which new partnerships with local school districts and businesses were forged. The regional and trade-specific career pathway programs, such as with MDC and UWM, can serve as models for other industries that are considering creating their own STEM career pathway programs.

There is not a single solution to increasing STEM degree completion but rather a collection of practices that, when combined, lead to a significant impact. NORC believed that three recommendations in particular have the potential to increase STEM degree completion and enhance industry-higher education partnerships:

1. implementing high-impact, work-based learning practices,
2. breaking down communication silos within higher education institutions, and
3. coordinating with city/regional K-12 systems that promote and articulate various academic and career pathways in STEM.

LOOKING FORWARD TO SUSTAINABILITY AND INSTITUTIONALIZATION

WITH THE EXCEPTION of the University of Wisconsin-Milwaukee, the sites are planning to continue their projects after the grant funding ends, either as they currently are or in a modified way. Leadership support for each of the sites has been critical to sustainability.

City University of New York

City University of New York is planning a clone of its program, which has resulted in a pipeline from community college, to the bridge program, to the capstone research project, to a data science and engineering master's program, and finally to industry (with a slight change in the delivery model). In addition, the summer bridge program curriculum/model is now being used for the CUNY Research Scholars Program Environmental Analytics Bootcamp. CUNY has also identified a critical role for urban, public universities in supporting near-term urban sustainability transitions, including smart city innovations. Through an ongoing partnership with IBM and new partnerships with a variety of regional private sector employers, the university plans to continue to update its academic curricula to better meet industry needs and develop apprenticeship programs to prepare students to meet emerging sustainability challenges.

Miami Dade College

Due to the success of the program under the NSF grant, Miami Dade College plans to sustain all program activities and personnel through its School of Engineering and Technology, continue offering the stackable programs at two different campuses to guarantee student accessibility, develop new courses and concentrations in areas such as healthcare analytics and artificial intelligence, and complete an articulation agreement with Florida International University to guarantee a pathway for students that want to continue their studies with a master's degree.

Northeastern University

Northeastern University is sustaining its industry-aligned, five-course systems administration and cybersecurity concentration within the bachelor's of science in information technology degree beyond the grant, as it is now a standard curriculum offering. It is also increasing overall enrollment in both the degree and the cybersecurity concentration; continuing efforts to recruit and enroll more women, first-generation, low-income, and underrepresented-minority students; and forging deeper partnerships with community colleges, including developing on-site bachelor of science completion models, shared scholarship pathways, and dual-admission strategies. Northeastern will also continue expanding virtual internships with its community college partners through its NSF award through 2020.

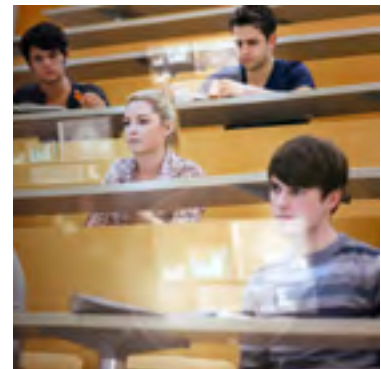
The time and level of commitment that their administrators and faculty members put into the academic program were two of the key ingredients of success to date.

University of Wisconsin-Milwaukee

Although the program is not expected to continue in its current form, the University of Wisconsin-Milwaukee has included the WATER-SYS STEM program as part of a pending Freshwater Collaborative proposal to the university system. It will serve as an important component for the new major in freshwater, with a specific track for students from tech colleges and two-year institutions. The university's principle investigators will also retain and cultivate collaborations with existing industry partners, apply for program funds through the NSF and other agencies, remain in communication with successful students to assist in their overall career pursuit and invite them to (pre)professional water technologist gatherings, and write one or more professional papers about the program.

Washington University in St. Louis

Washington University in St. Louis is building a makerspace for the Joint Engineering Leadership Development Program, continuing its mentor program, building on its current industry partnerships such as with Boeing, and recruiting additional industry partners as part of a St. Louis Regional Workforce Development effort. In particular, Boeing gave the university a seven-figure gift, a significant portion of which was passed on to the University of Missouri-St. Louis to sustain the program. Boeing has also expressed interest in replicating the partnership in other regions.



GRANT IMPACT ON BHEF'S FOCUS

IN THE MORE THAN SEVEN YEARS SINCE THE LAUNCH, the National Higher Education and Workforce Initiative has catalyzed over three dozen partnerships and supported its members with employment market analysis and skills and competency mapping to accelerate the design and deployment of more than 50 new academic credentials—ranging from business analytics certificates to minors, majors, and professional science master's programs in digital fields. In several cases, the partnerships have responded to large-scale digital workforce needs by developing robust talent ecosystems to accelerate and diversify the flow of talent into the regional workforce (BHEF, 2018a).

To share the learning from its NSF-funded business-higher education partnerships with a broader audience, BHEF collaborated with The National Academies of Sciences, Engineering, and Medicine to host *The Summit on the Intersection of Higher Education and the Workforce: Broadening the Role of Business in STEM Transfer and Persistence* on April 5, 2017 in Washington, D.C. The half-day summit convened consortium members and national leaders and experts to engage in deeper discussions on high-impact practices and business engagement models aimed

at increasing undergraduate STEM student persistence and workforce readiness, especially for community college transfer in STEM. The meeting provided highlights of how BHEF and the NSF partnerships and programs are shaping emerging fields such as DSA and cybersecurity, which were later captured in a related report (BHEF, 2017).

Most recently, BHEF and the Business Roundtable have worked together to expand the scale of business-higher education partnerships to address regions' workforce needs by sponsoring the Workforce Partnership Initiative. To date, the initiative has launched an additional dozen regional workforce development projects, with employer and higher education networks building or expanding credentials that range from traditional skilled trades and digital apprenticeships to new digital baccalaureates.

One WPI project supported by BHEF with funding from the JPMorgan Chase Foundation demonstrates how the partnership model developed and refined in the USI² consortium grant enables colleges and universities to collaborate with companies to rapidly create new credentials for digital skills

2018 RESKILLING AMERICA'S WORKFORCE WORKSHOP



Brian Fitzgerald (left), CEO of BHEF, moderates a discussion with Ken Eisner (second from left), Global Lead of AWS Educate at Amazon Web Services; Ellen Glazerman (second from right), Executive Director of the EY Foundation; and Joseph Aoun (right), President of Northeastern University, on partnerships at the nexus of education, training, workforce, and reform.

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LEADERS FROM BUSINESS,
HIGHER EDUCATION,
GOVERNMENT, AND THE
NONPROFIT SECTOR
EXPLORE CRITICAL ISSUES
RELATED TO EMPLOYERS'
HIGHEST-DEMAND
WORKFORCE NEEDS

At the *Reskilling America's Workforce* workshop, BHEF released a new workforce analysis that identified four trends in the engineering and advanced manufacturing sectors:



that are available to all students. Twelve universities throughout the Washington, D.C., Maryland, and Virginia region agreed to individually develop a credential reflecting the mastery of a foundational digital skill set. These credentials, which each university designed and awarded, denote that a graduate has mastered a common set of digital competencies that complements the graduate's primary discipline. The credentials were also designed to be accessible to students in all majors.

Following the Partnership Implementation Process, subject-matter experts from 16 companies across leading sectors in the region worked closely with faculty to identify the competencies that form the basis for these digital skills credentials. The faculty then mapped these competencies into courses and curriculum for each credential. The companies also committed to providing students enrolled or graduating with these credentials with select opportunities, such as internships, job-shadowing, and mentoring.

In less than one year, six universities in the region have launched their digital skills credentials, with others under development. This tremendous response by these higher education institutions reflects the urgency to create programs that develop digitally enabled graduates.

In addition to the focus on undergraduate credentials, a supplemental grant under its USI² grant permitted BHEF to begin preliminary work in reskilling the STEM professional. In September 2018, BHEF and NSF hosted *Reskilling America's Workforce: Exploring the Nation's Future STEM Workforce Needs*.

This two-day workshop brought together about 150 leaders from business, higher education, government, and the nonprofit sector to explore critical issues related to employers' highest-demand workforce needs and how to build the STEM-capable workforce to meet those needs. In particular, the workshop spotlighted the need for digital skills in the engineering and advanced manufacturing sectors.

The resulting report included recommendations for how federal agencies can more effectively support STEM workforce reskilling needs (BHEF, 2019b).

The supplemental funding and workforce analysis permitted BHEF to expand its focus from developing new digital talent to reskilling incumbent STEM employees. In partnership with the Business Roundtable and the Greater Washington Partnership's Capital CoLAB, BHEF received a nine-month, \$1-million NSF planning grant to create partnerships that will lead to an increase in reskilling and upskilling pathways for STEM professionals (Award No. 1936894). This Phase I award under the new NSF Convergence Accelerator grant program enables BHEF to support employer and university partners in the region by measuring demand for STEM professional reskilling and assessing the capacity of university partners to meet this demand. The award will also support analyses of any gaps and opportunities in order to create an implementation strategy that will form the basis for a Phase II proposal to allow BHEF to continue advancing NSF's goal of developing innovative, proactive solutions to today's STEM education challenges.



FINDINGS

Through BHEF's in-depth work with the five sites from the NSF grant, we identified the following key findings for success.



Develop and expand strategic, data-driven partnerships between business and higher education that grow regional talent ecosystems.

Through the NSF grant, BHEF developed a rigorous, data-driven methodology—the Partnership Implementation Process—outlining a series of steps and milestones to guide the development of business engagement with higher education in the creation of new academic programs and student pathways. Given the variety of differentiating factors that exist within each partnership engagement, the process served as a common means of not only facilitating change but also sharing outcomes.

The project demonstrated that the methodology is replicable, scalable, and can serve as a blueprint for moving partnerships from workforce analysis and competency mapping through to revised employer hiring practices—all of which are managed by a third-party intermediary playing a coordinating and oversight role that is essential for rapid success. These partnerships among four-year public and private universities, community colleges, employers, and other stakeholders create diverse and sustainable platforms for building and expanding successful new career pathways and job-training programs, ultimately resulting in sustainable regional talent ecosystems. The success of each site's partnerships early on through the use of this process attracted many more partners by the end of the grant.



Use intermediaries and consortia as a catalyst for partnerships.

Higher education and business leaders need to develop new processes for ensuring that educational offerings remain tightly aligned to workplace skills and competencies. Intermediaries and multi-party consortia may help facilitate that engagement and alignment. Multi-party consortia bring partners together as a community of learners. Meanwhile, a third-party intermediary, such as BHEF, serves as the backbone, providing an unaffiliated, broad perspective to define and establish a shared vision; map out mutually reinforcing activities; develop goals, objectives, and measures to track progress; engage in constant communication; and advance the potential for expansion, sustainability, and scaling.



Disseminate learning to inspire replication and scale.

Through robust dissemination efforts, BHEF and the sites have empowered others to apply the learning from the NSF grant on a larger scale. For example, after hearing about the University of Missouri-St. Louis/Washington University in St. Louis-Boeing project at one of BHEF's member meetings, Wes Bush, then chairman and CEO of Northrop Grumman Corporation, was so impressed with the Partnership Implementation Process that he suggested BHEF expand the process to multiple regions across the country with the Business Roundtable. That resulted in BHEF's \$1.2 million partnership focused on WPI. The WPI project in the Washington, D.C. region, in particular, serves as a concrete example of how BHEF's work with the Greater Washington Partnership's Capital CoLab has inspired its members to rapidly scale up their partnerships. Key publications, such as *Creating Purposeful Partnerships*, and public events like the September 2018 *Reskilling America's Workforce* further broaden the reach of insights from the grant.

FINDINGS



Build business-engaged, high-impact practices into program design to increase persistence and learning.

High-impact practices are a specific set of educational strategies—such as internships, experiential learning opportunities, and first-year experiences—that research has shown to substantially benefit undergraduate student engagement, learning, and retention. Each site developed multidimensional programs that provided participating students with at least two such experiences, ideally one in students' first year of transfer to the four-year institution and another before graduation. Embedding high-impact practices in the required curriculum ensured that every student benefited from engaging in these practices and enabled sites to increase and support students transferring from two- to four-year institutions.



Embed treatments in the core academic enterprise.

Relying solely on grant funding or partner resources to support multiple high-impact practices often results in challenges in scalability and sustainability. For example, the use of paid internships can limit the pool of business partners who are able to provide that intervention. Similarly, sites relying solely on grant funding for stipends must consider other alternatives when the grant ends. In addition, realistically, there may be upper limits in how many students can be served with both paid internships and stipends due the design and nature of those practices. As a result, it is critical to consider leveraging institutional resources and embedding treatments in the core academic enterprise to ensure larger numbers of participants and greater sustainability.



Meet learners where they are.

Higher education and business leaders must embrace a new model of continuous learning and skill development that serves nontraditional learners outside the 18–22-year old, on-campus student. Leaders should design offerings that are accessible and fit into such learners' lives, rather than forcing them to adapt to traditional university schedules and practices. In addition, higher education and industry should work together to ensure that employer-provided training can count towards an academic credential. They should consider creating unbundled and stackable offerings that students can take for both credit and non-credit, accommodating a diverse population of learners.



Grow partnerships to ensure sustainability.

Each of the sites had at least one original business and/or higher education partner with whom they began work to develop their respective programs. Over the course of the grant, those partnerships grew to include many other partners in the region committed to expanding and sustaining the efforts beyond the grant itself. Sites also benefited from discussions of partnership development through the consortium, with Washington University in St. Louis adding a mentoring component via Mentor Collective after learning of Northeastern University's success with them. Strong relationships with their original partners and consistent outreach to new ones through industry roundtables, networking events, and other meetings—with the support of organizations such as BHEF—stimulated robust partnership growth for program sustainability.



Use partnerships to change company strategies for talent acquisition and development and human-capital planning to effectively recruit diverse STEM and digital-skills talent.

The industry partners that BHEF worked with realized they should review their human-resource strategies and human-capital planning in light of their support of nontraditional students in STEM and digital-skills programs. For example, Washington University's new engineering pathway sparked internal discussions at Boeing, which typically recruits from highly selective academic institutions, about the need to recruit and retain engineers from diverse backgrounds and institutions—particularly those who began their academic work at two-year colleges. IBM typically focuses its educational outreach on K-12 STEM, notably through its support of the Pathways in Technology Early College High Schools program, as well as graduate education through fellowships, technology sharing, and other approaches. Its partnership with the City University of New York has demonstrated the value of engaging at the undergraduate level, particularly at the juncture between two- and four-year STEM programs, to develop diverse talent.



Translate employer-led partnerships into transformative metrics-driven change.

Employer-led partnerships have the power to create both small- and large-scale transformative change. Measuring the extent of such change through the use of metrics ensures that company leaders understand and recognize the impact of a partnership. That then serves as further justification for engagement in the partnership, provides insight into areas where improvement is needed, and informs data-driven decisions moving forward.

CALL TO ACTION

Create innovative pathways and programs and ultimately develop the diverse, highly skilled 21st century workforce the nation needs.

BHEF'S NSF GRANT HAS DEMONSTRATED IMPACTS far beyond the original pilot programs at each site. It has built an expanding network of regional partnerships, one that facilitates the transfer of students, particularly women and members of minority groups underrepresented in STEM fields, and builds a learning community through the USI² consortium. The effects demonstrate the potential of new kinds of STEM pathways with insights that are strongly influencing BHEF's focus, NSF's strategic planning of innovative and proactive solutions to advancing U.S. STEM education, and the broader community at large.

BHEF seeks to expand its STEM-capable talent development and diversity efforts to a wider network of companies, higher education institutions, government agencies, research and development centers, associations, professional societies, and other organizations. Through this report, we hope to inspire others to take action—replicating and scaling these kinds of partnerships and their critical project elements to create innovative pathways and programs and ultimately develop the diverse, highly skilled 21st century workforce the nation needs.

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