ADVANCED TECHNOLOGICAL EDUCATION IMPACTS

2020-2021

Strengthening the Skilled Technical Workforce

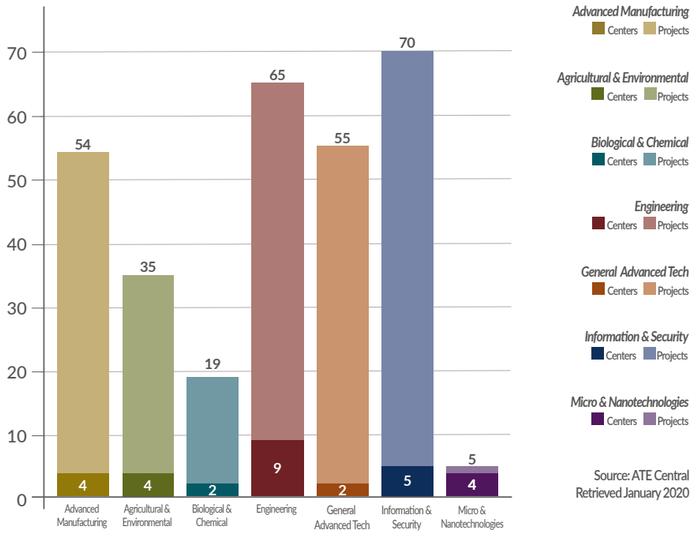
ATE by the Numbers

The National Science Foundation's Advanced Technological Education (ATE) program has multiple facets that have yielded a plethora of positive outcomes. All ATE program efforts aim to help students gain the skills they need for productive STEM technical careers and to enhance the work of educators engaged in preparing the STEM technical workforce.

ATE projects and centers work in and across the STEM disciplines that are critical for the nation's economy and security. Through collaborations with employers, other education sectors, and public agencies, ATE principal investigators endeavor to sustain their innovative initiatives and maximize the National Science Foundation's investment of taxpayer funds.

These data points provide a snapshot of their efforts.

ALL ATE PROJECTS & CENTERS BY SUBJECT AREA



Source: ATE Central
Retrieved January 2020

ATE PROJECT AND CENTER COLLABORATORS

490 PUBLIC AGENCIES

550 WITHIN HOST INSTITUTION

610 OTHER ATE PROJECT & CENTERS

2,260 2- OR 4-YEAR COLLEGES

2,510 K-12 SCHOOLS OR SCHOOL SYSTEM

BUSINESS & INDUSTRY 3,810

IN 2018, COLLABORATORS PROVIDED MORE THAN $15 MILLION IN MONETARY AND IN-KIND SUPPORT.

MOST ATE GRANTEES ARE LOCATED AT TWO-YEAR COLLEGES (n=279)

TWO-YEAR 73%

FOUR-YEAR 18%

NON-PROFITS 6%

84% OF ATE INITIATIVES THAT MODIFIED DEGREE OR CERTIFICATE PROGRAMS IN 2018 EMPHASIZED RECRUITMENT FROM GROUPS UNDERREPRESENTED IN STEM FIELDS.

IN 2018, ATE PROJECTS AND CENTERS DEVELOPED

7,110 MATERIALS

SUCH AS COURSES, MODULES, LAB EXPERIMENTS, OR OTHER TYPES OF EDUCATIONAL RESOURCES.

1,080 PROFESSIONAL DEVELOPMENT ACTIVITIES

IN 2018, ATE PROJECTS AND CENTERS PROVIDED WEBINARS, WORKSHOPS, SUMMER INSTITUTES, AND OTHER PROFESSIONAL DEVELOPMENT OPPORTUNITIES FOR CURRENT AND FUTURE EDUCATORS

Source: *ATE Annual Survey: 2019 Report* from EvaluATE (https://evalu-ate.org)


Advanced Manufacturing
Agricultural and Environmental
Biological and Chemical
NSF
Engineering
Information and Security
Micro and Nanotechnologies

Foreword

Victor R. McCrary, Jr.,PhD

Community colleges, now more than ever, are essential in growing America's STEM-capable workforce. As a key part of the nation's worker-value chain, programs that focus on science, technology, engineering, and mathematics (STEM) play a crucial and vital role in our economic future and national security. In a 2017 report, the National Academies of Science, Engineering, and Medicine (NASEM) estimated that by 2022 there would be unfilled openings of 3.4 million jobs requiring skilled technical workers. And NASEM's 2018 report on Minority-Serving Institutions (MSIs) reports that of the over 700 such institutions, roughly 50% are community colleges, and that our nation's MSIs play a vital role in producing America's diverse STEM workforce. Finally, the 2019 National Science Board report entitled, *The Skilled Technical Workforce: Crafting America's Science and Technology Enterprise*, speaks to the importance of skilled technical workers in both future-proofing our nation's investments in fundamental research, and our ability to compete globally.

The National Science Foundation's (NSF) Advanced Technological Education (ATE) program has been a leading champion in conveying the importance of STEM skills at the community college level, and a leading funder for developing these skills for our country's future technical workforce. Coming on the heels of the aforementioned reports, this *ATE Impacts* book showcases key activities and outcomes of the ATE program, and the technical career opportunities for workers with the needed skills, training, certifications, and experience without the need for a four-year degree. Employers, educators, and policymakers may all discover aspects of the ATE program within, to adapt or adopt in their work.

As the NSF celebrates its 70th anniversary in 2020, the ATE program is a point of pride. NSF investments in ATE initiatives are developing the skilled technical workforce, strengthening research in technician education, and improving the interface between secondary schools, community colleges, and four-year research institutions. As NSF looks forward to the future, we applaud its continued commitment to the ATE program and its inextricable contribution to NSF's mission of fundamental research, economic development, and national security for the United States of America.

Victor R. McCrary, Jr.,PhD, National Science Board Member
Vice President for Research and Graduate Programs and Professor of Chemistry
University of the District of Columbia

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Introduction

The National Science Foundation's Advanced Technological Education (ATE) program supports ongoing innovative efforts for educating highly skilled technicians. The knowledge and skills of technicians in disciplines as ancient as agriculture and as new as nanotechnology are critical to the nation's economic health and security. Since the ATE program began in 1993, it has prepared people for careers in advanced technology fields, not just particular jobs that might go away with the emergence of a new technology.

Through its competitive grants process, the National Science Foundation (NSF) provides funding that enables principal investigators to test their ideas for improving technician education and to enhance STEM initiatives that encourage participation in the rapidly changing technical workforce. Faculty from public community and technical colleges, which are the leading source of education for the skilled technical workforce in the United States, are the principal investigators of most ATE initiatives. ATE principal investigators lead projects and centers in partnership with both employers and educators in other education sectors to ensure that students are workforce-ready.

As ATE grantees focus on program creation, program improvement, faculty professional development, and research, they develop and deploy pilot versions of innovative activities each year. Thanks to NSF's investment in their ideas, these ATE program deliverables—curricula for entire degrees, lab exercises, skill standards, and templates for effective industry-education partnerships—are all freely available for others to adapt and adopt.

This publication's summaries of the activities and accomplishments of 30 ATE centers and 28 projects are intended to spark readers' interest. The website addresses included with each featured center and project link to more detailed information including downloadable resources and listings of professional development opportunities. Readers can direct questions and suggestions to principal investigators, who are accessible and interested in sharing their project and center results, data, and materials.

In addition to grouping ATE initiatives by discipline, this publication provides geographic location info (see the US map within the back flap) to help connect educators, employers, and students with the ATE initiatives that are underway in each state.

ATE Builds Partnerships with Employers & Across Education Sectors

The *ATE Annual Survey: 2019 Report* by EvaluATE (the evaluation hub for the ATE program) found that in 2018 alone, 279 ATE programs reported having a total of 10,320* partnerships: 3,810 were with business and industry; 2,510 were with K-12 schools or school systems; and 2,260 were with two-year and four-year colleges. The ATE program's dynamic partnerships not only inform planning and shape successful activities, they help sustain the work started with ATE when grant funding ends.

ATE principal investigators' attentiveness to business and industry trends is evident in other EvaluATE data. For example, in 2018 alone, 11,100 students benefited from mentoring and coaching offered by ATE programs. In addition to the business and industry field trips that have long been a feature of ATE's partnerships with employers, 54 programs offered internships. That is nearly half of the 112 programs that provided some type of workplace learning. Others include 17 co-operative learning arrangements; 17 job shadowing opportunities, and 16 apprenticeship programs.

Recognizing that technicians increasingly participate on innovation teams within companies and that in the future many technicians will likely be in business for themselves, 59 ATE initiatives taught 7,380 students business and entrepreneurial skills in 2018. Slightly more than half of these programs utilized course units or mentoring. Workshops, clubs, entire courses, and incubators were other ways that ATE projects and centers added entrepreneurship lessons to their programs.

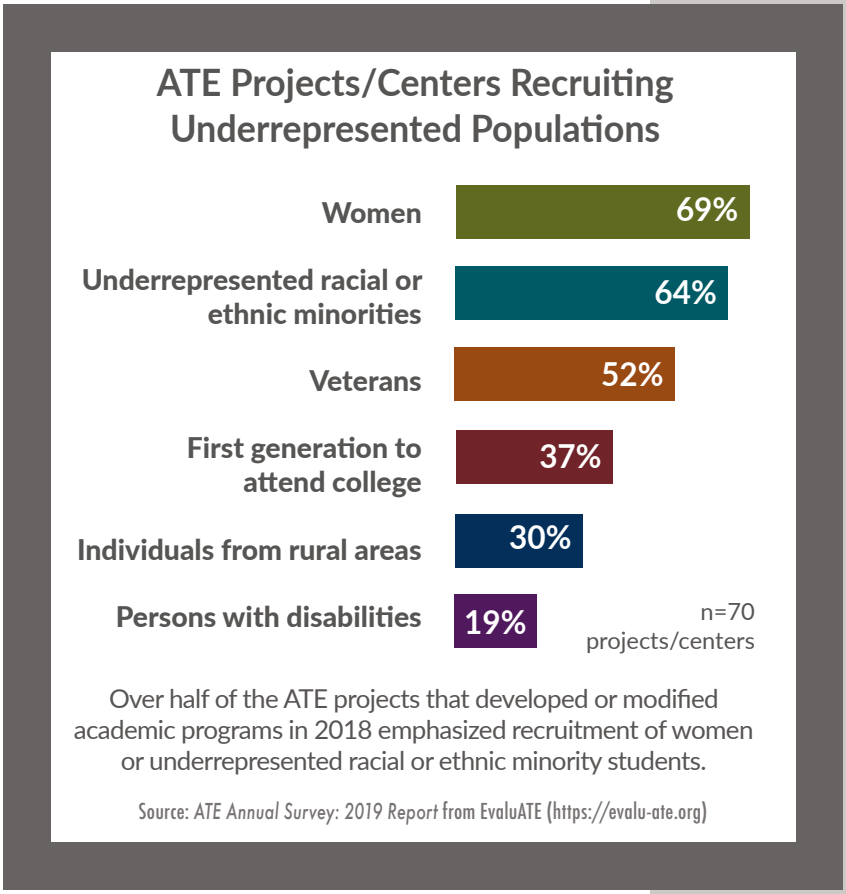
The leaders of ATE centers generally have broad goals such as developing initiatives that can be scaled nationally or industry-wide. Generally working on a smaller scale, principal investigators of ATE projects address specific workforce challenges in their regions that create model programs for others to adapt and adopt.

ATE Broadens Participation of Diverse Populations in Skilled Technical Workforce

Whatever their particular goals, most ATE grantees connect with secondary school teachers and two-year and four-year college instructors. These cross-sector efforts are developing robust career pathways that are accessible to high school students involved in dual-enrollment programs, to adults seeking new careers, and to incumbent technicians who want to refresh their skills.

To prepare educators to reach these various audiences, many ATE centers and projects offer faculty professional development. In 2018 alone, 44,050 students were impacted by the lessons their instructors learned during professional development programs offered by 135 ATE grantees.

ATE initiatives recruit populations underrepresented in high-tech fields including racial and ethnic minorities, people with disabilities, women, and veterans. During 2018, 65 ATE projects were located at minority-serving institutions; 49 of them were federally designated Hispanic-serving institutions.



EvaluATE reports that "over half of the ATE projects that developed or modified academic programs emphasized recruitment of women or underrepresented racial or ethnic minority students."

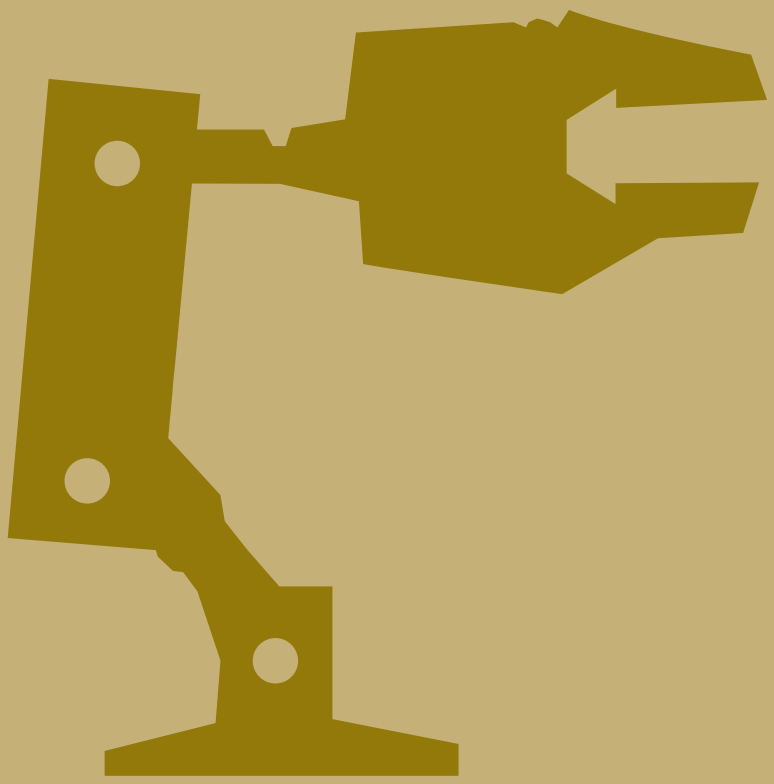
Increasing the participation of diverse populations in the STEM workforce is a key goal of ATE grantees as they endeavor to prepare a new generation of highly skilled technicians for the advanced technology fields that drive the nation's economy.

* All numbers rounded to nearest ten.


WELCOME

Advanced Manufacturing Technologies

http://ate.is/mfg



Mfg

"FLATE's ET Forum is always a great collaboration where FLATE has successfully bound together Florida's state and community colleges to drive progressive thinking and to share new ideas and innovations...It has been an honor to take part in the ET Forums."

Bryan Kamm, Chief Executive Officer
Kamm Consulting
Tampa, FL

FLATE Outreach Includes Manufacturing Day Tours & Messaging Advice

In 2018 the Made in Florida outreach program included 178 Manufacturing Day tours for 5,075 students and 392 educators and parents. The tours have proven to be an effective outreach strategy for engaging students in first-hand experiences in modern manufacturing. Forty-five percent (169 girls and 408 boys) of the 1,273 students who completed surveys reported that they were considering advanced manufacturing careers after their tours.

In responses to girls' interest in careers that help people, FLATE provides messaging that explains STEM technicians' roles in the sustained growth and stability of the US economy. FLATE's recruitment strategies for men and women emphasize manufacturing careers as creative, hands-on, and helpful to society.

Key Activities

- Facilitates a statewide approach that optimizes technician preparation in manufacturing.
- Partners with industry, education, and government organizations to create a sustainable community of practice.
- Utilizes curriculum reform, outreach activities, and professional development programs to enhance advanced manufacturing education.

FLATE programs introduce students to manufacturing fields and robotics.

FloridaMakes Sustains FLATE Activities

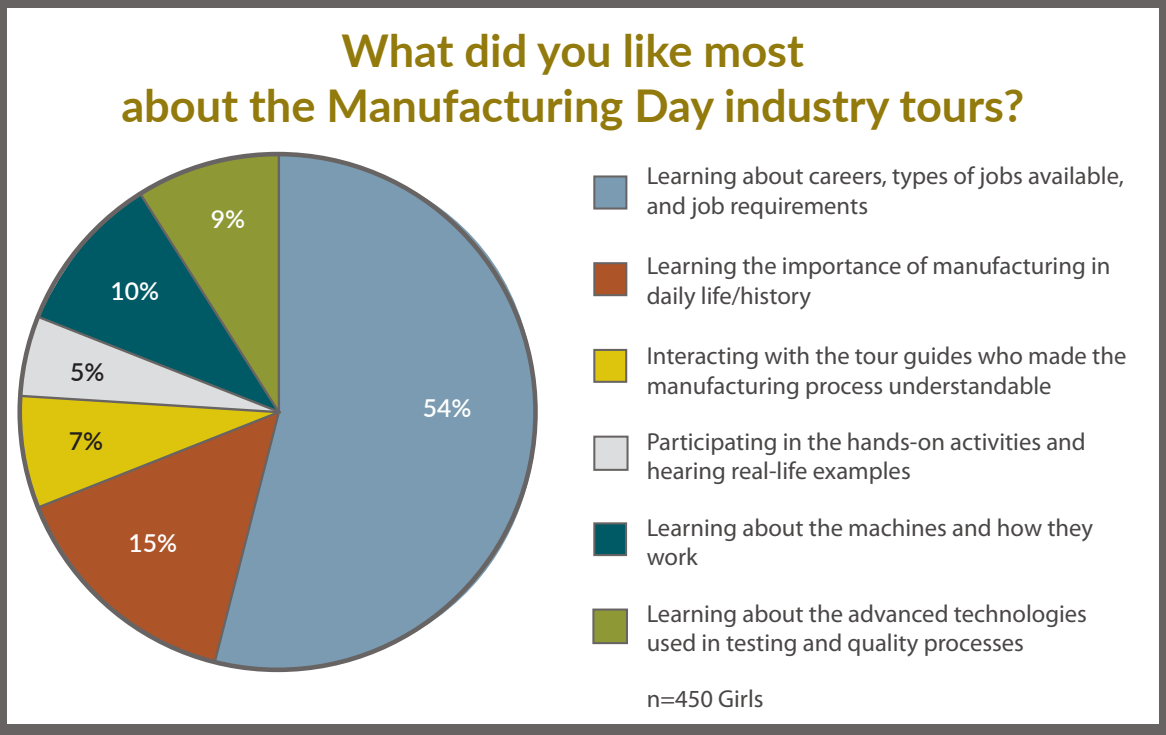
FLATE is integrating its education partnerships with FloridaMakes's regional manufacturing organizations. This partnership will help sustain FLATE's activities after its NSF funding ends. FloridaMakes's mission is to improve the productivity and technological performance of Florida manufacturers by accelerating technology adoption, talent development, and business growth, and to strengthen the state's high-wage manufacturing economy.

Community of Practice Begins with 10 Regional Convenings

To begin the transition FLATE and FloridaMakes convened 12 regional workshops in 2019 to construct a statewide community of practice among two-year degree manufacturing programs and the regional associations that support advanced manufacturing in Florida.

Manufacturing technicians must know how to control production inputs, maintain equipment, and troubleshoot problems.

Altogether 135 representatives of manufacturing companies attended the regional meetings for discussions with 66 educators, 21 CareerSource Florida counselors, and 69 other stakeholders. Manufacturers' challenges identified include finding technicians with language skills and soft skills who are able to solve problems collaboratively.



FLATE surveys have also found that girls want careers that help people and make a difference in the world.

Potential new activities include manufacturers hosting teacher professional development days at their facilities; holding summer camps for students and teachers; and creating a website to facilitate their communication with educators, trainers, and support organizations.

"What I like most about this welding course is that it is an out-of-classroom experience where you can learn at your own pace while getting hands-on experience."

Jack Patten, Manufacturing Technology Student
Northwest Technical College
Bemidji, MN

Educators Earn Manufacturing Industry Certifications

Through its collaboration with Pine Technical and Community College, the center is offering four Manufacturing Skill Standards Council (MSSC) training sessions to secondary school teachers and college instructors. There has been a 100% pass rate for all attendees to earn national industry credentials in the two sessions held in fall 2019. Ten instructors earned the MSSC Safety certification, and nine instructors earned the MSSC Quality Practices and Measurement certification.

MINNESOTA STATE
Advanced Manufacturing Center of Excellence
ATE Regional Center

In addition to earning certifications, the secondary school teachers work with college faculty to develop hands-on activities. The activities are then shared with other high school instructors who teach MSSC courses to their students through concurrent enrollment.

Key Activities

- Promotes the Digital Badge Pathway.
- Emphasizes various careers using the Manufacturing Career Tool.
- Develops and enhances manufacturing curricula.
- Leads the charge for manufacturing industry tours.
- Disseminates manufacturing career info to K-12 and college students, and adults.
- Encourages women to pursue manufacturing careers.

Manual and automated forging techniques are covered in the competency-based 360 eTECH curriculum.

"She Made It" Campaign Recruits Females

Center personnel developed "She Made It" branding to recruit females to manufacturing careers. This campaign includes giveaways, banners, manufacturing career information, and videos that feature young women excelling early in their manufacturing careers and successful women at the end of their careers.

New Video Explains Digital Badge Pathway

MSAMCOE created a video overview of the Digital Badge Pathway (https://dreamitdoitmn.com/badges-teachers) for its website and to introduce the program to teachers via webinars. MSAMCOE promotes the Digital Badge Pathway at conferences and youth outreach events such as robotics competitions. As of fall 2019, 604 badges had been issued to students.

Revised Curriculum Uses Competency-based Approach

MSAMCOE provided competency-based education (CBE) training to 27 faculty members from 11 Minnesota colleges. The faculty then revised the existing 360 eTECH curriculum and developed a medical device manufacturing certificate using CBE principles. Manufacturers provided feedback on the revised curriculum via in-person meetings, online surveys, and a web-based poll at a state manufacturing conference.

Mastering metal-joining techniques, such as brazing brass, is an essential skill for manufacturing technicians.

The CBE approach is expected to provide students and employers with clearer skill indicators that facilitate more flexible career paths and more efficient credential completion.

Minnesota Statewide Tour of Manufacturing Data

Year	2015	2016	2017	2018	2019
Manufacturer Hosts	132	105	138	181	195
Students Attended	2,040	2,100	2,383	2,220	10,422
Educators Attended	136	114	92	91	445
Total Attendance (Students & General Public)	11,088	14,910	19,698	25,720	28,080

MSAMCOE's targeted outreach to school superintendents helped increase participation by students and educators in the 2019 Statewide Tour of Manufacturing in Minnesota.

"I chose an RCNGM advanced manufacturing program to acquire training for an in-demand field. What I got was a passion for manufacturing and a career I can be proud of."

Meghan Gagnon, Inspector/CMM Operator
Senior Aerospace SSP
Enfield, CT
2019 Asnuntuck Community College
Manufacturing Program Graduate

Industry Experiences Lead to Exceptional Job Placement Rate

RCNGM industry partnerships provide on-the-job experience for students prior to the completion of their advanced manufacturing programs. Internships, for example, helped Asnuntuck Community College achieve a 90% job placement rate for its 272 certificate earners in 2017 and 2018.

Faculty Professional Development Fuels Student Success

RCNGM professional development for faculty is an important factor in students' success. For instance, a workshop on coding drones led to new curriculum for high schools and community colleges. Robotics workshops offered in partnership with the Advanced Robotics for Manufacturing Institute enhanced robot instruction in manufacturing courses, which are part of a statewide robotics apprenticeship program.

Key Activities

- Fosters community college partnerships with industry.
- Provides leadership for the development and implementation of industry-driven advanced manufacturing programs.
- Promotes advanced manufacturing as a high-tech career pathway.
- Engages faculty in professional development that enhances instruction in emerging manufacturing technologies.

RCNGM's curriculum teaches students multiple metal fabrication technologies.

Enrollment of Underrepresented Populations in Connecticut Community College STEM Programs Since RCNGM Began

	Fall 2004	Fall 2018	Increase
Black	310	744	140%
Hispanic	344	1,200	249%
Other	138	531	285%
Total Underrepresented Racial and Ethnic Minorities Enrolled in STEM Programs	792	2,475	213%
Female	540	855	58%

RCNGM's advanced manufacturing initiatives for students, educators, and guidance counselors are influencing enrollment of underrepresented populations in STEM programs.

RCNGM Partnership with AARP Recruits New Instructors & Mid-Career Students

The advanced manufacturing programs in Connecticut's community colleges continuously expand to help fill the thousands of manufacturing positions that will need to be filled over the next two decades.

To address the challenge of finding qualified instructors for growing programs, RCNGM expanded its partnerships to include AARP Connecticut to recruit advanced manufacturing technology instructors with extensive industry experience. This partnership has had the added benefit of exposing a new population of adults to advanced manufacturing programs and new manufacturing career opportunities.

More than 50 soon-to-be and currently retired advanced manufacturing employees have attended workshops to learn about opportunities to mentor and teach in the programs offered at Connecticut high schools and community colleges. Potential instructors with no prior teaching experience must attend professional development activities to prepare them to teach in a classroom.

The partnership with AARP Connecticut has also led to a scholarship program for people who are older than 50 and want to switch careers to advanced manufacturing.

Accurate product inspections are important for technicians at medical device companies and other manufacturers.

"Our industry is always trying to seek out trained NDT (nondestructive testing) technicians; we are constantly in need of these skilled individuals... As the welding trades and manufacturing increase, so will our NDT industry."

Brad Elchynski, Quality Inspector
Enerfab, Inc.
Cincinnati, OH

Collaboration Helps Students Formulate Career Plans

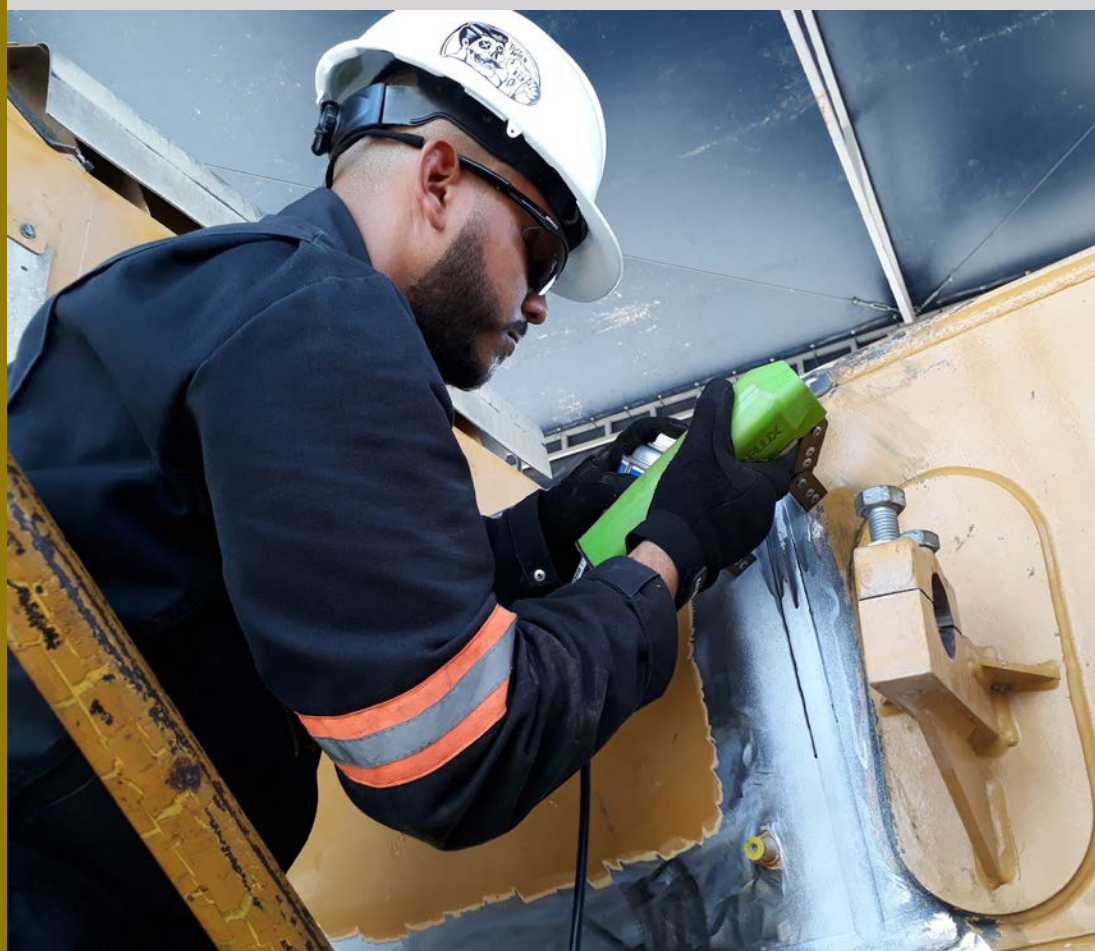
The Society of Women Engineers' Collegiate Section, in collaboration with the Department of Defense, hosts the ASVAB-CEP (Armed Services Vocational Aptitude Battery-Career Exploration Program) exam. This test is a helpful tool for measuring strengths and potential for success. It is designed to match students' skills and interests with careers as they select majors. It also helps students develop action plans as they explore career options.

When the ASVAB-CEP exam was administered in spring 2019 at Lorain County Community College in collaboration with the US Army, 23 participants successfully completed the exam. This was a 77% increase in participation over the previous year.

Key Activities

- Supports initiatives to increase career awareness in welding and nondestructive testing.
- Offers comprehensive welding professional development programs for faculty.
- Fosters innovation and strategic partnerships to advance welding technology programs nationally.
- Expands educational opportunities for nondestructive testing technicians.

Magnetic particle testing is one of many nondestructive testing techniques Weld-Ed promotes through its industry partnerships.



Partnership Expands Opportunities for Nondestructive Testing Technicians

Nondestructive testing (NDT) education is the focus of a dynamic partnership between Weld-Ed, the American Society for Nondestructive Testing (ASNT), the American Welding Society (AWS) Foundation, Chattanooga State Community College, and Lorain County Community College (LCCC).

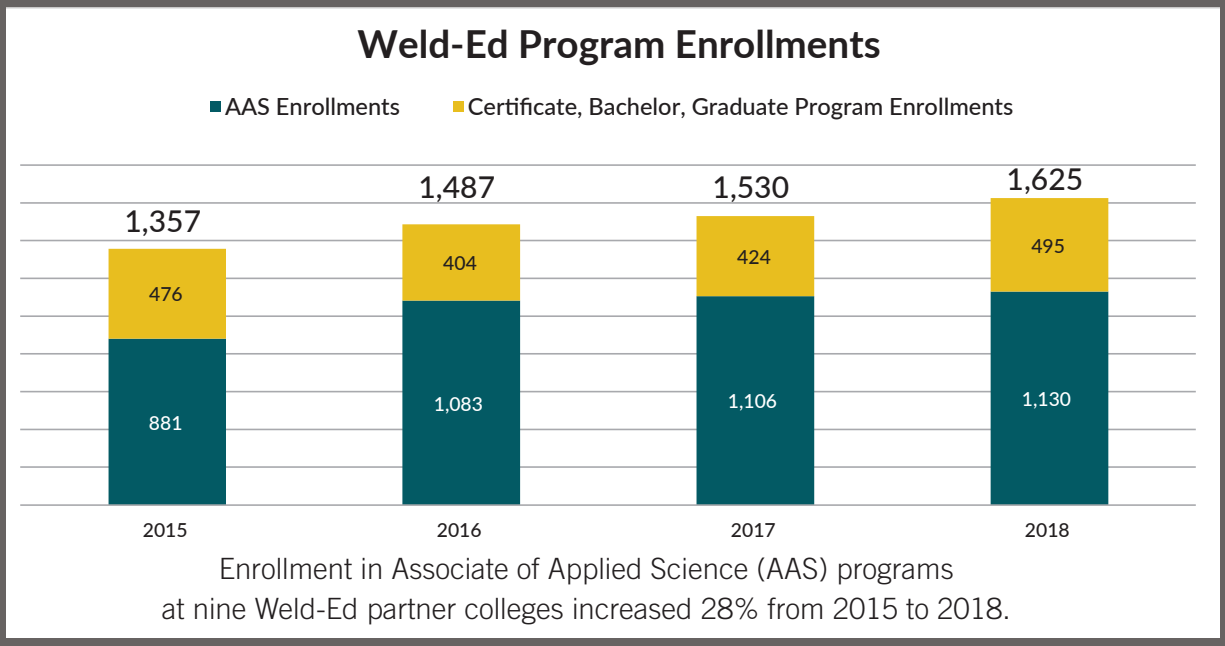
The partnership will

- evaluate and standardize NDT education in academic settings;
- increase NDT awareness among the general population; and
- develop academic and experience roadmaps for NDT careers.

Guided wave testing is one of the ways that welding technicians check buried pipelines for corrosion.

The overall goal of this initiative is to expand educational opportunities for nondestructive testing technicians. With stackable certificates and degrees, proficient NDT technicians will be able to shape their careers to be most meaningful for them and to help them attain their professional aspirations.

To increase awareness of career opportunities in NDT, a "Discover NDT" wall was installed in the Careers in Welding outreach trailer that tours the US. The wall, which is just inside the entrance, features a black and white full length mural of an NDT technician in action and actual NDT equipment around a flat panel liquid-crystal display.



Enrollment in Associate of Applied Science (AAS) programs at nine Weld-Ed partner colleges increased 28% from 2015 to 2018.

Advanced Manufacturing and Automation Flexible Delivery (AMAFD)

Truckee Meadows Community College, Reno, NV
http://ate.is/tmcc

Flexible Delivery Addresses Students Needs

AMAFD allows Truckee Meadows Community College students to complete course readings, view videos of lectures, and take quizzes online, and then attend open labs on campus at their convenience.

The lab station reservation program, devised for this project, is particularly helpful for rural students. By reserving lab stations during open labs, students are assured of immediate access to space in the lab at times that fit their schedules. Instructors staff the lab to help students with questions or problems.

More than 500 advanced manufacturing students benefited from the reconfigured, industry-aligned curriculum in 2018-2019.

Students take advantage of a six-day, 10-hour open lab schedule to complete assignments.

Central Virginia Advanced Manufacturing Initiative

Piedmont Virginia Community College, Charlottesville, VA
http://pvcc.edu/technology

Project-Based Modules Engage New Generation of Technicians

The Central Virginia Advanced Manufacturing Initiative has created 10 impressive project-based modules that are being used in college and high school courses and incorporated into recruitment activities.

The dynamic involvement of 17 employers who serve as advisors is exemplified by one manufacturer's implementation of a wireless production device developed by students who were employees working toward AAS degrees.

The initiative's collaboration with Emerson Automation Solutions received the Career and Technical Education Creating Excellence Award from the Virginia Department of Education. As a project partner, the company covered the cost for 23 employees to take college credit courses at its facility.

Central Virginia Advanced Manufacturing Initiative Outcomes Data			
	2016	2019	% Increase
Student Enrollments	86	178	106%
Courses (*includes 9 on Campus, 1 Online, 2 at Industry Sites)	7	12*	71%
Declared majors in Industrial Electronics AAS, Certificate or Electronics Technology Certificate Programs	18	45	150%

Since the initiative began, enrollment in manufacturing programs at Piedmont Virginia Community College has doubled; courses and declared majors have increased too.

North Dakota Welds Program (NDWelds)

North Dakota State College of Science, Wahpeton, ND
http://ate.is/NDWelds

During welding camps each girl fabricates a metal rose using hand tools and welders.

Project Sets Up Statewide Welding Effort

NDWelds's infrastructure to bring more people into welding includes the following:

• Outreach activities for students between 12 and 18 years old. More than 200 girls participated in welding camps during 2018-2019.

• Professional development for educators. More than 20 secondary school teachers have learned welding skills in workshops where they also received college credit, stipends, and equipment.

• A standardized statewide welding curriculum. The curriculum follows the guidance of Weld-Ed, an ATE Center, and the standards of the American Welding Society (AWS).

To help students throughout North Dakota earn industry credentials, North Dakota State College of Science has become an AWS Accredited Testing Facility.

SMART Future

Chippewa Valley Technical College, Eau Claire, WI
http://ate.is/SMARTfuture

Nearly 400 high school students utilized the mobile lab in two years; the majority earned industry credentials the second year.

Mobile Lab Brings High-tech Lessons to Rural Areas

The SMART Future project brings together rural high school technology instructors, technical college faculty, and industry professionals to design and deliver instruction in Industry 4.0, supply chain, and automation concepts via a mobile manufacturing laboratory.

During week-long professional development workshops, high school instructors from four rural Wisconsin schools receive instruction on equipment and simulations. This enables them to deliver learning modules in advanced manufacturing to their students with the assistance of the mobile lab's technician.

When high school students learn in the lab, they gain industry-recognized credentials that help them transition to college or employment. They also receive credit for prior learning to facilitate their acquisition of academic credentials.

Agricultural and Environmental Technologies

http://ate.is/ag-env

AgEnv

"One of the most inspiring and educational experiences of my professional career. During the [CREATE Energy Storage Project] site visits, I learned about a thermal mass material I never knew existed. I can't wait to talk about phase change energy storage and vacuum-type insulation with my students."

Jenny Brinker, Energy Management Technology Instructor
Northeast Wisconsin Technical College
Green Bay, WI

CREATE Leads International Renewable Energy Network

CREATE developed an international learning community of renewable energy educators to explore emerging energy technologies and share best practices in teaching, career pathways, and academic program development.

Through a series of international exchanges, 41 US educators have conducted extensive examinations of the renewable energy sectors in Australia, New Zealand, Denmark, Germany, and the Caribbean. Most recently, the CREATE Energy Storage Project sent a delegation to Germany to explore the rapid growth of energy storage technology and its integration with renewable energy, electric vehicle, and smart grid technologies.

This initiative advances the skills of participants and helps them add an international context to their renewable energy programs.

Key Activities

- Provides professional development for renewable energy faculty.
- Establishes and fosters renewable energy industry, business, and academic partnerships.
- Promotes renewable energy technician careers and visibility.
- Improves renewable energy technician knowledge, skills, and competencies.
- Distributes model renewable energy materials, curricula, and pedagogical practices.

CREATE Energy Institute participants learn how to install solar photovoltaic panels.

CREATE Energy Institutes Improve Content Knowledge

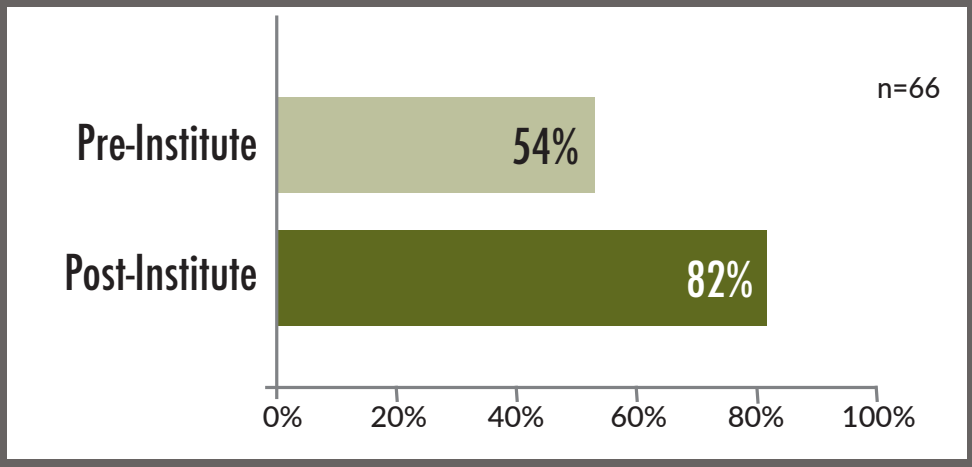
CREATE's mission is to advance the field of renewable energy by championing cutting-edge renewable energy education programs. CREATE works with faculty, providing professional development, curriculum and instructional materials, establishing academic partnerships with industry, promoting renewable energy careers, and addressing the rapidly evolving knowledge and skills required by renewable energy technicians.

CREATE Renewable Energy Institutes provide professional development for high school and two-year college educators. The CREATE Energy Institutes blend a combination of applied academic content with hands-on technical experience. Participants work with full-scale renewable energy systems and with smaller bench-scale activities that are more easily replicated with students. Sixty-five teachers participated in the 2019 CREATE Summer Energy Institutes held in Dover, DE; Normal, IL; Shoreline, WA; and Madison, WI. Collectively, these instructors will teach more than 8,800 students in the upcoming year.

One hundred percent of the participants reported that as a result of the workshop they are more likely to include renewable energy concepts in their courses. In anonymous evaluations the institutes were praised as "an amazing gift of lesson plans, resources and ideas" and as a "fantastic learning opportunity!"

CREATE Energy Institute participants learn about proper use of personal protective equipment for electrical safety.

Faculty Test Passage Rates Pre- and Post-Institute



CREATE Energy Institutes increase educators' knowledge and skills for teaching about renewable energy.

RCNET
Regional Center for Nuclear Education & Training

Indian River State College
Fort Pierce, FL

http://gonuke.org

"RCNET has been the imagination for the nuclear workforce pipeline. By creating products that speak to today's youth—products that have gone viral and products that can be used by industry and colleges across the nation—RCNET has maintained a sustainable workforce pipeline."

Stacey Presnell
Human Performance Manager
Energy Northwest

RCNET Alumni Persist in STEM Technical Workforce

RCNET's largest measure of success is the placement of more than 2,800 program graduates in STEM technician jobs at 80 industry partner locations. A longitudinal study of RCNET graduates from a representative sample of colleges over an eight-year period was conducted by surveying students through direct contact and LinkedIn networks. Of the 161 students involved in the study 85% maintained STEM employment and 32% continued on to four-year degree programs.

Initiatives Address Barriers to Entry & Success

RCNET's data-driven programs to eliminate barriers for minority students have led to significant increases in nuclear programs at several colleges. These initiatives include Men of Color recruitment events and Redesigning Math materials for teaching math in the context of energy technical careers.

Key Activities

- Provides comprehensive curricula for power generation, life and plant sciences, and environmental management.
- Instigates academic and career pathways across nuclear STEM fields.
- Broadens industry and academic partnerships to increase student completion and career placements.
- Offers best practices for hands-on and affective domain instruction.

RCNET students earn nationally recognized rigging and lifting certifications inside Indian River State College's flow loop lab.

RCNET Prepares Today's Students for Tomorrow's Careers

Nuclear technology has quietly been embedded into multiple disciplines and has become crucial to the present and future of the United States' technical workforce. Nuclear industries account for more than 2.6 million jobs and contribute $120 billion toward the nation's gross domestic product. Nuclear energy accounts for 80% of greenhouse-gas-free energy production in the US. With an aging population, usual attrition, and job growth, there will be more than 65,000 high-paying nuclear career opportunities by 2030. RCNET has positioned itself as a leader in nuclear technician education and is preparing today's students for tomorrow's careers.

An RCNET graduate and BHI Energy employee shows an RCNET student how to isolate hazardous materials.

Because the nuclear industry uses emerging technologies such as robotics, sensors, and cybersecurity, RCNET has become an expert in embedding emerging technologies into current curriculum pathways. Not only have the aforementioned technologies been embedded into nuclear programs across the nation to diversify technicians' skill sets, but RCNET has also helped colleges embed modules that cover these emerging and converging technologies into other programs such as automotive technology, public safety, and health sciences.

RCNET 2019 Student Outreach Event & Faculty Professional Development Participation

	Attendees from Secondary Schools				Attendees from Postsecondary Institutions			
	Students	Educators	Schools	Students Impacted	Students	Educators	Colleges	Students Impacted
34 Outreach Events	2,087	119	60	3,401	32	253	153	1,777
29 Professional Development Events	50	15	11	480	283	85*	31	4,334

Nearly 10,000 students have been impacted by RCNET outreach events and faculty professional development programs during 2019.

** Most of the college instructors attended multiple RCNET programs, resulting in total professional development attendance of 305.*

"VESTA's online courses and field experiences at our winery enable me to progress while still working full time. VESTA gave me the competitive edge and knowledge and skills needed to excel as a winemaker in an ever-evolving industry."

Danielle Schmidt, Student Apprentice
Adam Puchta Winery
Hermann, MO

Mentored Field Practicums Benefit Students & Employers

Feedback from students continues to enable refinement of VESTA's nine, mentored field practicums and two facilitated workshops. These practical learning experiences maximize students' opportunities to apply the knowledge they gain in VESTA's online courses and develop specific technical skills. The benefits for employers and students are exemplified by a recent VESTA graduate who became the vineyard manager at the site where he had participated in a field practicum.

VESTA also has proven to be a valuable resource for those seeking a second career. Examples include retired law enforcement and military officers who have enrolled in VESTA courses and then established commercial vineyards and wineries.

Key Activities

- Provides industry-validated knowledge acquisition via online courses in viticulture, enology, and entrepreneurship.
- Expands the learning experience through mentored field experiences in vineyards and wineries.
- Develops registered apprenticeships to address workforce needs of the grape and wine industry.

VESTA students work on fermentation tanks and complete other winery operation tasks during apprenticeships.

VESTA Makes Highly Specialized Courses Available Throughout the US

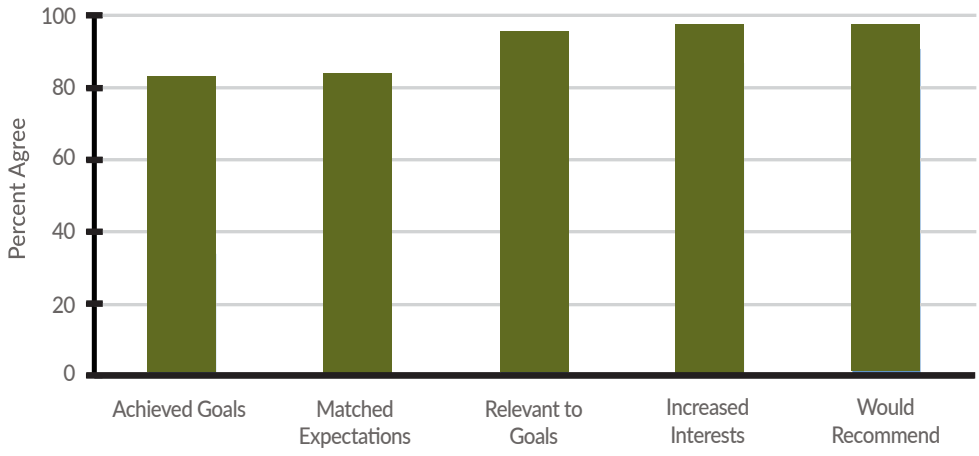
Since 2003, VESTA has partnered with 30 two-year colleges and three universities in 23 states to bring the center's 34 industry-validated online courses in viticulture, enology, and wine business entrepreneurship to students nationally.

The US grape and wine industry (GWI) guides all aspects of the program including curriculum development and provides more than 600 field sites across the country for students to complete practicums and internships. VESTA's newest emphasis on workforce development involves students participating in apprenticeships in three states.

The VESTA education model makes highly specialized, advanced technological education accessible across the US, particularly in rural communities where GWI businesses and students are most often located. GWI-specific courses are taught by national content experts and industry professionals. Each VESTA course is offered by a two-year college in the VESTA network through a unique course-sharing model. Enrollment in VESTA courses is through a central registration and payment portal making comprehensive GWI programs of study and workforce development available to students and possible for colleges that would otherwise not be able to offer associate degrees in these disciplines.

VESTA offers Sensory Evaluation Workshops and other hands-on programs across the US.

Aggregate End-of-Course Survey Responses by VESTA Students



n = 1,198 Responses over an eight-year period

Results of the most recent post-course surveys demonstrate students' approval of VESTA online courses, field practicums, and workshops.

Clean Tech ATE

Shoreline Community College, Shoreline, WA
http://shoreline.edu/clean-energy

After installing a solar array during the Solar Institute, teachers create solar photovoltaic technology lessons to implement in their classrooms.

Clean Tech ATE Prepares Energy Innovators

Clean Tech ATE prepares students to join the community of innovators working to solve the challenges of climate change, resource depletion, and renewable energy technologies distribution. With advice from 12 industry partners, the project has identified the knowledge, skills, and abilities that are incorporated in three new courses that blend theoretical learning with practical, hands-on practice using high-tech tools and software.

Graduates of the Clean Energy Technology Program—20 associate degrees and 11 certificates were awarded from 2016 to 2019—are employed doing tasks that include energy modeling, renewable energy evaluation, and energy life cycle cost analysis.

Educators who have attended the project's Solar Institute have used its alternative energy lessons with 4,000 students from 2017 to 2019.

Developing a Precision Agriculture Workforce Ladder (LIFT-PA)

Northeast Community College, Norfolk, NE
https://northeast.edu/NSF

LIFT-PA Lifts Precision Agriculture Education to New Levels

LIFT-PA utilizes modular courses and combines real-world scenarios with hands-on learning to teach teens, college students, and technicians. The curriculum helps each group advance and move up the workforce "ladder."

The mobile Precision Agriculture Learning (PAL) simulator that the project team created allows students to gain hands-on experience with precision hardware and software in real-world settings, such as actual farm fields.

Teachers at 20 high schools use five LIFT-PA modules to increase students' awareness of precision agriculture technologies and careers.

Three precision agriculture college courses have been modularized and use data from the college's farm. Technicians attend LIFT-PA workshops to update their knowledge.

Learning to deploy software that operates precision agricultural equipment helps technicians improve return on investment.

Enhancing Aquaculture

University of Alaska Southeast, Sitka, AK
http://salmonculturesemester.alaska.edu

Students learn to dissect salmon smolts to check for pathogens in the hands-on fish pathology course.

Innovative Approach Enhances Aquaculture Instruction in Alaska

The Enhancing Aquaculture project partnered with Alaska salmon hatcheries to create an engaging, experiential program that prepares students for fishery industry careers in remote settings.

A key result is an industry-recognized occupational endorsement for students who complete the 13-credit Salmon Culture Semester. In addition to faculty-led lessons, students intern for 150 hours at aquaculture facilities in Southeast Alaska. There they learn from industry professionals how to raise salmon for the enhancement of commercial, sport, and subsistence fisheries in Alaska.

Project leaders created mariculture and fish pathology courses for the program that also teaches small vessel operation, cold water survival, and outboard motor maintenance.

Partnership for Advanced Marine and Environmental Science Training for Pacific Islanders

University of Hawai'i at Mānoa, Honolulu, HI
http://pbrc.hawaii.edu/nsf-ate

Partnership Impacts Faculty & Students at Five Pacific Island Colleges

The Partnership for Advanced Marine and Environmental Science Training for Pacific Islanders strengthened regional technological education through the minority-serving community colleges of the Pacific Islands: American Samoa Community College, College of Micronesia–FSM, College of the Marshall Islands, Northern Marianas College, and Palau Community College.

The project supports curriculum development, the professional development of community college faculty, internships, and field experiences for students while strengthening the scientific infrastructure of the partner institutions. Its focus on climate-change impacts and island-ecosystem sustainability has benefited more than 2,000 students and is enhancing workforce development in STEM disciplines for highly underrepresented minority students.

Students perform photo-quadrant surveys to determine the benthic cover in American Samoa.

Bio and Chemical Technologies

http://ate.is/bio-chem

Bio/Chem

"A skilled and educated workforce with instruction that is relevant to the dynamics of the contemporary workplace is essential for building the biotechnology industry locally."

James C. Greenwood, President and
Chief Executive Officer
Biotechnology Innovation Organization (BIO)
Washington, DC

Students Hone Bioscience Skills at Center's Hubs

InnovATEBIO will establish hubs that prepare students for biotech careers with hands-on work experiences. Each hub will be a network of community colleges, high schools, and industry partners.

The hub in Northern California emulates the BioSCOPE Project, which from 2017 to 2019 employed 204 community college students. The biotech kits they created were used by 9,000 high school students.

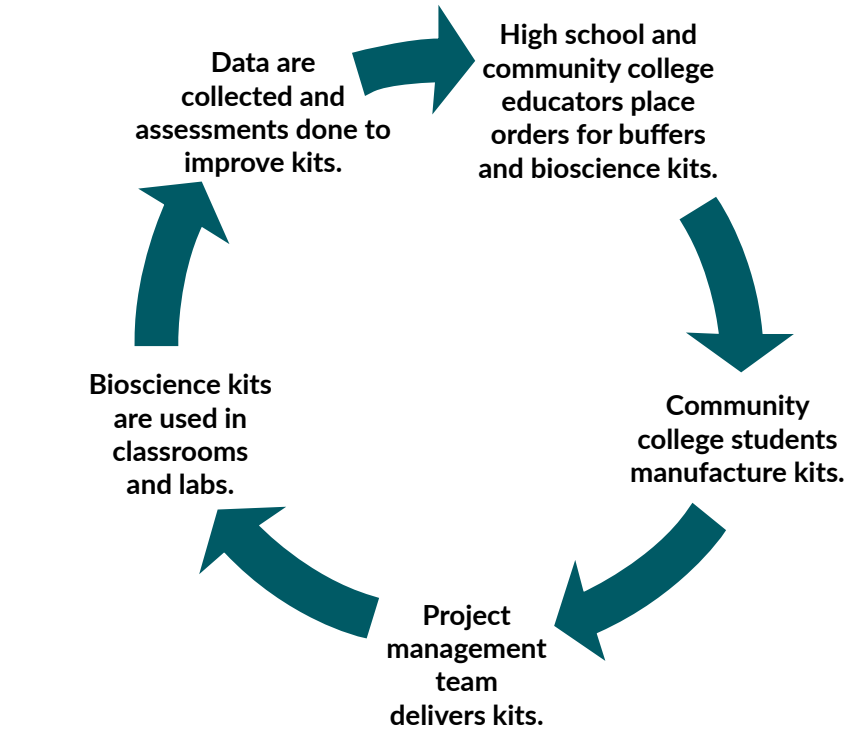
The hub in New York led by Cold Spring Harbor DNA Learning Center and City College of Technology focuses on genomic products and services.

At peak operation, InnovATEBIO's student-managed hubs will produce 1,500 DNA barcode and 2,400 next-generation sequencing kits annually. This level of activity will support 975 research projects involving 3,900 community college students.

Key Activities

- Provides mentorships to support educators and expand pathways for students in underserved areas.
- Conducts workshops on undergraduate research experiences and leadership for biotechnology programs.
- Collaborates with industry and trade organizations to build a diverse network of educators, students, alumni, and employers.
- Launches hubs that engage students in producing biotechnology education products.

Supply Chain Operations for Bioscience Kits



InnovATEBIO emulates BioSCOPE's supply chain model for sharpening community college students' biomanufacturing skills through the production of buffers and bioscience kits.

InnovATEBIO Devises Cross-discipline Synthesis

To achieve a cross-disciplinary synthesis of bioscience-related workforce development, the center is organized according to the Business Industry Leadership Team (BILT) model developed by the Convergence Technology Center. That means that employers and other workforce representatives co-lead InnovATEBIO with community college biotechnology educators. InnovATEBIO leaders also collaborate with ATE initiatives that focus on nanotechnology, optics, and information technology.

CSBI Report Offers Workforce Insights

InnoATEBIO is partnering with the Coalition of State Bioscience Institutes (CSBI) to enable more information about biotechnician workforce needs in its biennial *Life Sciences Workforce Trends* report. By broadening the data gathering, InnovATEBIO leaders hope to influence industry expectations and to shape technician education requirements.

Biosciences Leadership Institute Cultivates New Leaders

InnovATEBIO's Biosciences Leadership Institute informs the next generation of educational leaders about the strategies and problem-solving processes used in bioscience's private, public, and not-for-profit sectors. Institute workshop participants gain insights about bioscience workforce issues, and learn how to work with industry and trade organizations and state policymakers. They also receive guidance for navigating federal agency requirements.

Biomanufacturing students at Skyline Community College verify the content of bottles for BioSCOPE educational bioscience kits.

As part of a Cold Spring Harbor Laboratory outreach program, students collect invertebrates to identify by DNA barcoding.

"I have used much of the NBC2 curriculum for my courses. This miniBIOMAN experience will help me improve the implementation of this curriculum. Thank you for all the help. This has made our biotech program at Blinn [College]."

Michael Johanson,
Research Engineering Associate IV
National Center for
Therapeutics Manufacturing
Texas A&M University
College Station, TX

NBC2 Accomplishes Many Goals

NBC2's Western Hub, MiraCosta College, graduated 22 students in the first cohort of its bachelor's in biomanufacturing program. Nineteen students (86%) were employed or had been offered biomanufacturing employment at graduation.

Of the 79 two-year and four-year college faculty who attended NBC2 miniBIOMAN hands-on workshops from 2016 to 2019, 93% of the 77 survey respondents expressed an intention to implement all or some of the activities and techniques covered.

Two curriculum modules—Quality in Biomanufacturing and Design of Experiments in Biomanufacturing—were created in 2019. The seven modules that NBC2 designed for faculty to incorporate readily into their courses are available in the Instructor's Portal on the center's website.

Key Activities

- Supports faculty through mentoring, hands-on workshops, and curriculum modules.
- Provides an extensive bank of industry-relevant and open-source biomanufacturing curricular materials.
- Creates awareness of biotechnology careers at the high school level through industry-supported teacher conferences and student workshops.

NBC2's advanced biomanufacturing curriculum covers protein purification techniques.

NBC2 Mentors Faculty

NBC2 continued to mentor two-year and four-year college faculty as they developed new programs or expanded biotechnology or biomanufacturing courses. One hundred and twenty-four faculty have accessed the NBC2 Instructor's Portal at http://biomanufacturing.org and downloaded lectures, standard operating procedures, exams, and ancillary materials.

NBC2 Connects Students with Employers

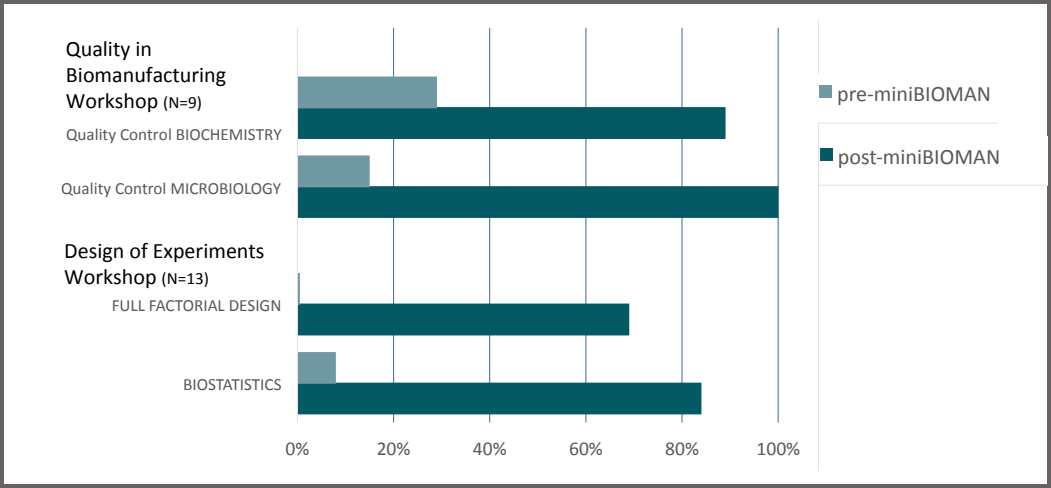
Working with local employers, NBC2 offered eighteen biotechnology/biomanufacturing career fairs at its six hub colleges to serve more than 500 students. These events provided employment guidance to students and resulted in many students receiving interviews, internships, and job offers.

A Montgomery County Community College graduate performs cell culture techniques at Rockland Immunochemicals, Inc.

NBC2 Raises Awareness of Biomanufacturing Careers

NBC2 impacts biomanufacturing career awareness through industry-supported high school events for students and teachers. One hundred and thirty-one high school students attended BIOMAN Academy workshops at five NBC2 regional hubs; 55 high school teachers participated in Protein is Cash summer workshops; and 47 attended a one-day career pathways conference where they networked with industry representatives. A total of 6,413 high school students were impacted by these activities.

Participants' Self-Assessements of Changes in Understanding & Confidence from NBC2 miniBIOMAN Workshops



NBC2 miniBIOMAN workshop participants reported significant increases in their understanding of biomanufacturing and their confidence to teach it.

Biotechnology Unified Education Network of Opportunities (BUENO)

Texas Southmost College, Brownsville, TX
http://ate.is/bueno

BUENO Builds Biotech Career Paths in Lower Rio Grande Valley

BUENO teaches middle and high school teachers biotechnology techniques, such as bacterial transformation, to use in their classrooms.

BUENO uses existing ties between the college, local school districts, industry, and other groups to build a network that prepares a high-quality workforce for the growing biotechnology industry in Texas. As the first biotechnology program in the Lower Rio Grande Valley, the project is developing clear career paths for students.

In its first 13 months BUENO held two workshops for teachers, infused introductory biology labs with biotechnology, and offered biotechnology camps for middle and high school students. Through these activities almost 100 students in college-level classes and more than 150 middle and high school students learned how to do DNA extractions, bacterial transformations, column chromatography, electrophoresis, and the diagnostic assay ELISA.

Building New Pathways to Biotechnology Careers

Madison Area Technical College, Madison, WI
https://ate.is/matccures

Project Offers Experiential Learning Opportunities

Students explore various research questions with faculty mentors in the open lab funded by the project.

During its first year, the Building New Pathways to Biotechnology Careers project developed and implemented

- course-based undergraduate research experiences (CUREs) in biology;
- an "open lab" for mentored research;
- a new internship program for liberal arts transfer students; and
- industry-informed digital badges to assess and document student mastery of key bioscience skills.

Offering CUREs, internships, digital badges, and the new certificate program to the liberal arts transfer students—who are currently not in the biotechnology or bioscience career pipeline—improved their engagement and retention rates, and increased their skill acquisition. All activities aim to increase the number of skilled biotechnicians.

Coordination Network for Advanced Biomanufacturing

Madison Area Technical College, Madison, WI
http://ate.is/CAMCTP

Careers in advanced manufacturing of cell and tissue-based products begin with mastery of laboratory skills.

Consortium Creates Infrastructure for Careers in Cell & Tissue Manufacturing

This coordination network promotes STEM career pathways in advanced manufacturing of cell and tissue-based products (AMCTP).

Relying on a new kind of manufacturing, the process uses robotics, microfluidics, computational modeling, and engineering to construct biologically relevant products composed of living cells in combination with natural or synthetic materials. This cross-disciplinary field is built upon advancements in micro and nano-scale technologies, biotechnology, stem cell biology, genome editing, biofabrication, and tissue engineering. AMCTP products have the potential to treat medical conditions such as neurodegenerative diseases, heart diseases, and cancers.

To generate a highly-skilled, diverse workforce for AMCTP, the consortium is identifying AMCTP core competencies; disseminating information about workforce education options; and fostering sustainability with a structure for public-private partnerships.

Technician Training in Gene Editing (TTiGE)

Delaware Technical Community College, Newark, DE
https://dtcc.edu/events/ttige

Community college instructors perform gene-editing lab activities in workshops at DTCC.

Students & Faculty Acquire Gene-Editing Skills

TTiGE, a collaboration of Delaware Technical Community College (DTCC) and the Gene Editing Institute at Christiana Care Health System, delivers cutting-edge CRISPR gene-editing curricula to community college students and instructors.

Dozens of DTCC students have learned CRISPR gene-editing techniques through the hands-on laboratories, two courses, and capstone experiences that allow them to explore a topic of their choice in-depth.

The 31 community college faculty members—from 22 institutions in 12 states—who participated in the project's first four workshops reported making notable gains in their understanding of scientific content and how to incorporate gene-editing content into their courses. Three more workshops will be offered in 2019-2020.

Engineering Technologies

http://ate.is/eng

Eng

BEST

Building Efficiency for a Sustainable Tomorrow Center

Laney College
Oakland, CA

http://bestctr.org

"BEST enhances our program by motivating me as an instructor. These workshops build up my weak areas—some I never knew existed. As a higher-performing instructor, I will produce higher-performing students, and they will become higher-performing employees."

Charles Miller, Energy Systems Technology Instructor
Walla Walla Community College
Walla Walla, WA

With Expansion, BEST Network Educates More Highly Qualified Building Technicians

BEST has steadily expanded into a network of more than 70 colleges supporting the building operations sector. Through BEST's faculty workshops and webinars, more than 260 instructors and administrators have been introduced to new technologies and strategies to advance their programs and student outcomes.

In addition, employers report that BEST graduates

- are knowledgeable about building systems and energy conservation,
- learn quickly and possess excellent hands-on skills, and
- transition effectively to the workplace.

Through innovative curricula and successful entries into the workforce, BEST and its network of colleges are delivering well-prepared students to become a new generation of high-performance building technicians.

Key Activities

- Assists faculty with model curricula, lab designs, and professional development.
- Partners with industry and STEM organizations to increase awareness of technician careers.
- Provides advanced operations and maintenance education for incumbents.
- Leads national technician certification in high-performance building operations.

Educators compare building systems data during a workshop exercise at Lawrence Berkeley National Laboratory.

Project-based Learning Prepares Technicians for Building Operations Challenges

Twenty-first century commercial buildings require operations personnel with sophisticated skill sets. Technicians must be able to solve complex HVAC (heating, ventilation, and air conditioning) problems and use data to optimize building performance for comfort, occupant health, and energy savings.

To address the demand for qualified building technicians, BEST and its network of colleges are deploying project-based learning (PBL) methods in their programs. Students who become self-directed learners and adept problem-solvers are better able to handle the challenges of working with advanced mechanical equipment or digital building control systems for fault detection and diagnostics.

BEST leads faculty in designing PBL strategies at its annual workshops. Instructors work in teams and learn by doing—the very essence of PBL. They often wire, program, test, and troubleshoot building automation systems linked to mechanical devices. They also analyze building systems data to identify problems or potential opportunities for improvement. Through this immersion in PBL, instructors can more effectively devise and implement engaging, real-world scenarios for their students.

BEST Student Completion & Employment 2014-2019

6,760
students enrolled in building science courses

2,420
program completers and graduates

2,570*
technicians entering the workforce

Since 2014, BEST's network of 70+ colleges has helped to boost the US building operations workforce.

* Includes program non-completers.

The College of DuPage's building automation program integrates hands-on learning for improved skills development.

CAAT

Center for Advanced Automotive Technology

Macomb Community College
Warren, MI

http://autocaat.org

"I've had technicians who have been students from Macomb Community College on staff at the General Motors Climatic Wind Tunnels and Laboratories. Each of them has made a positive contribution to the operations of the facility."

Ronn Jamieson
Director, GM Laboratories
GM Technical Center
Warren, MI

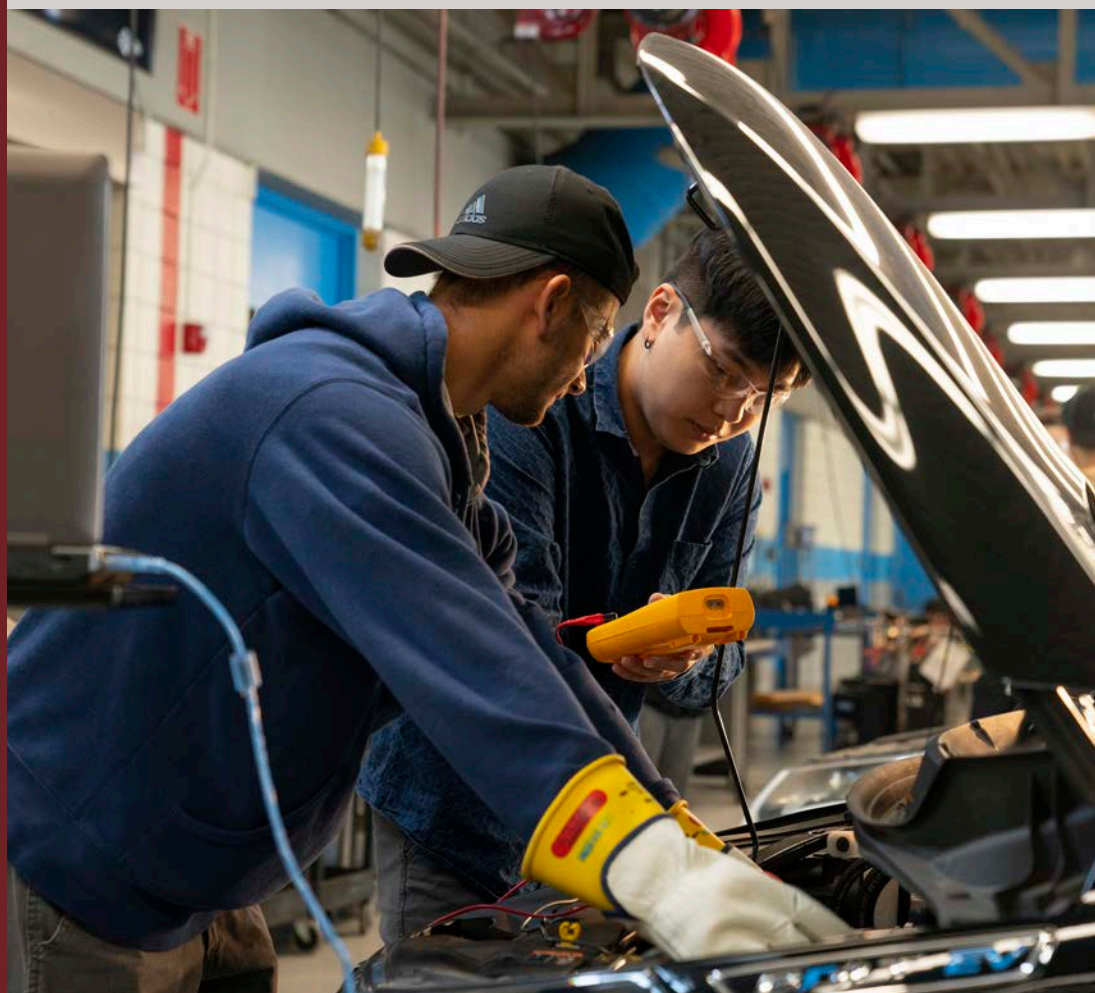
CAAT Develops Curriculum in Auto Technologies to Meet Industry Needs

Through visits with industry partners, CAAT leaders identified an industry need for a vehicle development technician to work on test and prototype systems with engineers at automotive companies and suppliers. The new associate degree program combines electronics, computers, and experimental testing, and it was launched at Macomb Community College in fall 2018.

CAAT worked with seed-funding partner Kettering University to create a cross-discipline course: Automotive Cybersecurity for Automotive Technicians. It is available for download from CAAT's website.

CAAT offers a professional development short-course on electric-drive vehicle technology and participates in educator instruction at professional meetings such as the Michigan Auto Teachers Association Conference.

Electric vehicle technicians work on an all-electric Chevy Bolt.



Key Activities

- Works with industry and education partners to create advanced automotive technology degree programs, courses, and modules.
- Offers professional development opportunities for educators and industry professionals.
- Engages thousands of middle and high school students each year in STEAM-related outreach activities.

Partnerships Drive the Skills Needed for the Next Generation of Automotive Technicians, Engineering Technologists & Designers

At the request of Fiat Chrysler Automobiles (FCA), CAAT created an Automotive Manufacturing Program (AMP) that combines academic coursework at Macomb Community College (MCC) with paid on-the-job experience one day per week at an FCA manufacturing facility. When students graduate with an associate degree from MCC, they may be offered a job as part of FCA's production supervisor development program. Based on initial success, FCA offered the program for a second consecutive academic year in 2019-2020.

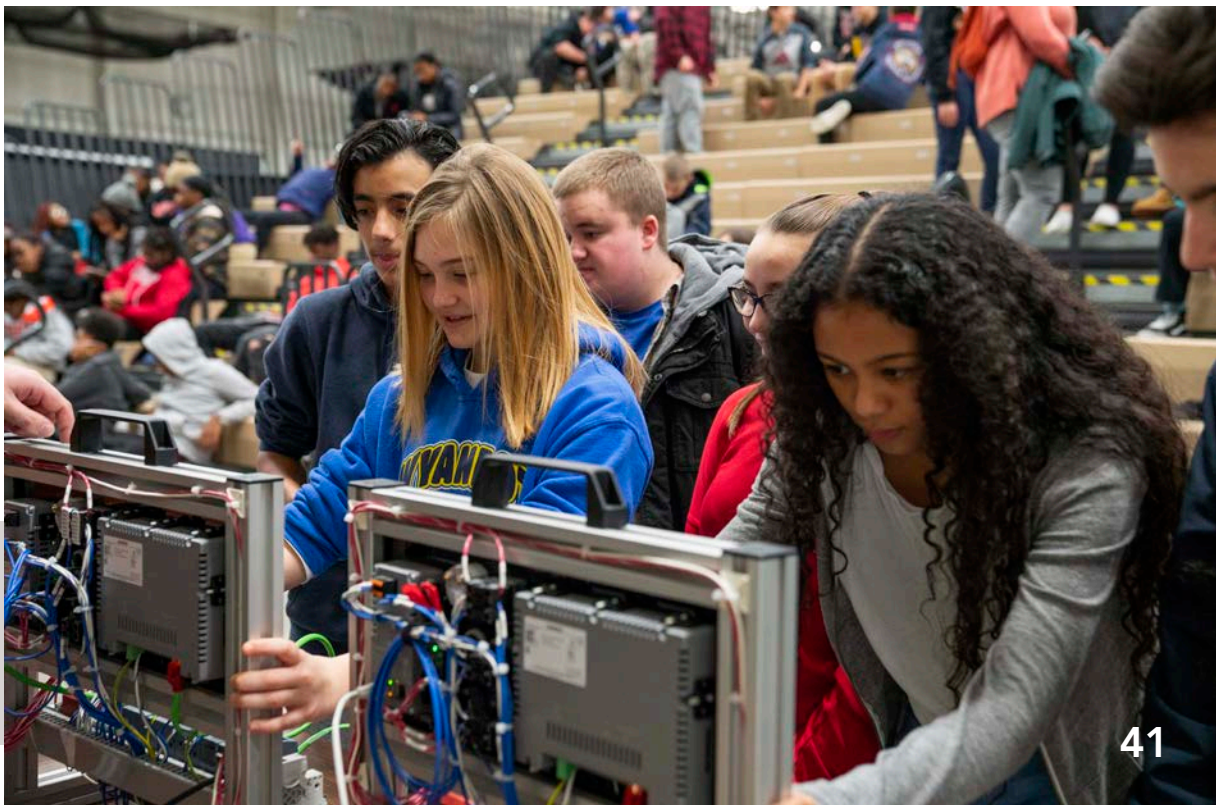
Outcomes of CAAT Seed Funding

Course Topics	Course Modules	Complete Courses
Hybrid and Electric Vehicles	11	3
Connected and Automated Vehicles	1	3
Automotive Cybersecurity	0	1
Lightweighting	0	7
Experimental Testing	0	1
General STEM	1	1

CAAT's seed funding resulted in 16 complete courses and 13 course modules in advanced automotive technology. All may be downloaded for free from CAAT's website.

CAAT also leveraged its partnerships to

- create curriculum in collaboration with other educational institutions by providing them with seed funding;
- host an Auto STEAM Days event for approximately 2,500 middle/high school students each year with support from General Motors (GM), Ford, FCA, and several auto industry suppliers;
- offer STEAM career camps sponsored by GM and Bosch to 50 middle school students;
- host an Engineering Day event for 65 Girl Scouts; and
- develop STEM camps and professional development workshops in partnership with the NSF National Center for Autonomous Technologies (NCAT).



At Auto STEAM Days, students program robots at Kuka Robotics' hands-on exhibit.

"The associate in science degree in electronics engineering technology with the specialties of robotics and photonics opens you up to so many different job specialties. It feels very good to graduate from college without owing thousands of dollars in loans."

Dina Aguilar, Biomedical Technician
Cleveland Clinic/Martin Health
Stuart, FL
2017 Indian River State College Graduate

LASER-TEC Adds Diverse Student Populations to Programs

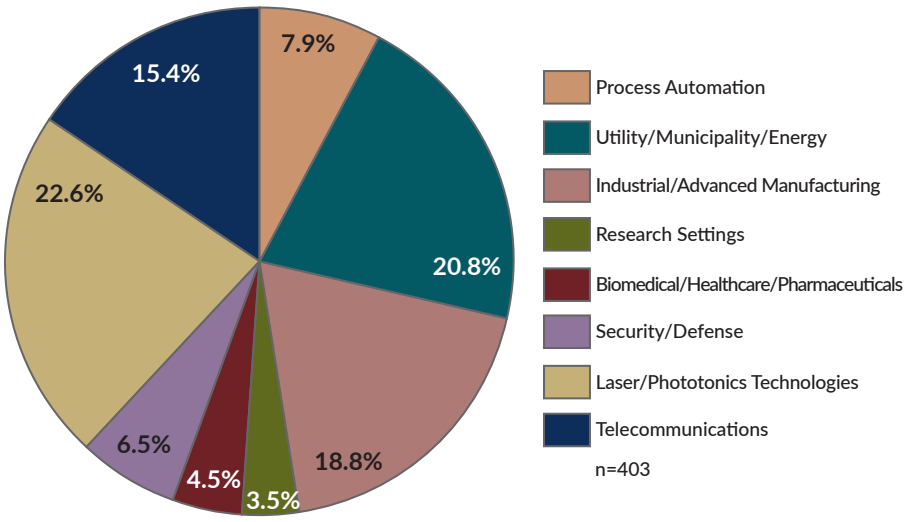
LASER-TEC facilitates expansion of diversity in the laser, photonics, optics, and fiber optics (LPOFO) workforce pipeline. Carefully tailored recruitment strategies and partnerships with local, state, and national organizations that support underrepresented groups have enriched LASER-TEC college programs with veterans and previously unemployed or underemployed individuals.

Specifically, 45% of the Indian River State College photonics cohort of 91 students and 28% of the 267 students enrolled across all LASER-TEC programs during 2018-2019 are from populations historically underrepresented in STEM fields. In 2019 the number of female students in LASER-TEC colleges tripled to 30. Enrollment by veterans nearly quadrupled increasing from eight in 2013 to 31 in 2019.

Key Activities

- Assists colleges in adding laser, photonics, optics and fiber optics (LPOFO) technologies to their academic program offerings.
- Develops and disseminates instructional curricula for classroom and laboratory use.
- Fosters partnerships among colleges, industry, and professional societies to benefit students.

Percentages of LASER-TEC Program Graduates Employed by Industries



LASER-TEC program graduates work in industries that are critical to the nation.

LASER-TEC Activities Cast Big Net

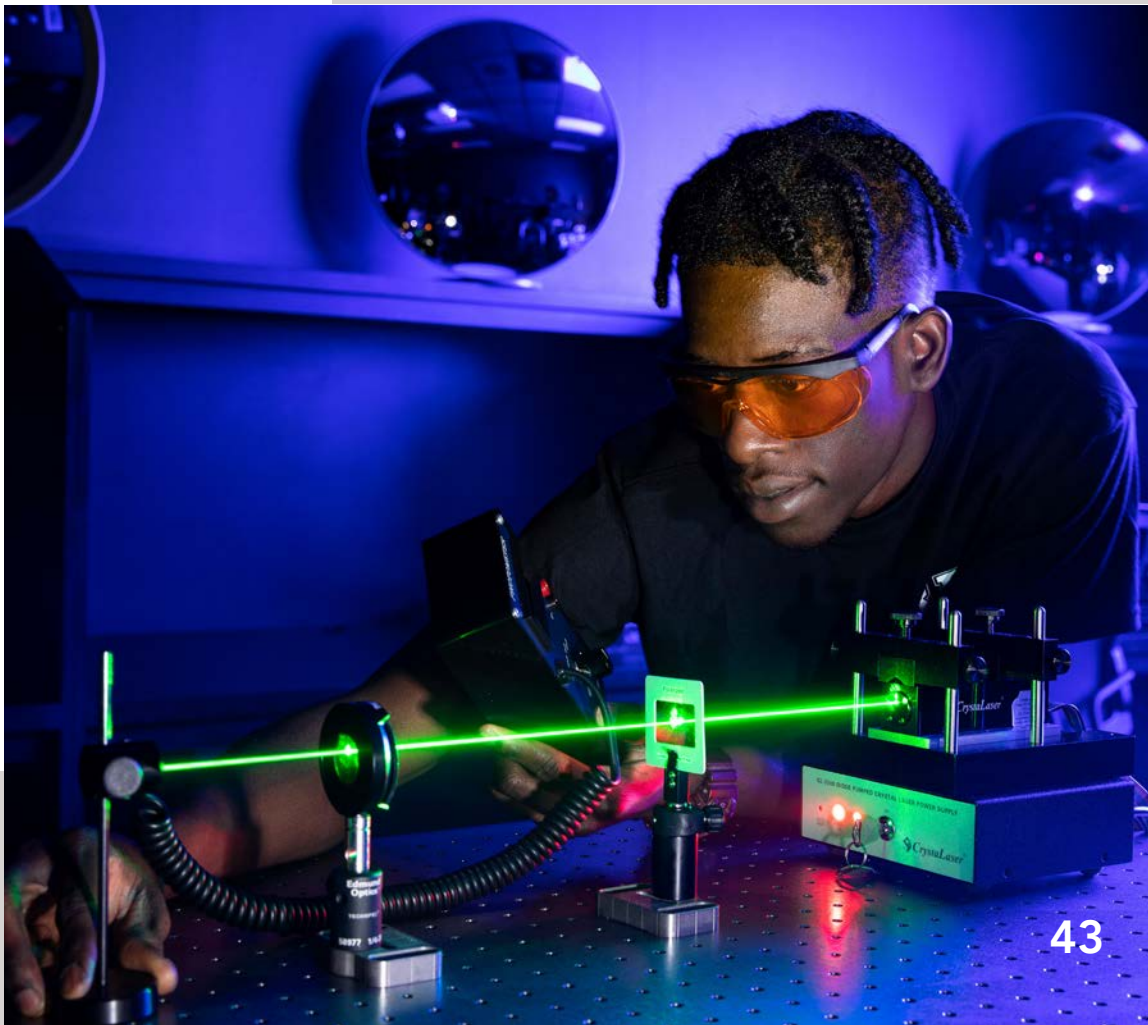
Since 2013 LASER-TEC has delivered professional development to more than 700 secondary and postsecondary educators who have taken one or more of LASER-TEC's 40 professional development sessions on laser-based technologies and their infusion into existing programs.

Through its outreach programs LASER-TEC has had direct contact with almost 40,000 people: secondary and postsecondary students, parents, teachers, counselors, advisors, and members of the general public.

LASER-TEC's effort to expand the LPOFO workforce is supported by its Industry Network of 162 companies and seven professional organizations. The members of the network come from all over the country. They are proactively engaged in LASER-TEC's activities and share insights about current and future workforce trends, assist in developing curricula, conduct faculty professional development, design and build laboratory facilities, and donate or provide training equipment at highly discounted prices.

LASER-TEC has organized and facilitated 51 on-campus or on-site hiring sessions for LPOFO companies. This effort encourages employers to hire qualified technicians who are graduates of LASER-TEC programs. More than 400 LASER-TEC program graduates work in laser technologies and other industries critical to the nation's economic health and security.

A LASER-TEC graduate tests ferromagnetic detectors used for magnetic resonance imaging safety.



LASER-TEC's curriculum teaches students how to measure output power from lasers.

"I'm often asked why Eastman invests in advancing ocean science, and the answer is simple: the ocean matters everywhere. There's no better opportunity to ensure the future of ocean science and technology than to inspire today's students through real-world educational experiences like the MATE competitions."

David A. Golden
Retired Senior Vice President
Eastman Chemical Company
Kingsport, TN

Student-run Underwater Robotics Store Serves Thousands

SeaMATE.org is a student-run social enterprise that provides community college students with income and workplace experience while creating products and services that promote education.

SeaMATE was created in 2012 to help ROV teams find underwater robotics supplies to participate in the MATE ROV Competition. Now the customer base has grown beyond competition teams to include students, teachers, and hobbyists building ROVs for science projects and fun.

Since inception, SeaMATE has employed 50 students, sold more than 4,000 ROV kits, and brought in $2 million in sales. Students learn the basics of manufacturing, quality control, management, entrepreneurship, and networking with marine professionals.

Key Activities

- Develops knowledge and skill guidelines for the ocean technical workforce.
- Organizes regional and international underwater remotely operated vehicle (ROV) competitions.
- Operates SeaMATE, a social enterprise that provides students with workplace experience.
- Offers at-sea technical internships to students.
- Provides technology-rich professional development.

A marine technician advises an intern preparing to launch an autonomous underwater vehicle.

Intensive Professional Development & ROV Competitions Lead to Student Success

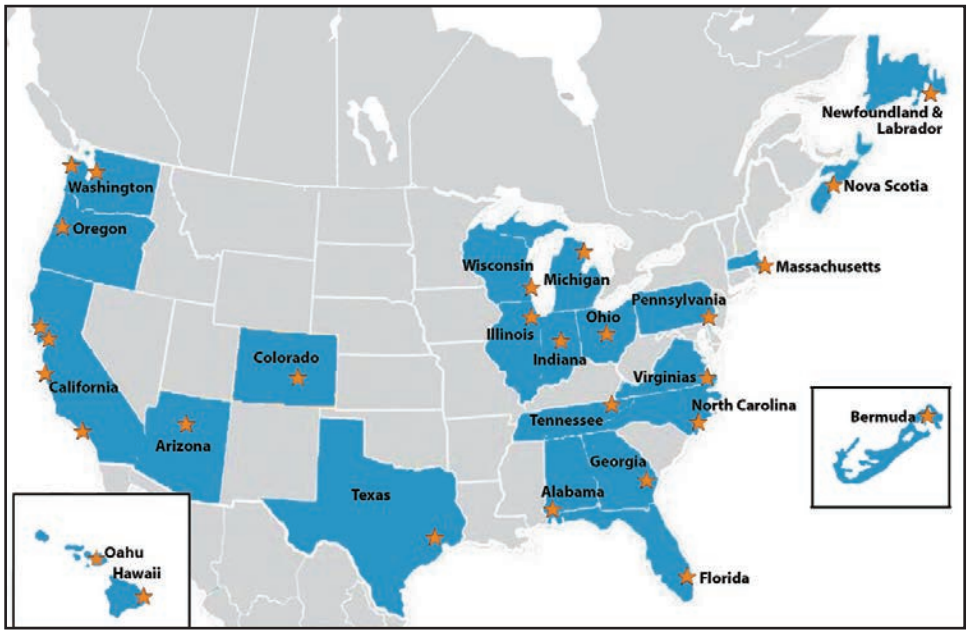
Through intense summer institutes, MATE has provided more than 850 educators with professional development. Eighty percent of the week-long institutes have focused on Underwater Robotics and Engineering Design where college, university, and secondary educators are presented with an underwater mission and challenged to build an underwater robot to accomplish the mission.

MATE's summer institutes receive high marks with 97% of the educators rating the institutes as excellent and 86% of the educators returning to their schools and building ROVs with their students.

Marine technicians prepare to drop a sensor package below sea ice.

MATE has a variety of resources to help the teachers and students succeed. These resources include the comprehensive textbook *Underwater Robotics: Science, Design and Fabrication*, 100+ educational modules, four levels of ROV kits, an online store SeaMATE.org that sells ROV kits and accessories, and a world-wide network of ROV competitions.

MATE coordinates 40 regional competitions in North America and elsewhere that lead to its World Championship every June. In surveys, competition alumni have reported that their participation on ROV teams played an instrumental role in obtaining jobs, internships, and scholarships and even starting businesses.



MATE Regional ROV Competition Network

The MATE ROV Competition Network consists of 40 regional events: 25 in the US and neighboring countries, and 15 in other international locations.

"We started making our first projects yesterday and substituted roasted poplar for calico walnut. The kids in the shop call it 'bacon wood' as they claim it smells like smoked bacon when cut."

Tim Wilhelm, Instructor
Kankakee Community College
Kankakee, IL

MatEdU Offers Faculty Innovative Learning Opportunities

With materials science developments affecting multiple disciplines, employers' needs for qualified technicians who understand the basics of materials technology grows exponentially. MatEdU serves as a trusted international resource to identify and articulate the linkages between materials science and manufacturing processes.

MatEdU National Resource Center
www.materialseducation.org

Its Virtual Reality (VR) Workshops exemplify the innovative learning opportunities MatEdU and its partners have developed to promote student engagement in materials science.

At VR Workshops instructors explore equipment, software, design, and implementation options as they create projects for their classrooms. For example, one teacher incorporated VR into his welding curriculum to improve safety and accuracy while testing the impact of using different materials.

Key Activities

- Provides resources for materials science.
- Develops outreach to Hispanic-serving institutions.
- Explores models of industry and other partnerships, such as national credentialing bodies.
- Mentors educators as they add materials science programs.
- Facilitates strategic national and international partnerships.

A navy veteran works on getting her fret board completed in the Guitar Heroes: Operation TWANG guitar-building workshop.

Core Competencies Clarify Technicians' Understanding of Relationships Between Material Properties & Production Processes

Core competencies provide a set of performance indicators that technicians, scientists, engineers, educators, and technologists need to know in today's advanced manufacturing environments to work effectively. Delineating core competencies assists educators in determining subjects that the technology student needs in order to attain the required depth of proficiency.

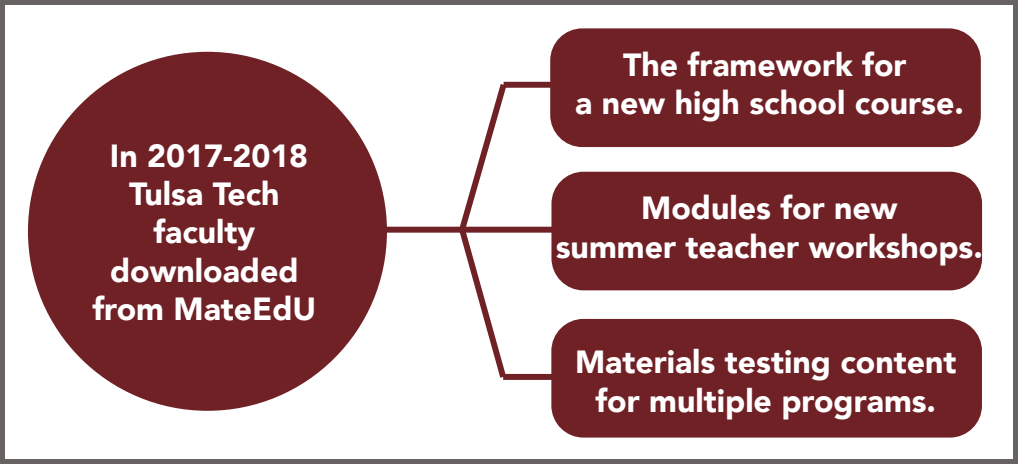
Through development and dissemination of nine materials-related core competencies, MatEdU has been a major contributor to enhanced quality of education in manufacturing processes, as well as engineering design. Active partnerships with other entities allow MatEdU to impact and integrate materials information in diverse areas. The more technicians understand the relationships between material properties and production processes, the better the quality of their work, their personal productivity, and the competitiveness of their employers' companies.

Educators learn about corrosion during a hands-on lab at the 2019 M-STEM Workshop.

M-STEM Enhances Technology Education Integration

More than 7,500 people—students, educators, and employers—have participated in the hands-on materials science lessons offered at Materials in STEM (M-STEM) programs. Peer review and publication of the M-STEM experiments and demonstrations provide up-to-date, valuable aids for teaching and research.

Impact of MatEdU Resources at Tulsa Tech



Most of the 70,000 downloads from MatEdU's website since 2009 are by educators who repeatedly access the free content to enhance their courses.

"They [NCAT leaders] saw the challenges and addressed them before anyone else. They understand the technicalities in the uses of drones, and knew where the applications were going—so impressed."

Charlotte Swanson, Publisher
Minnesota Flyer Magazine
Moose Lake, MN

Outreach Activities Foster Public Understanding of Autonomous Technologies

NCAT's first mission is to foster public understanding of three autonomous technologies (ATs): unmanned aircraft systems (UASs), connected automated vehicles (CAVs), and unmanned underwater vehicles (UUVs). All three types of autonomous technologies require highly skilled, agile technicians who can design, monitor, utilize, repair, and control them.

Explaining what autonomous technologies do and the career opportunities they generate are part of the center's effort to expand educational programs about these emerging technologies. NCAT provides professional development programs for educators, STEM engagement events for the public, service-learning opportunities for students as well as educational and research resources.

Key Activities

- Leads professional development for educators and industry professionals.
- Inspires opportunities to use autonomous technologies in STEM education.
- Connects workforce and community stakeholders to enhance programs and workplaces.
- Serves as the source for autonomous technologies curriculum, interactive content, applications, and idea exchanges.

NCAT's curriculum teaches technicians to operate and maintain various types of autonomous vehicles.

NCAT Prepares Technical Workforce to Use Autonomous Technologies

As the first national ATE center in autonomous technologies, NCAT is crafting, adapting, and implementing educational resources to help two-year college faculty and other educators in many disciplines meet current workforce demands while increasing the quality and diversity of technicians.

NCAT leaders are drawing on their extensive experience developing replicable instructional models and are utilizing best practices to recruit underrepresented populations and support their entry to STEM careers. NCAT is also a catalyst for research on the knowledge and skills that technicians will need as job titles and work assignments shift.

To accomplish the center's goals NCAT leaders have engaged stakeholders from industry and government as well as colleagues from ATE centers and projects. Their shared priority is preparing the nation's technical workforce to use autonomous technologies that are changing how people live, work, and learn.

NCAT is using service-learning activities to engage community partners on projects that integrate autonomous technologies to solve real-world problems. NCAT expects this approach will enhance curricula, increase hands-on learning opportunities, improve communities, and create or modify two-year colleges' degree and certificate programs.

NCAT Cross-Domain Activities

- Student Competitions for Youngsters and Adults
- High-Intensity Short Courses for Technicians
- Service-Learning Opportunities for Students
- Collaborative Workshops for Educators and Technicians

NCAT's multidisciplinary activities prepare communities to interact with autonomous technologies and encourage individuals to pursue careers that use these new technologies.

Industry partners support NCAT's development of software tools for facility inspections using autonomous technologies.

"If we want to address the challenges of growing the supply chain workforce, we need scalable solutions and credentialing like that developed by the SCA to increase participation in training programs."

Phil Jones, Director
Supply Chain Engineering
Target Corporation
Minneapolis, MN

Key Activities

- Maintains a nationally replicable, scalable, model program of study that supports industry requirements.
- Develops industry-recognized certifications to prepare the next generation of automation workers.
- Convenes technology educators and logistics industry leaders annually for capacity-building, networking, and collaboration.

SCA Strengthens Supply Chain Education & Improves Access to College Programs

SCA promotes program development at community colleges to prepare students for careers in the booming supply chain industry. With more than 150 community college partners and nearly 50 industry collaborators, the center strives to develop education and industry relationships that bring increasing numbers of supply chain technicians to work in some of the most technologically advanced supply chains nationally.

As a result of its e-textbook, case studies, course outlines, and other educational resources, the center has become a sought-after program-development resource for institutions and industry partners that are doing technician-education programs throughout the country and internationally.

SCA Launches Industry-endorsed Credential

In 2020 the Manufacturing Skill Standards Council (MSSC) with SCA and its partners will launch the certified technician-supply chain automation certificate. This industry-endorsed credential adds an incentive for students to complete a technical program. It also increases completers' employability and potential for career opportunities, while providing a baseline for employers to validate entry-level technicians' skills. Employers may also use its standards to assess the skills of incumbent workers.

Supply chain automation students practice their skills with a training module.

SCA Fosters Infrastructure to Develop Supply Chain Workforce

2019 MHI Annual Industry Report states that 65% of companies rate hiring qualified supply chain workers as extremely or very challenging. To address this workforce shortage SCA focuses on creating and advancing educational programs that bring STEM-prepared individuals to the supply chain workforce.

SCA personnel advise faculty and administrators at educational institutions as they create or expand supply chain technology programs to ensure that courses meet employers' needs with skills-based learning and practical classroom instruction.

SCA cultivates relationships with industry partners to engage students in internships, field trips, and job shadowing; to advise community college faculty on related curriculum; and to share their expertise during SCA's annual national symposium.

A supply chain technician oversees the operation of a conveyor system.

SCA Key Performance Indicators

College Partners	164
Industry Partners	>60
Instructional Materials Downloads	>3,200

SCA raises awareness of careers in technologically advanced supply chains in collaboration with dozens of college and industry partners. Its instructional influence is evident in the number of downloaded materials.

"The sharing of best practices from across the country allows the maritime community to create and enhance our own programs without building everything from scratch."

Garry Mercer, Apprentice Program Manager
Huntington Ingalls Industries, Inc.-Gulf Coast
Pascagoula, MS

SMART Career Pathways Blend Academic & Industry Credentials

SMART prepares students to excel in the maritime industry, which encompasses shipbuilding and ship repair, marine engineering, and port operations.

The career pathways that SMART has developed allow students to receive college credits toward a certificate or an associate in applied science degree in maritime technologies while they work to earn industry credentials.

For example, the center's college partners are able to provide instruction for more than 50 different United States Coast Guard (USCG) certifications. During the 2018-2019 academic year students who were enrolled in courses at SMART partner colleges earned 1,779 USCG certificates in addition to academic credits.

Key Activities

- Provides maritime career awareness for students, parents, and educators.
- Promotes collaborative partnerships between industry leaders and educators.
- Mentors community colleges in creating new maritime pathways and programs.
- Delivers industry-centric professional development opportunities for educators.

A maritime student demonstrates how to use the welding simulator.

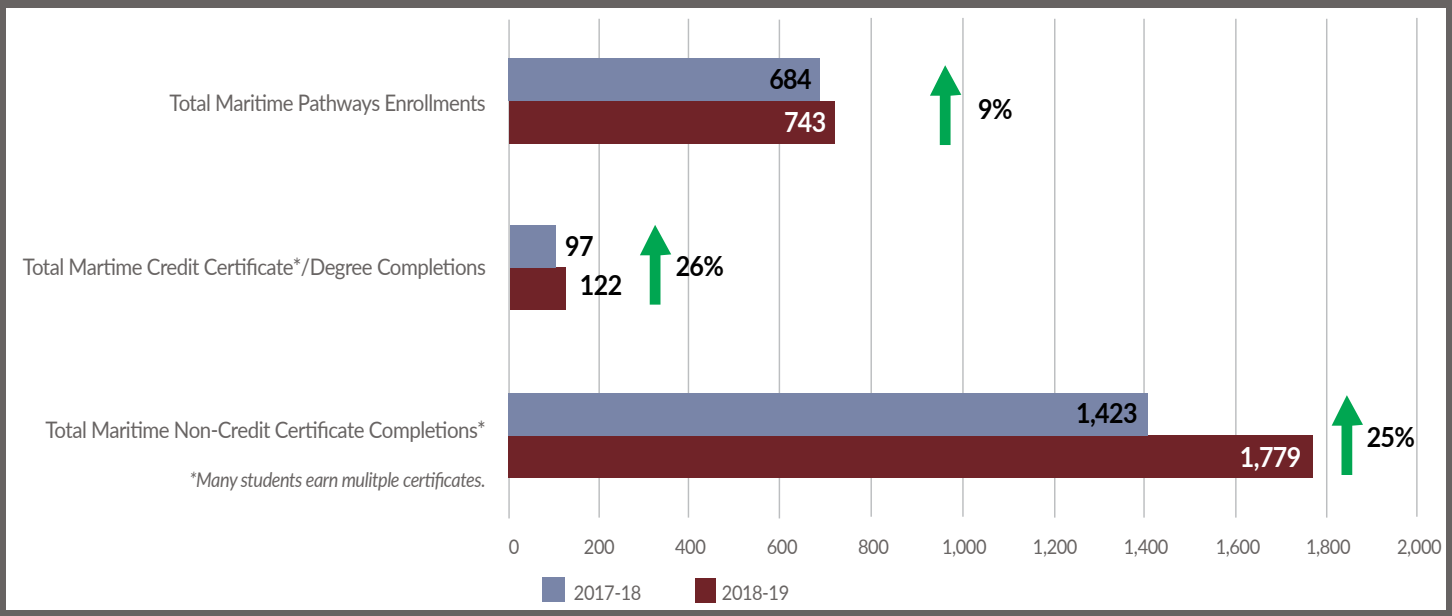
SMART Reaches Students & Educators in Strategic Locations Across the US

SMART youth initiatives—including field days, workshops, and summer camps—give students hands-on experiences with the maritime industry while they learn about STEM careers. Regional professional development opportunities inform educators about the benefits of the industry and maritime career pathways. During 2019, SMART hosted 21 events in five strategic locations on the East Coast, Gulf Coast, and West Coast. These events directly impacted 392 educators and 2,731 students. Through these participants SMART successfully reached students and educators in every major maritime area of the country.

Welding is the highest-demand technical skill in the maritime industry.

SMART also produced the All Hands on Deck program in 2019. The center was eager to provide this national maritime education forum for industry and education leaders to share and develop new strategies for building maritime education programs that meet industry expectations. This conference brought together secondary, postsecondary, industry, and government leaders from across the country to share best practices for maritime education. More than 100 attendees participated in sessions on creating collaborations and partnerships, teaching emerging maritime technologies, and growing STEM education programs.

SMART Maritime Pathways Student Enrollment & Completion



Enrollment in maritime pathway programs grew at the three SMART partner colleges, and students' completion of credentials improved since 2017.

SpaceTEC

National Resource Center for Aerospace Technical Education

Eastern Florida State College
Titusville, FL

http://spacetec.org

"As a national resource center, with decades of experience relating to the shuttle program and other high-profile aerospace ventures, the partnership [with SpaceTEC] gives us access to information and standards that we do not have locally."

John Floyd, Assistant Professor of
Electronics & Computer Technology
Eastern Shore Community College
Melfa, VA

SpaceTEC Shares Space-related Instructional Resources

SpaceTEC® reaches out to primary, middle, and high school students and STEM educators through Schools-to-Space, a web-based resource at https://schools-to-space.com. This site contains information teachers can use to teach about space. It also provides info for teacher workshops that explain the Certified Aerospace Technician® STEM career pathway.

SpaceTEC Expands Industry Certifications to High Schools

The Aviation Fabrication and Assembly program at Eau Gallie High School in Melbourne, FL, recently became an approved training provider for the aerospace/aircraft assembly certification exam through the American Society for Testing of Materials - International (ASTM), and the National Center for Aerospace & Transportation Technologies.

Key Activities

- Provides FAA-recognized, performance-based certifications for aerospace technicians.
- Offers aerospace curricula for two-year degree programs, workshops, and prep courses for performance-based certifications.
- Delivers customized computer-based testing for high schools, training centers, and colleges.
- Offers job, task, and gap analyses.

SpaceTEC interns participated in the machining competition at the International Manufacturing Technology Show SmartForce Student Summit in 2018.

SpaceTEC Leads World-class Apprenticeship Program

SpaceTEC is the administrator and fiscal sponsor of the Space Coast Consortium Apprenticeship Program. This fresh approach to industry-driven apprenticeships in Florida's Space Coast began in August 2019 with a cohort of eight mechatronics apprentices spending three days each week working at companies and two days attending classes. Apprenticeships in advanced computer numerical control machining and fiber composite manufacturing will begin in 2020.

SpaceTEC Supports Veterans' Transitions to STEM Technical Workforce

Developed in partnership with the US Department of Veterans Affairs (VA) and the military's Credentialing Opportunities On-Line organizations, the VetTEC website tool helps transitioning veterans match military occupational codes to aviation, aerospace, and advanced manufacturing credentials that qualify them for civilian jobs. All SpaceTEC® and CertTEC® certifications have been developed with industry partners, are internationally accredited, and are approved for VA reimbursement.

Nunez Community College Adopts SpaceTEC Aerospace Technology Curriculum

Nunez Community College in Chalmette, LA, uses SpaceTEC's curriculum to prepare technicians for work at NASA's Michoud Assembly Facility where the Orion spacecraft and part of the Space Launch System are being built for deep space travel.

A SpaceTEC mechatronics apprentice checks calculations with his mentor at Knight's Armament Company.

SpaceTEC Results

21
SpaceTEC-led DACUMs* resulted in

10
Aviation/Aerospace Occupational Skills Standards

SpaceTEC-supported curricula has been adopted or adapted by

37
Two-year Colleges

5
Universities

5
Technical Training Centers

5
Secondary Schools

3
Adult & Community Education Programs

14
Industry Training Centers

** DACUM stands for Developing A Curriculum*

Mechatronics with Instrumentation and Controls (MwIC)

Central Community College, Columbus, NE
http://mechatronics-mec.org

Mechatronics students work on MwIC custom-designed trainers in the new state-of-the-art Instrumentation and Controls Learning Laboratory.

Project Sparks Student Interest in Mechatronics

MwIC worked with its Business and Industry Leadership Team to develop a process instrumentation and controls pathway in the existing mechatronics AAS degree program. This is the first two-year instrumentation program in Nebraska and addresses the process industry's need for technicians.

MwIC has

- developed six new credit courses;
- created custom-designed trainers for hands-on learning;
- helped establish multiple scholarship and internship opportunities;
- raised awareness of mechatronics careers with high school presentations, open houses, and hands-on lab events; and
- provided professional development workshops to teachers and administrators from 50 high schools.

Together these efforts have increased enrollment by 25% from 59 in 2016-17 to 74 in 2018-19.

Northwest Engineering and Vehicle Technology Exchange (NEVTEX)

Central Oregon Community College and Rio Hondo College, Bend, OR and Whittier, CA
http://ate.is/NEVTEX

NEVTEX Develops Standards for Technicians of Electric-Drive Vehicles

West Coast automotive consumers' use of electric-drive vehicles has increased demand for technicians to maintain electric, hybrid, and hydrogen fuel-cell vehicles. These vehicles' use of high-voltage electricity or high-pressure gaseous fuels requires a dramatic redesign of automotive technician education programs.

NEVTEX is working with 30 industry and community college partners to create a standardized approach for training and certifying electric-drive vehicle technicians. Project leaders hope the standards will eventually lead to a licensing process for these highly skilled automotive technicians.

The project's outreach liaisons have talked about vehicle electrification careers with 5,500 students in Oregon and California; program enrollments are increasing.

Students at NEVTEX partner colleges learn to use analysis tools for predictive maintenance of hybrid vehicles.

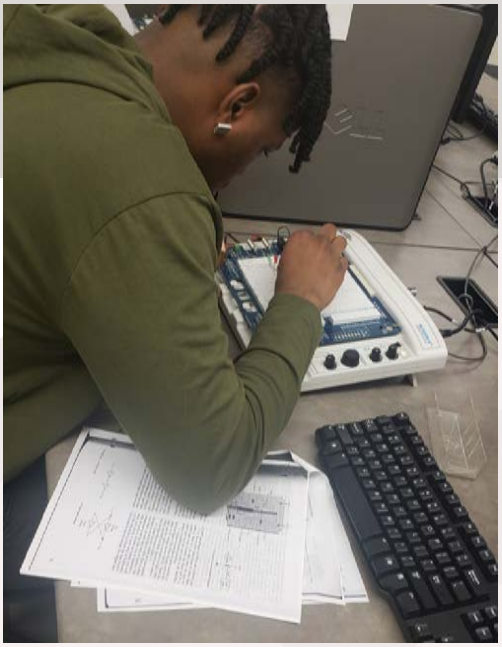
Skilled Technical Education & Experiential Learning (STEEL)

Albany Technical College, Albany, GA
http://ate.is/STEEL

Project-based, Online Course Introduces Students to Engineering Technology

To attract more students to engineering technology programs and help students enter the science, technology, engineering, art, and math technical workforce more quickly, STEEL has transformed Albany Technical College's Introduction to Engineering course into an online, project-based offering.

The project began pilot tests of the new seven-week course in fall 2019. The rubric for assessing real-life problems considers students' understanding of various concepts and the creativity of their solutions. The project-based course will eventually be taken by all of the technical college's students who enroll in civil, electrical, and computer engineering programs.



All engineering technology students at Albany Tech will eventually take the online, project-based Introduction to Engineering course.

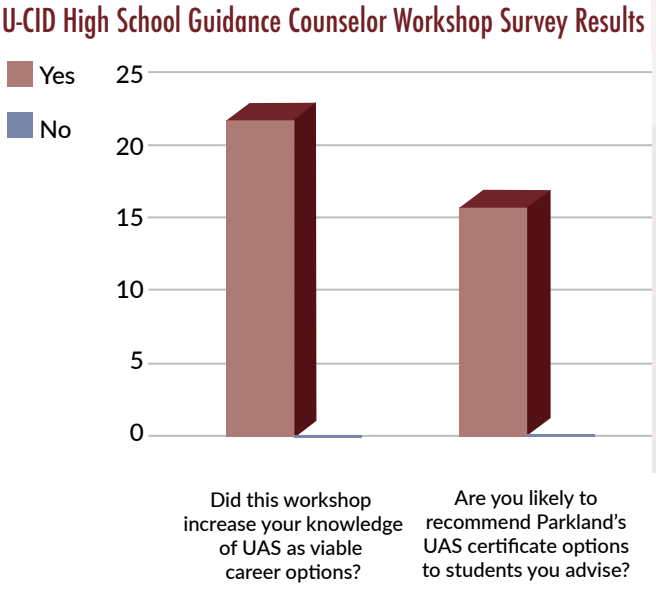
UAS Curriculum for Industry Demand (U-CID)

Parkland College, Champaign, IL
https://aviation.parkland.edu/EXPLORE/National-Science-Foundation

Students Gain UAS Skills for Multiple Industries

U-CID created two certificates to address the need for education in the rapidly expanding area of unmanned aircraft systems (UAS) in the Midwest. The new courses teach manual and autonomous flying of unmanned aircraft and prepare students to obtain commercial certifications. Students also learn to collect and apply data for agriculture, marketing, and insurance companies.

To advance its work as a model for other institutions, the project has implemented strategies to recruit and retain women and veterans. To increase awareness of UAS careers, the project has engaged with high school teachers, guidance counselors, and students.



All 22 workshop participants reported gaining knowledge about UAS careers; 16 indicated they would recommend Parkland College's UAS certificate program.

General Advanced Technological Education

http://ate.is/gen

General

ATE Central

Supporting Advanced Technological Education

Internet Scout Research Group, University of Wisconsin
Madison, WI

http://atecentral.net

"ATE Central helped us build relationships with the ATE community, which led to our bringing 25 faculty from Achieving the Dream institutions to the 2019 HI-TEC Conference. We look forward to continuing our partnership with ATE Central and the rest of the ATE community, and better supporting community college educators and students through that partnership."

Ryan Kelsey
Chief Strategy & Innovation Officer
Achieving the Dream, Inc.
Silver Spring, MD

ATE Central Promotes Knowledge-Sharing & Access

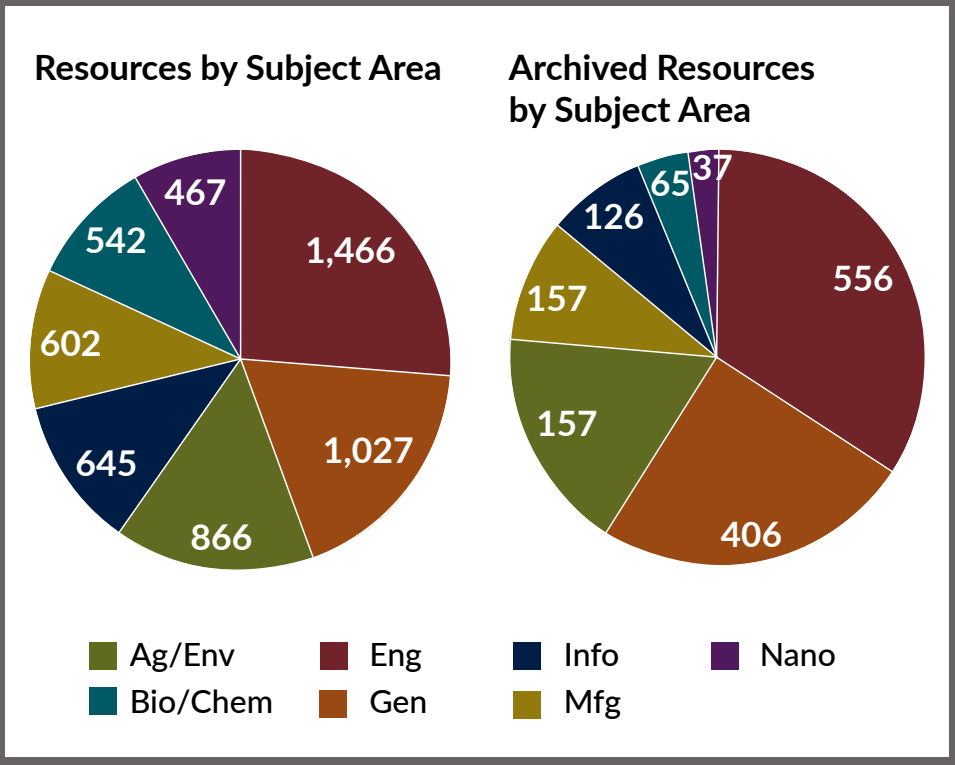
ATE Central shares resources and knowledge within and beyond ATE through a variety of pathways and project components.

Through webinars, a community-wide online chat service, a metadata-rich online collection, and the monthly *ATE Central Connection* newsletter, ATE Central's tools and services help push out resources and support dissemination to a host of stakeholders. Long-term access to ATE deliverables is provided via the ATE Central Archiving Service, ensuring that even after funding ends, curricula and other materials are available to educators to adapt and adopt.

Key Activities

- Amplifies the efforts of the ATE community through resource dissemination and knowledge-sharing.
- Ensures long-term access to ATE-developed materials through the ATE Central archiving service.
- Supports communication and community-building through online and in-person activities including workshops, webinars, and chat.

ATE Central's Collected and Archived Resources



The ATE Central resource collection showcases the valuable work of ATE, and archives grantees' work to help sustain NSF's investment.

ATE Central Supports Innovation & Collaboration

In its role as an information hub for the community, ATE Central helps educators and other stakeholders build on work created with ATE funding to support innovation in community college STEM programs. Through a diverse set of pathways, which include social media, webinars, publications, and the project website, ATE Central encourages educators to leverage and build on the work created within ATE, to benefit their institutions, programs, faculty, and students. ATE Central also works with organizations outside ATE, such as the American Association of Community Colleges and Achieving the Dream, to foster collaborations with ATE grantees and create partnerships and activities that benefit both communities.

Through its dissemination and outreach pathways, ATE Central highlights the impacts of the ATE program on students, faculty, and institutions.

ATE Central's resource collection ensures that educators have access to materials that can benefit students in a variety of settings.

DeafTEC

Technological Education Center for Deaf and Hard-of-Hearing Students

Rochester Institute of Technology
Rochester, NY

http://deaftec.org

"DeafTEC has been a key partner for Caterpillar in advancing our employment of individuals with disabilities. Our disability-inclusion-focused Employee Resource Group would not be where it is today without the collaboration of DeafTEC and their partner employers and schools."

Charles Golden, Abled & Disabled Employees Partnering Together (ADEPT) Global Chair
Caterpillar, Inc.
Peoria, IL

DeafTEC Helps Deaf/HH Students Prepare for STEM Careers

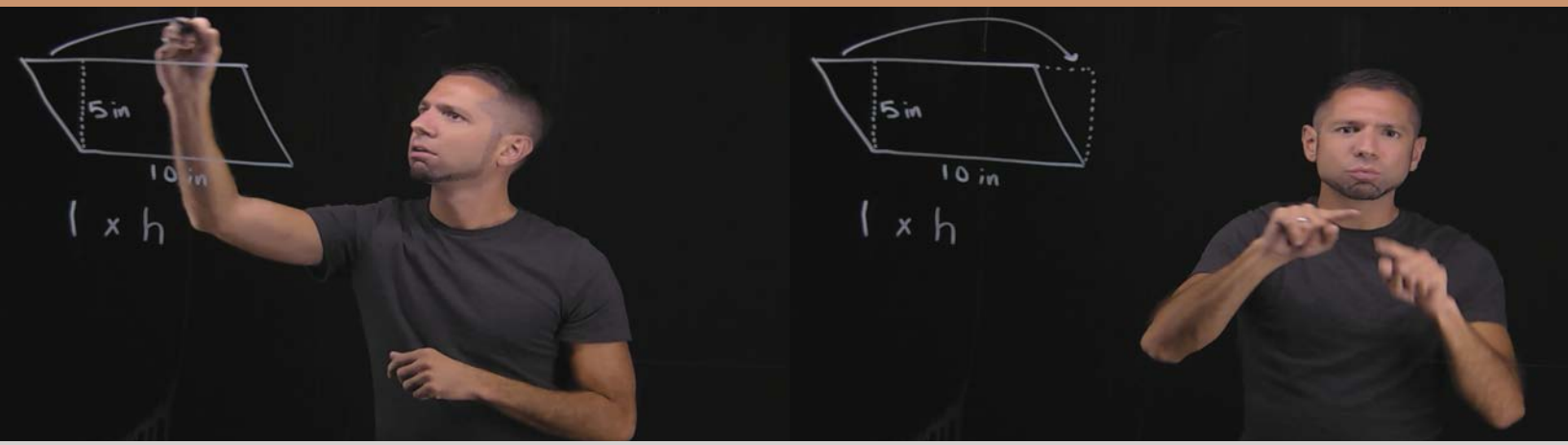
DeafTEC provides online STEM career awareness curriculum for deaf/hh middle and high school students. This four-unit, twenty-two lesson curriculum increases teachers' abilities to teach introductory STEM concepts. It is accompanied by videos of deaf/hh high school students interviewing deaf/hh college students in STEM majors about their experiences in college, why they chose that major, and the challenges that they have faced and overcome on their path to a STEM education.

DeafTEC offers job readiness curriculum for deaf/hh students that provides targeted assistance in preparing for a job: developing job search skills, writing resumes, and interviewing, as well as understanding workplace expectations, communication, and accommodations. This online course consists of nine self-paced modules. DeafTEC's other free digital resources include Working Together workshops, math tutorials, instructional best practices, STEM career information, and an American Sign Language STEM dictionary.

Key Activities

- Improves access to learning for deaf and hard-of-hearing (deaf/hh) students.
- Informs faculty about teaching student veterans with hearing loss.
- Offers online course to help employers develop inclusive workplaces.
- Leverages partnerships to broaden professional development opportunities for faculty.
- Provides online resources on best practices for teaching.

An applied computer technology student successfully builds a personal computer.



DeafTEC's remake of Khan Academy algebra videos in American Sign Language (ASL) improves access to online resources for deaf/hh students.

DeafTEC Professional Development Breaks Down Barriers

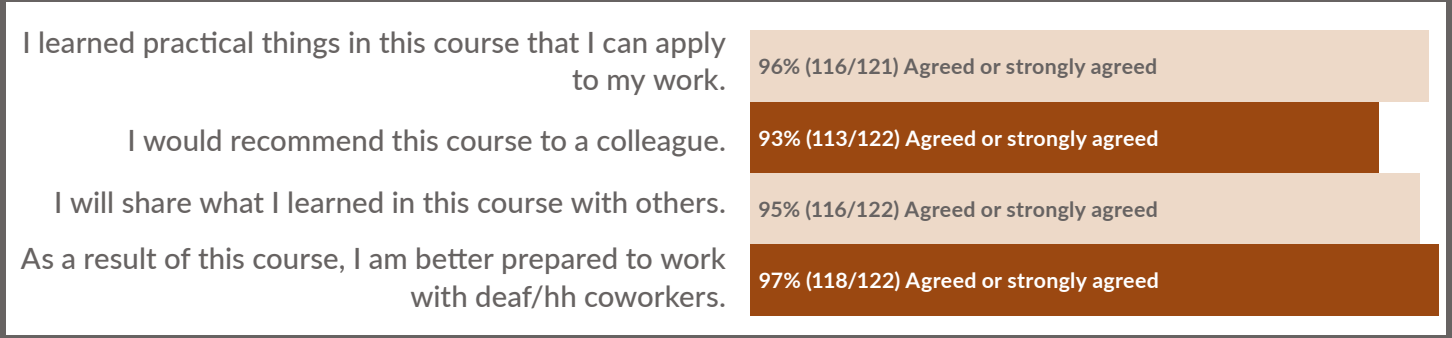
DeafTEC provides professional development on site and online for high school teachers, community college faculty, and employers to improve access to learning and STEM technician employment for deaf/hh individuals. DeafTEC also offers on-campus workshops aimed at improving instruction and services for student veterans with hearing loss. The workshops are customized to address the needs of students and faculty. By using pre-program surveys of student veterans, DeafTEC helps STEM faculty and disability services identify strategies that help bridge their efforts to address their student veterans' unmet needs.

DeafTEC partners with national conferences to broaden the understanding of how disability inclusion can build a stronger STEM workforce. In 2020, DeafTEC will send teams from 20 community colleges to the Equity and Excellence Access in High Education Conference. In 2021, DeafTEC will send six educators to participate in sessions with business diversity leaders at the Disability:IN Annual Conference & Expo.

DeafTEC Builds Khan Academy American Sign Language Demonstration Website

DeafTEC is partnering with Khan Academy to develop a model for online STEM instructional videos in American Sign Language (ASL). Making ASL an official language on Khan Academy will improve access and help lessen the achievement gap in mathematics for deaf/hh individuals.

Feedback from Online Working Together Participants: May 2018 to November 2019



People who took Online Working Together to improve interactions between deaf/hh people and coworkers in STEM workplaces gave it an average rating of 9.16 out of 10.

EvaluATE

Evaluation Hub for Advanced Technological Education

Western Michigan University
Kalamazoo, MI

http://evalu-ate.org

"In our work with the ATE community our evaluation company uses EvaluATE's website information and checklists in every evaluation. Through the center, we've fine-tuned our practice, and we watch the recorded webinars often. The center's staff [members] strive for excellence and they are highly knowledgeable and responsive."

Terryll Bailey, President
The Allison Group
Seattle, WA

EvaluATE Helps the ATE Community Leverage Evaluation to Enhance Project Impact

EvaluATE engages in an array of services and activities oriented to advancing evaluation knowledge, practice, and impact within the ATE program: coaching, webinars, workshops, videos, resource materials, newsletters, networking support, a community-driven blog, research on evaluation, and reports on the activities and achievements of ATE projects and centers.

Sound evaluation of ATE projects and centers provides NSF with evidence of their quality and outcomes. More importantly, effective evaluation supplies projects and centers with timely information they can use to enhance their activities and deepen impacts.

Key Activities

- Educates the ATE community and others about evaluation.
- Conducts research on ATE evaluation in order to advance practice.
- Fosters a network of ATE evaluation stakeholders to facilitate collaboration and peer learning.
- Collects and reports data on ATE program activities and achievements.

Evaluation produces accurate and useful information that improves a project while it is a work-in-progress.

EvaluATE's Research Builds Knowledge Base about Evaluation

Through four new research endeavors, EvaluATE is working to fill knowledge gaps about the practice and use of evaluation in ATE programs:

- What are the core tasks that evaluators and principal investigators engage in over the course of an evaluation? Who does what and what do they need to be able to do?
- How do project personnel navigate the pitfalls of securing evaluation services, especially when the expectations of their institutions, NSF, and evaluators may be at odds?
- How do ATE projects evaluate their work in terms of equity, diversity, and inclusion? What is their capacity to gather meaningful data related to NSF's important priority to broaden participation in STEM?
- The value of evaluation lies in its potential to produce accurate and useful information that improves a grant-funded initiative while it is a work-in-progress and to assess its impact. What does the use of evaluation look like in the ATE program? What makes an evaluation useful? Who uses evaluation results and how?

EvaluATE is using diverse methods and engaging research partners from across the ATE program to tackle these and other questions about evaluation practice and impact.

EvaluATE endeavors to strengthen evaluation in the ATE program to build a strong evidence base about outcomes and effective practices.

Key Areas of EvaluATE's Work

The four key areas of focus for EvaluATE are evaluation training, an evaluation network, research on evaluation, and the ATE Annual Survey.

Creating Technical Scholars (CTS)

Eastern Shore Community College, Melfa, VA
https://es.vccs.edu/academics/creating-technical-scholars

CTS recruits non-traditional students into technical studies and offers paid internships to encourage work-based learning.

CTS Creates Flexible Career Pathways in Rural Community

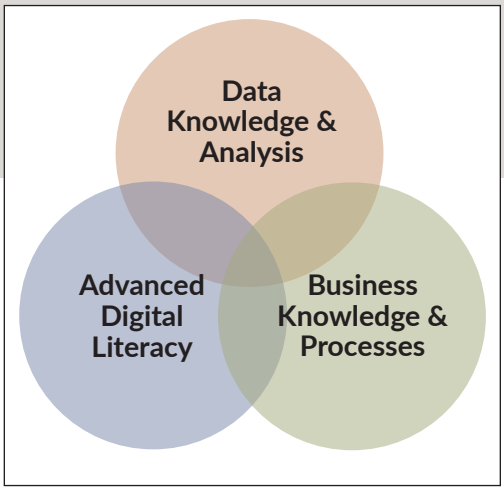
Since 2017 CTS has brought together local high-tech employers, school districts, and four-year institutions to create flexible career pathways with an emphasis on recruiting and retaining underrepresented populations.

The project fills a gap left by short-term training programs that have helped individuals obtain immediate employment, but that have not prepared people to earn degrees, which are often required for promotion to higher-paying jobs within particular trades.

Because the employer needs and demographics of the Eastern Shore align with other rural areas dealing with high poverty and unemployment, the pathways created serve as a model for other colleges.

Preparing Technicians for the Future of Work

Center for Occupational Research and Development (CORD), Waco, TX
http://preparingtechnicians.org



Employer and educator input influenced data gathering on these topics as the project identified key skills for STEM technicians.

Forward-thinking Project Identifies Technician Program Challenges

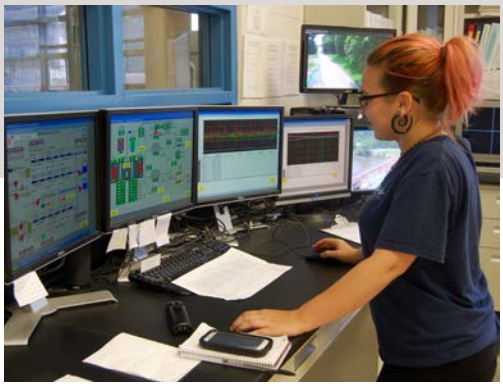
Preparing Technicians for the Future of Work explores the rapid evolution of advanced technologies and their implications for technician education, workforce development, and regional economies. It convened ATE center principal investigators and industry leaders to identify cross-cutting topics that associate degree programs must address as they prepare technicians for occupations that do not yet exist.

Ongoing activities include

- conducting industry visits to document the effects of emerging technologies on working technicians;
- holding special interest group meetings with industry and education leaders;
- convening regional meetings to determine the skills and knowledge technicians will need in the next decade; and
- producing podcasts on Future of Work issues.

Skilled Women Get STEM Jobs

Thaddeus Stevens College of Technology, Lancaster, PA
http://ate.is/SWSTEM



A water technology student gains experience with municipal water system operations during an internship.

Meeting Female Technicians Part of Recruitment Initiative

Skilled Women Get STEM Jobs focuses on increasing female enrollment in the computer integrated machining, electrical technology, and water and environmental technology programs. It is accomplishing this goal through partnerships with high schools and industry to increase awareness of STEM technical careers.

Since 2015 more than 350 young women have met female technicians during industry tours. As a result of seeing role models' work environments and other gender-diversity outreach initiatives, more females are participating in the targeted programs.

Recruitment for the computer integrated machining program has been particularly successful with female enrollment reaching a new high of 12% in fall 2019 when four women were enrolled.

Stairway to STEM

Pellet Productions, Reading, MA
https://stairwaytostem.org

Stairway to STEM Supports Autistic Students' Transitions to College & Career

Stairway to STEM is an online resource for autistic students / students on the spectrum, their parents, and postsecondary STEM educators. Its resources help students realize their capacity for success as they transition to college and STEM careers.

Hiring autistic contributors ensures Stairway to STEM's free blogs, videos, interviews, podcasts, and e-books meaningfully address the concerns of the autistic college transition community in STEM. Content is intended to help build the confidence, resiliency, and self-advocacy of autistic students.

More than 100 people attended the project's May 2019 conference, including autistic employee presenters from Microsoft. Stairway to STEM is a featured resource on Neurodiversity Hub, a global autism and workforce transition organization, and other organizations.

STAIRWAY TO STEM

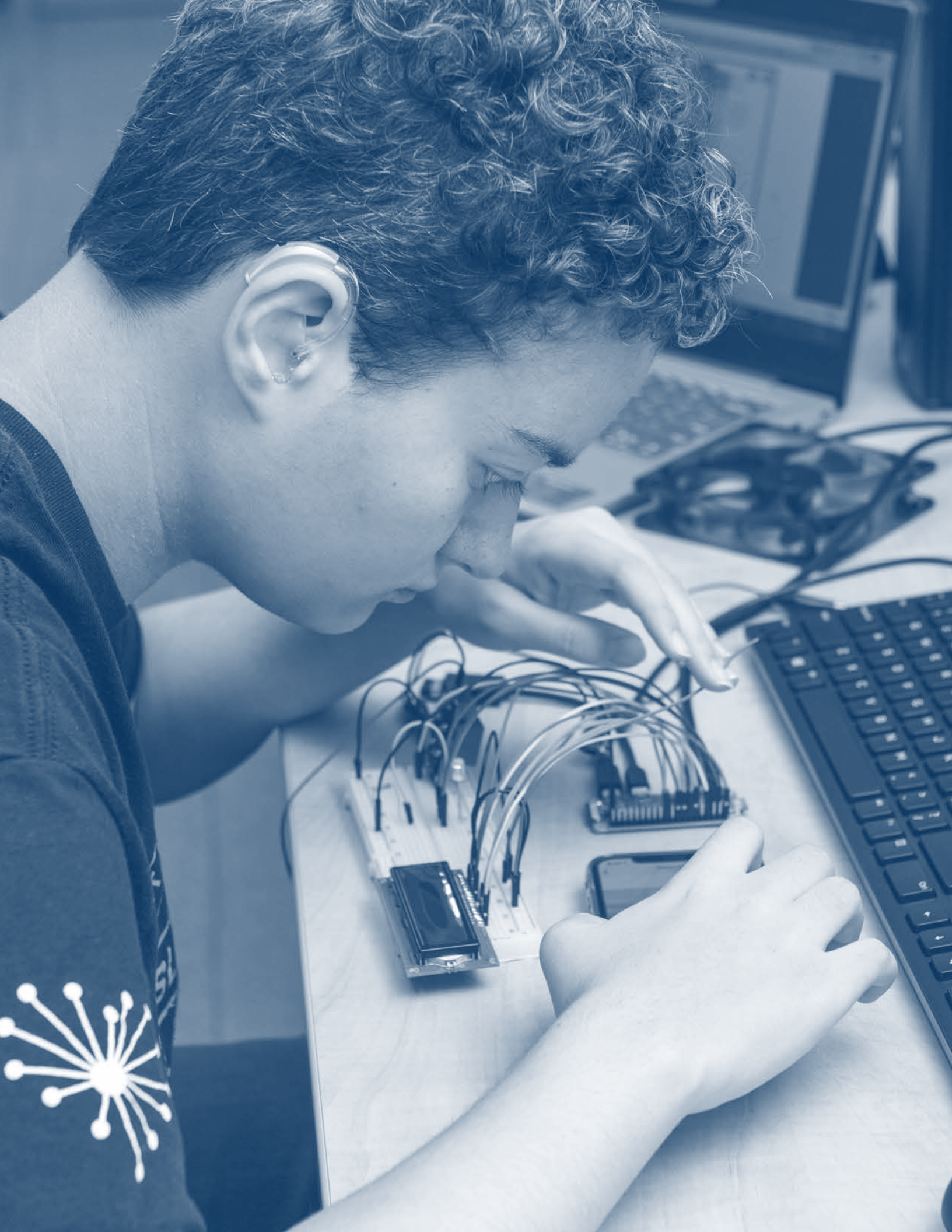
9,000+
Users

15,000
Sessions

35,000
Page Views

2,500
Users visited 15+ times

With nearly one-third of users returning to Stairway to STEM 15+ times, its free digital resources are impacting its audience.



Information and Security Technologies

http://ate.is/info

Info

CSSIA

Center for Systems Security and Information Assurance

Moraine Valley Community College
Palos Hills, IL

https://cssia.org

"The CSSIA team has been instrumental in assisting our institution in receiving the NSA CAE-CDE [National Security Agency designation as a National Center of Academic Excellence in Cyber Defense Education]."

Michael Qaissaunee, Professor & Chair
Engineering & Technology
Brookdale Community College
Middletown, NJ

CSSIA Helps Start & Strengthen Cybersecurity Programs

The center currently focuses on creating resources and mentoring programs to assist academic institutions as they start cybersecurity pathways or strengthen existing programs.

CSSIA
National Support Center for Systems Security and Information Assurance

The center's library of lab activities is used by more than 300 schools. The lab activities provide students with relevant experiential learning opportunities that expose them to the latest products, technologies, and threat scenarios.

The center participates in the NSF CyberCorps Scholarship for Service program, and encourages other community colleges to participate in it too. This NSF program provides talented community college students with tuition scholarships and stipends to attend school full time, to transfer to baccalaureate degree programs, and to gain employment with federal agencies.

Key Activities

- Recruits women and underrepresented minorities for cybersecurity careers.
- Develops new instructional materials and lab exercises.
- Mentors secondary school teachers and college educators.
- Develops national infrastructure for cybersecurity skill development with virtual labs.
- Operates a national cybersecurity faculty development academy.

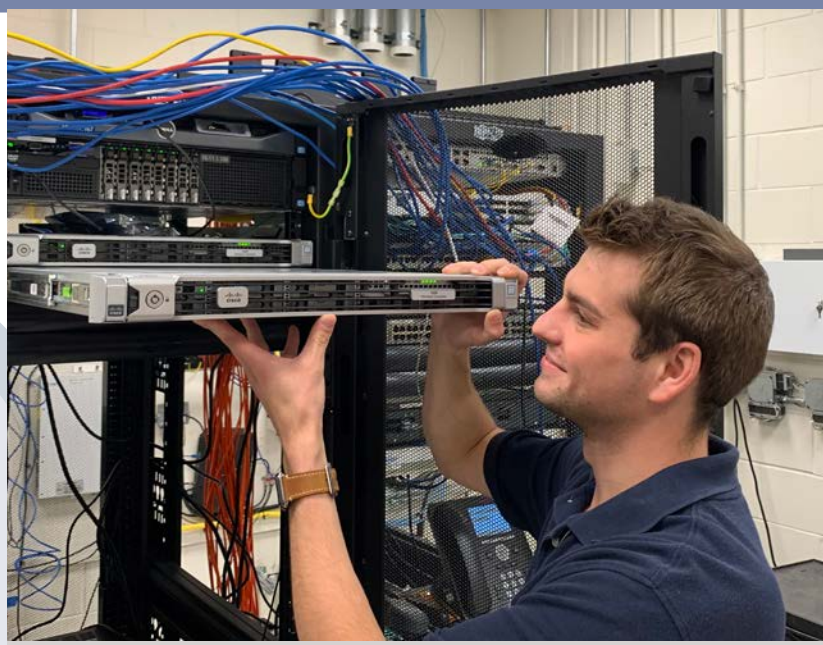
Students learn to master local area network technologies with instruction from CSSIA's curriculum.

CSSIA Studies Cybersecurity Workforce Questions

As an NSF ATE Center for more than 16 years, CSSIA has designed and implemented several workforce and industry research projects. All of these studies provide evidence of the cybersecurity skills and knowledge of community college graduates in an industry that has long prioritized hiring baccalaureate degree-holders.

These studies include an analysis of existing cybersecurity career pathways programs in seven states. It examined the successes, best practices, and challenges that communities face in developing effective career pathways in cybersecurity. The study revealed strong examples of dual credit, dual enrollment, and tech prep programs that provide K-12 students with robust career information and effective access options for pursuing careers in cybersecurity. The study also identified the challenges school districts face when implementing K-12 cybersecurity programs.

The center recently completed a community college cybersecurity workforce study. This study takes a close look at the job roles that community college graduates carry out. CSSIA plans to use this study to promote community college graduates with employers who have previously limited their cybersecurity hiring to baccalaureate degree-holders.



This CSSIA program graduate and many others manage companies' computer servers.

Most-Attended National Faculty Development Academy Courses

- *NetLab+ Instructor Administration*
- *NetLab+ Virtual Custom Environments*
- VMware vSphere ICM
- Orientation to Cybersecurity Careers

More than 150 educators took online courses from CSSIA's National Faculty Development Academy during the first eight months of 2019.

"CTC's BILT provides an excellent opportunity for me to help guide the nationwide development of two-year technology degrees that are increasingly, urgently needed for the multitude of open positions in the IT and cybersecurity fields."

Aaron Burciaga, Global Operations Director,
Data Science and Advanced Analytics
HCL America
Washington, DC

Working Connections Helps Faculty Teach New IT Technologies

Just since 2016 CTC has delivered eight intensive professional development events—called Working Connections—on 23 cutting-edge topics. The 258 faculty attendees have been from 107 colleges in 30 states. Most of the educators attended multiple events.

In a longitudinal survey conducted in 2019, 75% of the 222 faculty respondents reported that the Working Connections sessions they participated in between January 2016 and December 2018 focused on topics that they were not already teaching.

By providing faculty with easy access to top-notch programming about new IT technologies, CTC helps educators deliver new IT technologies to their classrooms and teach students skills they may not have otherwise been able to learn. Working Connections is now in its nineteenth year.

Key Activities

- Engages its Business and Industry Leadership Team (BILT) to co-lead all activities.
- Facilitates collaboration between 74 institutions to share curriculum and processes.
- Offers Working Connections professional development workshops for IT faculty.
- Leads development of seven regional education hubs to strengthen 2+2+2 articulation.

As a senior network engineer, a CTC program graduate manages a municipality's IT infrastructure.

CTC's BILT Model Provides Process for Innovation

At the request of its national Business Industry Leadership Team (BILT), CTC developed an employer-led course that uses hybrid cloud business problems to teach high-demand technical and employability skills. At the BILT's suggestion CTC staffers also developed e-portfolio exercises for existing IT courses. In fall 2019, 62 students at six colleges were testing the e-portfolios' value for demonstrating expertise at job interviews.

CTC's Convergence College Network (CCN), a community of practice, continues to gather information about institutional challenges to implementation of the "BILT model" in order to formulate strategies to overcome them. CTC developed the BILT and promotes its use for engaging business leaders as co-leaders of academic programs through quarterly meetings and annual job skills updates.

CTC has disseminated information about the BILT model to more than 1,000 people at 22 education conferences since 2015. Colleges are now using BILTs to strengthen existing programs, to develop new programs, or to align curricula with workforce needs.

BILT adopters include Maricopa Community College (AZ); Northeast Iowa Community College; Luzerne County Community College (PA); Central Community College (NE); and Forsyth Technical Community College (NC).

Students practice wireless networking skills in a CTC-supported cloud classroom lab.

CTC Working Connections Outcomes 2016-2018

943

Courses Impacted

64

New Programs Created

Working Connections professional development events have directly influenced information technology classroom instruction and creation of new programs.

GeoTech Center

National Geospatial Technology Center of Excellence

Jefferson Community and Technical College
Louisville, KY

http://geotechcenter.org

"The GeoTech Center has been a focused, respected, and innovative force that has positively impacted educators, researchers, and administrators not only in community colleges, but throughout higher education as well as in informal and K-12 education by promoting, supporting, and advancing the application of geospatial technologies."

Joseph Kerski, Education Manager
Esri
Broomfield, CO

Center's Test of Geospatial Educator Credential Underway

Educators who teach geospatial technology are increasingly being asked to provide evidence of their competence, qualifications, and expertise, by principals and superintendents. In response, the GeoTech Center hosted a forum where subject-matter experts explored the feasibility of developing a geospatial technology educator certification program.

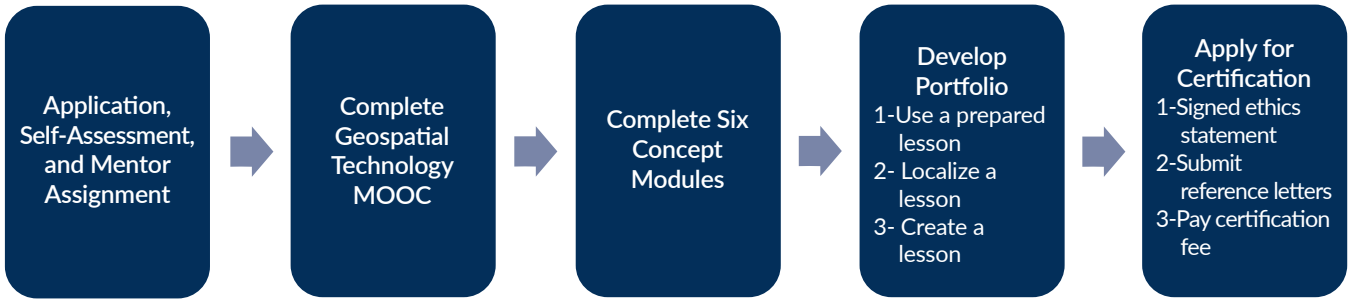
A pilot project is now delineating a pathway for geospatial educator certification. Twenty educators will complete the pilot study and provide feedback after each step in the pathway. A post-pilot forum will be convened to determine if a geospatial technology educator certification is needed and, if it is, to finalize the steps of the certification pathway.

Key Activities

- Develops geospatial technology standards, curriculum, modules, and teacher certification.
- Offers professional development for educators and geospatial professionals.
- Provides unmanned aerial vehicle DACUMs (Developing A Curriculum) and revised meta-DACUMs in geospatial technology.
- Maintains a national database of geospatial programs.

Palomar College students practice flying a four-rotator unmanned aerial vehicle equipped with a camera.

Geospatial Technology Educator Certification Process



GeoTech is testing each facet of the certification process it developed for geospatial technology instructors.

GeoTech Offers Wide Range of Professional Development Opportunities

GeoTech's professional development activities include exploratoriums, single-concept regional workshops, and direct mentoring of individual educators. Center leaders also share their knowledge at professional organizations' workshops and conferences.

The GeoEd Exploratorium is a three-day event where government employees, geospatial technicians from the private sector, as well as educators from secondary and postsecondary sectors come to learn from geospatial technology experts. The mix of participants enriches the learning experiences for all and expands networking opportunities.

GeoTech's regional workshops utilize the standards-based curriculum developed by the center. At the workshops, participants have the opportunity to explore introductory to advanced geospatial concepts. More than 150 educators attended the 2019 workshops at San Diego State University (CA), Parkland College (IL), Mountwest Community and Technical College (WV), and Lane Community College (OR).

In addition to formal learning experiences, GeoTech has developed numerous vendor-neutral concept modules that can be accessed from its website.

The center provides mentors to assist faculty beginning geospatial technology courses; revising existing courses; developing or realigning a certificate program; integrating geospatial technologies into other STEM courses; or implementing micro-credentials.

Educators at a GeoTech workshop prepare for controlled flights of unmanned aerial vehicles.

"The National CyberWatch curriculum guidelines were a key influence on our degree. Our desire was to create a general cybersecurity degree with a smaller core and room for specialization among the electives. We also created pathways within the electives."

Cara Tang, Instructor & Department Chair
Computer Information Systems
Portland Community College
Portland, OR

National Cybersecurity Student Association Grows

Launched in 2015, the National Cybersecurity Student Association (NCSA) is a one-stop shop created to enhance the educational and professional development of cybersecurity students through events, networking opportunities, and collaboration.

NCSA membership has increased 500% in one year with 260+ colleges and universities joining in 2019.

As of September 2019, NCSA had 2,224 members in chapters at 474 colleges and universities in all 50 states and 10 countries. The association supports the cybersecurity educational programs of academic institutions, inspires career awareness, and encourages creative efforts to increase the number of graduates in the field.

Key Activities

- Collaborates with industry, academia, and government agencies to strengthen the national cybersecurity workforce.
- Sets cybersecurity educational and assessment standards.
- Develops new skills-based curricula tied to job classifications, professional certifications, and competency frameworks.

Students discuss strategies with industry advisors at the Mid-Atlantic College Cyber Defense Competition.

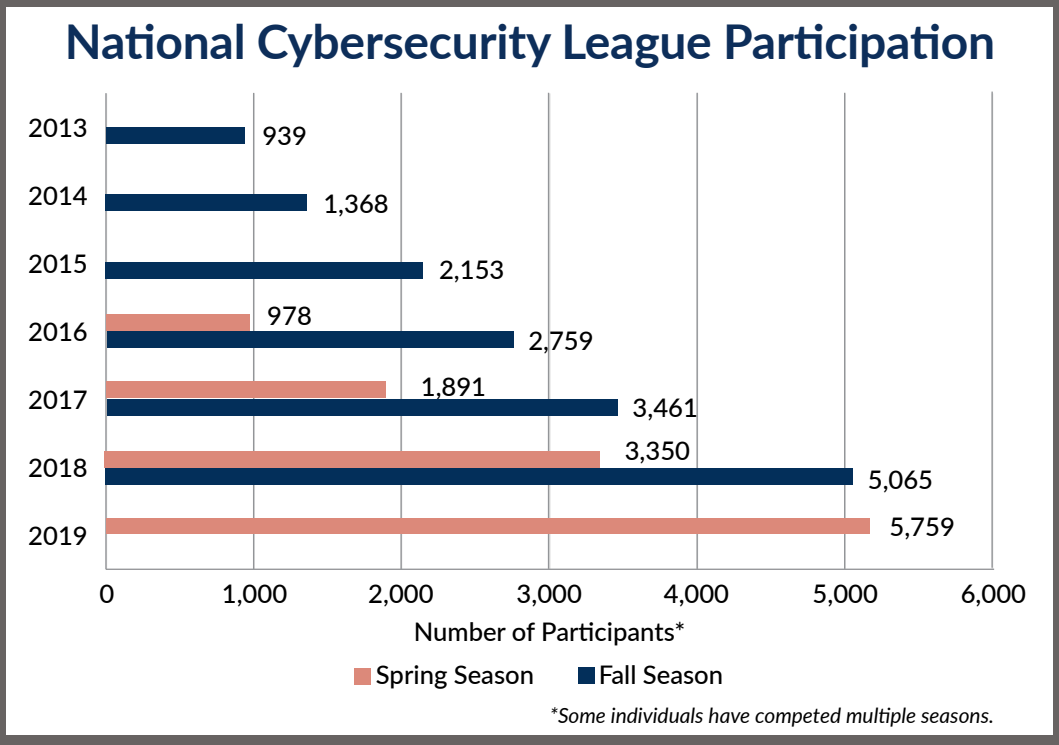
Skill Up to Scale Up Mitigates Skills Gap

A major contributor to the cybersecurity labor shortage is the lack of mature information security capabilities among the incumbent information technology (IT) workforce. When properly educated and mentored, incumbent technicians can be transitioned into high-skill cybersecurity specialist responsibilities.

To deploy the institutional knowledge of incumbent IT technicians with up-to-date cybersecurity tactics, techniques, and procedures, NCC launched Skill Up to Scale Up in 2019. This accelerated learning program leverages NCC's competency-based, assessment-driven, and accelerated performance training systems.

By raising the information security capability of incumbent technicians, these individuals are able to mentor entry-level workers and pre-apprentices. NCC industry partners have identified strengthening incumbent technicians' skills and improving how novices start as essential for the stable growth of cybersecurity career pathways.

Cybersecurity students talk with potential employers at the Community College Cyber Summit (3CS) Student Job Fair.



Increased student participation in the National Cyber League means more qualified information security technicians in the workforce.

Cybersecurity Skills Journal Aims to Raise Workforce Capability

National CyberWatch's *Cybersecurity Skills Journal: Practice and Research* (CSJ) is the world's first double-blind, peer-reviewed journal dedicated to the scholarly analysis of cybersecurity education and professional practice. Its free, open source articles are supplemented with practice artifacts, such as lab exercises, that can be purchased.

"Being funded by CyberWatch West [now NCyTE] to attend the Women in Cyber Security conference was of huge benefit for me. Because of opportunities like this one, I am able to further excel in my career by making connections in the field of cyber. Thank you."

Amber Blair, Student
Whatcom Community College
Bellingham, WA

Workshops Help Faculty Update Courses Quickly

Governance, Risk Management, & Compliance workshops were conducted in six different regions around the country and online for community college faculty. More than 60 faculty members received instruction and materials on incorporating these key aspects into existing technology courses. Workshop materials may be downloaded from NCyTE's website.

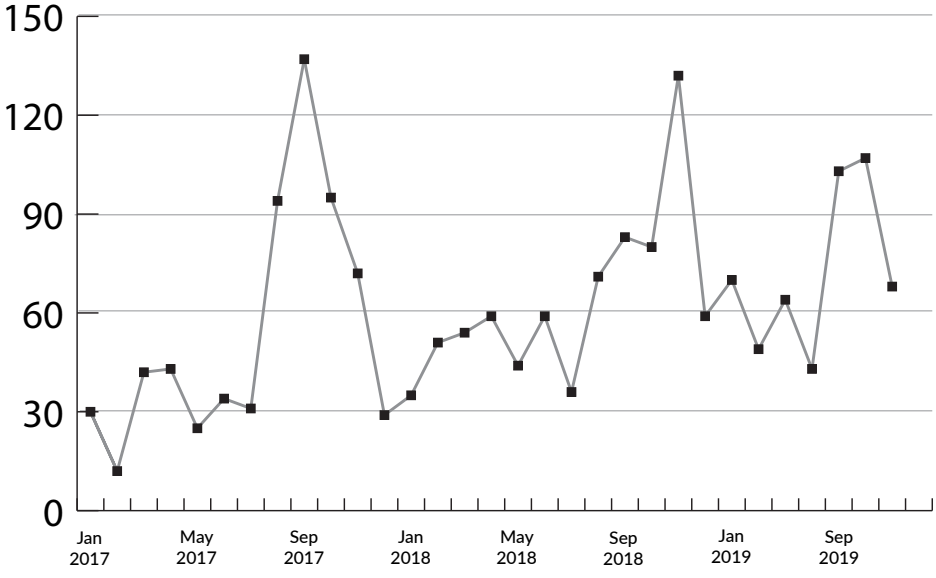
Recruitment Programs Build Future Workforce

To attract young people to cybersecurity careers, NCyTE supports

- Girl Scout Badge Days;
- Girl Power workshops at the Mescalero Apache Reservation;
- Women in Cyber Security conference travel stipends for students; and
- National Cyber League, Western & Pacific Rim Regional Collegiate Cyber Defense Competitions, and CyberPatriot Cyber Defense Competitions.

Key Activities

- Provides mentoring, technical assistance, and leadership training to improve cybersecurity education.
- Disseminates cybersecurity curricula.
- Offers professional development for faculty.
- Sponsors industry events and hosts virtual career fairs that support student-employer connections, as well as regional workforce and economic development.



NCyTE's strong and timely cybersecurity curricula resources enable faculty to adjust courses in response to changes in technology.

NCyTE Events Connect Industry Partners & Educators

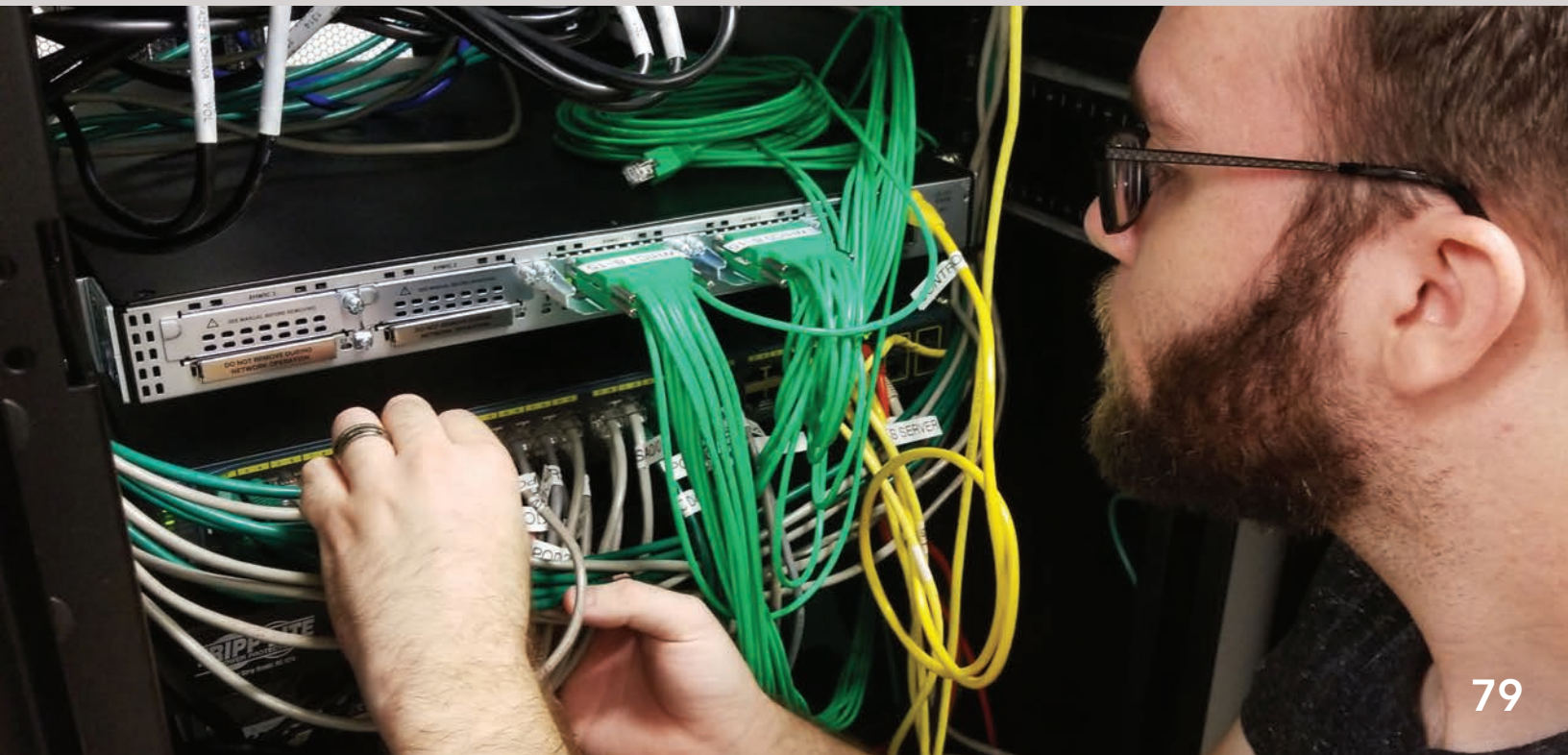
For three years in a row, NCyTE has served as a partner and host of the successful Virtual Career Fair with the Center of Academic Excellence (CAE) community. Participation in this event has increased each year with more than 1,800 cybersecurity students and graduates participating in 2019. The fair connects students with internships and jobs for technicians and other higher-level positions at companies and government agencies across the nation.

NCyTE's educational membership has grown from 40 colleges in 2014 to more than 200 high schools and colleges in September 2019. This growth reflects the demand for rigorous cybersecurity curricula and up-to-date resources. NCyTE members access professional development opportunities, utilize model curricula, and network with employers at industry events.

NCyTE sparks interest in cybersecurity with Girl Scout Badge Day and Cyber Girls programs.

NCyTE has developed a replicable model for industry events where students and educators meet representatives of regional educational institutions, government agencies, and cybersecurity employers. The 10 networking events NCyTE has sponsored have helped educators keep up with rapidly evolving cybersecurity skills and knowledge. These meetings have also facilitated participants' efforts on shared workforce development goals and employment connections.

NCyTE disseminates curricula that introduce cybersecurity skills in networking courses.



Natives in Cybersecurity Education (NICE)

Turtle Mountain Community College, Belcourt, ND
https://tmcccyber.com

The NICE project improves information assurance education at tribal colleges and encourages Native Americans, women, and veterans to pursue cybersecurity careers.

NICE Project Prepares Native Americans for Cybersecurity Careers

The NICE project teaches cybersecurity skills to members of the Turtle Mountain Tribe.

The cybersecurity AAS degree that project leaders developed with the five-institution Northern Information Technology Consortium is designed for adaptation by other tribal colleges. The project also partners with TestOut for online labs that give students hands-on cybersecurity experiences in safe, simulated environments. The labs prepare students for industry-recognized certification exams.

Nine students took the project's first cybersecurity course in spring 2019. Four female and four male students—chosen from local high schools based on their interest in earning cybersecurity degrees—and two instructors learned cyberdefense skills sought by employers during a week-long Cyber Patriot camp at Bismarck State College in summer 2019.

Pathways to Geospatial Technology and Careers (PGTC)

Bronx Community College, Bronx, NY
http://ate.is/PGTC

Project Creates Geospatial Pathways & Careers in Metro New York City

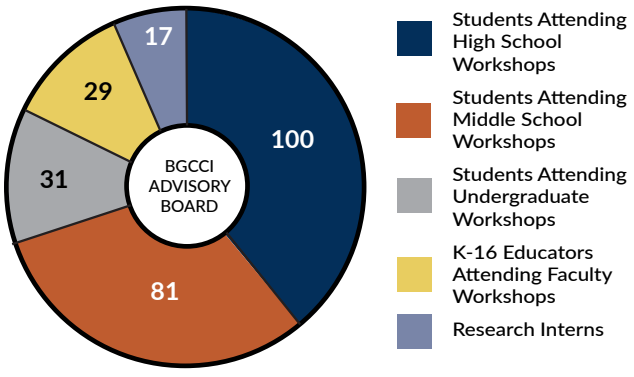
PGTC creates skilled geospatial technicians by offering inquiry-based, year-round workshops, professional development programs, and workforce-focused research internships for underrepresented students and educators from schools and colleges in the New York City region.

Geospatial experts from a dozen leading companies deliver guest workshops, host brown bag lunch sessions, and offer internships to undergraduates and high school students.

Since 2017, 229 students from middle schools, high schools, and undergraduate institutions, and 29 educators from schools and colleges have been exposed to geo-analytics and cutting-edge research.

All PGTC activities are conducted at the Bronx Community College Geospatial Center of the City University of New York CREST Institute, a state-of-the-art geospatial computer facility.

PGTC Program Participation 2017 to August 2019



PGTC's collaborations with ESRI, Harris, NASA, Digital Globe, Langan, HERE, and Open support and facilitate all its programs.

RoadMAPPS to Careers

National Technical Institute for the Deaf (NTID) at Rochester Institute of Technology, Rochester, NY
http://ate.is/RoadMAPPS

RoadMAPPS Puts Students on Track for App Development Careers

The RoadMAPPS to Careers project helps deaf-and-hard-of-hearing (deaf/hh) people begin careers producing apps or pursue bachelor's degrees in web and mobile computing.

Project leaders worked with business partners to create a capstone course experience and help prepare students for co-op work opportunities. Multiple apps designed and developed by students for their capstone projects have been published via the Apple and Android stores.

More than 400 deaf/hh teens have attended summer camps to explore mobile app development careers. Outreach activities with incoming NTID students are also fueling interest in the five-semester program, which had its first two graduates in 2018.

A student works on a RoadMAPPS to Careers capstone project—a mobile greenhouse control.

Simul-ATE

Orangeburg-Calhoun Technical College, Orangeburg, SC
http://ate.is/Simul-ATE

Cross-discipline Teamwork Prepares Students for STEM Workplaces

The Simul-ATE project uses a cross-disciplinary approach to teach transportation, distribution, and logistics (TDL) and advanced manufacturing. Having students work on projects with other students in computer technology, management, and accounting programs enables everyone to learn the problem-solving, teamwork, and communication skills that employers expect.

Project-supported upgrades to the college's simulated production line have also enhanced mechatronics instruction, particularly in management and control systems.

Outreach to secondary school career counselors and teachers about the total supply chain process equips them to direct eighth grade students and others to career paths that involve not only TDL and modern manufacturing, but also supply chain management and accounting.

Eighth Grader Participation in Simul-ATE Workshops

	Attended	Male	Female	Black/African American	White	Asian/Pacific Islander	American Indian	Hispanic/ Latino	Other
8th Grade Workshops	160	44%	56%	66.4%	17.60%	5.60%	0.80%	6.40%	3.20%

To promote TDL careers among underserved populations the project offers on-campus workshops in manufacturing, engineering graphics, and TDL.


NaBH4

Micro and Nanotechnologies

http://ate.is/nano

Nano

NACK Support Center

Nanotechnology Applications and Career Knowledge Support Center

Penn State University
University Park, PA

http://nano4me.org

"[NACK] resources allow me to believe that what I'm doing in the classroom is a good start. The different educator workshops I have attended are helping me build confidence and be more comfortable in teaching nanotechnology with more depth than before."

Sara Chen, Teacher
South River High School
Edgewater, MD

Webinars Deliver Diverse Nano Topics

NACK sponsored and supported the delivery of twelve 90-minute webinars designed specifically for educators to learn more about nanotechnology-related topics. Subjects range from in-depth looks at nanocharacterization tools to new developments in nanotechnology manufacturing and research.

The educator-targeted content includes strategies for building nanotech programs within colleges and advice on resources to use in classrooms.

These webinars were offered live and then archived for viewing via NACK's website. Since 2016, more than 600 people from approximately 18 different countries have attended these webinars live. More than 1,250 viewers have watched webinars from the center's online archive.

Key Activities

- Encourages inclusion of underrepresented minorities in nanotechnology workforce development partnerships.
- Expands development of international nanotechnology skill standards.
- Increases partnerships that facilitate access to remote nanotechnology educational equipment.
- Cultivates diversified modes of dissemination of nanotechnology course materials.

NACK's education program aspires to engage underrepresented undergraduate students.

NACK and ASTM Offer Stackable Certificates

After finalizing the six ASTM standards for nanotechnology education based on NACK's industry-approved core skills, NACK and ASTM International have been developing programs that award stackable certificates for individuals entering the nanotechnology workforce. Two new certifications—Health and Safety in Nanotechnology and Nanotechnology Workforce Characterization—became available in 2019. Two more are scheduled for release in 2020. These certificates will provide employers with a benchmark for evaluating the skills and qualifications of their staff members. People who earn these certificates will be able to differentiate themselves within the employment marketplace.

NACK Webinar Data
2016-2019

12
Webinars

600+
Attendees during live broadcasts

1,250+
Viewers of archived webinars

NACK's live and archived webinars teach viewers nanotech concepts and cross-discipline applications.

RAIN Network Continues to Grow

Recent studies by partners of the Remotely Accessible Instruments for Nanotechnology (RAIN) Network have found that RAIN sessions increased interest in science among underrepresented students who previously had no plans to pursue science degrees. RAIN provides educators with web access to state-of-the-art nanocharacterization and nanofabrication tools. Continued growth in 2019 brings the network to 23 universities, colleges, and a K-12 cooperative extension service. RAIN has hosted more than 300 sessions attended by 5,600 students.

A NACK program alumnus excels as a laboratory teaching assistant.

"Nano-Link and the Nano infusion modules represent innovating tools that have motivated my students to learn and understand the importance of nanotechnology, also improving their science literacy ... and establishing an undeniable commitment to their own process of acquiring science knowledge in every activity."

Rodfal Alberto Rodriquez Delgado, Teacher
Cupey Maria Montessori School
San Juan, Puerto Rico

Nanoscience Knowledge Grows in Puerto Rico with Nano-Link Resources

Eight Nano-Link modules have been translated into Spanish, which has been instrumental in the modules being used in Hispanic communities.

There is a particularly engaged audience of module users in Puerto Rico where Nano-Link began outreach efforts in 2018. Two teachers at Cupey Maria Montessori School in San Juan, Puerto Rico, completed Nano-Link's professional development to become emerging technology coaches who educate other educators about nanoscience. Thanks to their efforts more than 60 educators and administrators in Puerto Rico use Nano-Link's modules.

In 2019 Cupey Maria Montessori School began offering an Advanced Placement Nanoscience course to its high school students with Nano-Link's help and resources.

Key Activities

- Delivers modules on nanobiotech, nanomaterials, chemistry, and electronics that feature hands-on activities.
- Provides faculty professional development on Nano-Infusion modules and the science behind them.
- Prepares educators to serve as emerging technology coaches who instruct other educators.

A nanoscience technology student measures chemicals to make silver nanoparticles.

Nano-Link Helps Faculty Infuse Nanotech Knowledge in Courses

Nano-Link provides educators with the resources and support to add nanotechnology to college or high school courses.

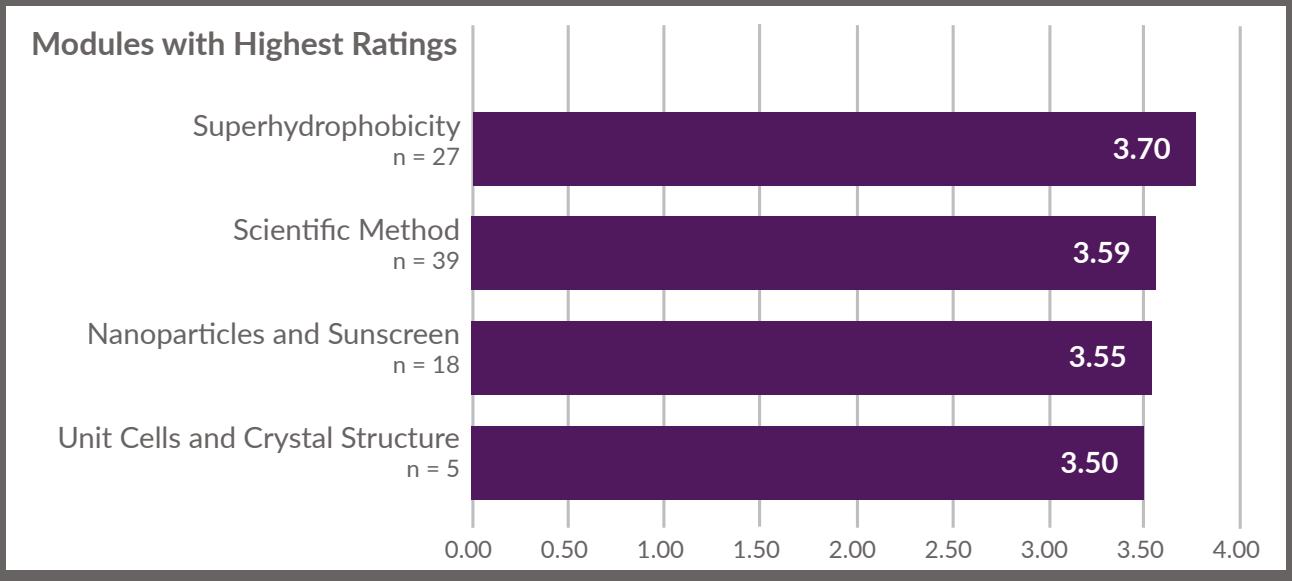
Nano-Link offers two types of modularized content via its website. The eight Nano-Infusion modules are each designed to be completed in one class period with kits that Nano-Link supplies for free. Ten do-it-yourself (DIY) modules are more complex. The DIY modules' hands-on activities require equipment and come with a list of supplies and sources for the items. These modules also come with educator guides, activity flow chart, slides, and procedure descriptions for the hands-on activities.

Nano-Link offers on-site workshops for groups of educators to learn how to use the Nano-Infusion modules. These six-to-eight hour sessions teach the science behind the modules. As of fall 2019, 588 instructors and administrators have participated in these professional development programs.

A nanoscience technology program graduate uses a scanning electron microscope for process engineering tasks at AVEKA.

Nano-Link also prepares educators to serve as emerging technology coaches who lead Nano-Link training programs for community college and high school educators. Eight coaches currently focus on reaching underrepresented populations in STEM fields.

Teacher Self-Reported Understanding & Ability to Teach Module Concepts



All 142 teachers who responded to a Nano-Link survey reported the center's modules supported improved understanding and ability to teach nanotechnology concepts.

"NEATEC workshops contributed to me being hired in an amazing position in thin films technology. I look forward to learning more with NEATEC, and I definitely recommend these workshops to anyone pursuing a career in nanotechnology."

Terrance Barker, Cleanroom Technician
GlobalFoundries
Malta, NY

NEATEC Facilitates NIST Internships for Two-Year College Students

Thanks to NEATEC's partnership with the National Institute of Standards and Technology (NIST) each year since 2014, nine students from two-year colleges across the US have had the opportunity to intern at the agency's headquarters in Gaithersburg, MD.

During the paid 16-week internships the students receive mentoring from NIST scientists and engineers as they gain experience using cleanroom tools and running nanotech processes at the agency's prestigious laboratory.

The 39 students who completed internships between 2014 and 2019 all received excellent job offers. Given the program's success, NEATEC is working to add more federal agencies as internship sites in 2020.

Key Activities

- Offers in-person and online nanotech courses for students.
- Places students in paid internships.
- Provides professional development for educators to embed nanotechnology modules in high school and community college courses.
- Offers workshops to new employees of semiconductor manufacturers.

A community college student interning at NIST uses an electron microscope to check the pattern of a semiconductor wafer.

NEATEC Creates New Semiconductor Technician Certificate Program with SEMI

NEATEC and SEMI, the global Semiconductor Industry and Standards Association, are partnering to develop a credentialing process to certify the skills of technicians from a wide array of technical backgrounds for employment in the nanotech and semiconductor industries. NEATEC is initiating this process by analyzing the courses at 18 community colleges and high school technician education programs. SEMI will develop certifications utilizing industry input and skill standards based in part on those developed by the Maricopa Advanced Technology Education Center.

NEATEC Boosts New Technicians' Skills

To help with the rapid growth of GlobalFoundries' workforce in the Northeast US, NEATEC provides five-day workshops for the semiconductor manufacturer's new employees. Lessons in mechatronics, vacuum technologies, and basic electrical components are taught to GlobalFoundries' entry-level technicians at NEATEC's SUNY Polytechnic labs.

NEATEC Helps Soldiers Transition to Advanced Technology Careers

NEATEC expanded its workshops at the US Army's Fort Drum in Watertown, NY, from three to five days. The longer workshops give soldiers who are transitioning to the civilian workforce more hands-on experience with advanced manufacturing processes in NEATEC's satellite facility in rural Jefferson County. The soldiers also tour high-tech companies.

This Hudson Valley Community College student works as a cleanroom technician at SUNY Polytechnic Institute.

NEATEC Impacts 2016-2019

150 students
Interned at NIST and SUNY Polytechnic Institute

350 high school teachers
Learned to use NEATEC modules

700 GlobalFoundries technicians
Instructed as they began work

NEATEC grows the nanotech workforce with multi-faceted programs for students, educators, and technicians.

"It is great to have your educational materials. I don't have to dream them up myself, which gives me more time to work on other educational avenues for my students."

Tom Lieurance, Instructor
Renewable Energy Technology
Columbia Gorge Community College
The Dalles, OR

SCME Takes Microsystems Education to Diverse Audiences

SCME expands knowledge of microsystems through its downloadable online educational materials, its YouTube videos, and its in-person cleanroom workshops for faculty and students.

The center's online offerings include 20 new asynchronous courses in microelectromechanical systems (MEMS) and BioMEMS foundations. By 2021, SCME plans to have a total of 48 short MEMS courses online. With 500 active faculty users of SCME resources, center leaders hope to impact the education of 20,000 students each year.

SCME also supports the integration and advancement of BioMEMS education at Lone Star College. More than 200 students have participated in pilot tests of MEMS in biotech courses there since 2018.

Key Activities

- Leads Micro Nano Technology Education Special Interest Group.
- Provides online short courses and hands-on cleanroom workshops.
- Provides faculty mentoring, and access to micro and nanotechnology partnerships.
- Integrates microsystems into biotech programs at Lone Star College.

Lone Star College biotech students explore the concepts covered in SCME's nanopore-based DNA sequencing kit.

Community of Practice & New Certificates Address Workforce Needs

SCME supports the Micro Nano Technology Education Special Interest Group (MNTeSIG), a collaboratory that has evolved into a community of practice. Its goal is to foster collaboration between educators, industry, and agencies for ongoing improvement of the micro and nanotechnology workforce.

In fall 2019 MNTeSIG had 125 active members. They included educators from every sector and a growing contingent of industry people. Participants meet monthly online (https://mntesig.net) and face-to-face once a year to learn from each other in order to improve and promulgate micro and nanotechnology education.

In addition to creating innovative, online short courses, SCME continues to develop the workforce by providing educators with classroom kits, professional development, and mentoring opportunities.

Advice from SCME's industry advisory board—with representatives from Honeywell, Texas Instruments, NXP, HT Micro, 3D Glass, Sandia National Laboratories—led to development of a new four-certificate program. The certificates in BioMEMS, MEMS foundations, MEMS fabrication, and MEMS applications have the support of the Association of Technology, Management, and Applied Engineering (ATMAE). These certificates will improve the marketability of students and industry technicians alike.

SCME YouTube Channel Data February 2012 to October 2019

56 SCME-created videos on micro and nanotechnology

3,000 Subscribers

863,359 Views

2.2 Million minutes of viewing

The majority of the SCME YouTube channel viewers are 18 to 24 years old, and are mostly from the US and India.

Students and faculty work together to fabricate a micro-pressure sensor during an SCME workshop.

Nanotechnology Professional Development Partnership (NPDP)

Penn State University, University Park, PA
https://nano4me.org/workshops

NPDP Makes Educator Workshops More Accessible

The Center for Nanotechnology Education and Utilization's Nanotechnology Professional Development Partnership (NPDP) project reinvented the traditional onsite workshops on nanotechnology to make them more accessible and affordable to educators across the country.

The workshops combine live-stream lectures, remote-access laboratory demonstrations, open-discussion sessions, and web-accessible supplemental materials to help faculty and administrators start nanotechnology programs at their institutions without the burden of travel.

The workshops were developed by Penn State faculty with the assistance of educators at the partnership's most active colleges: Erie Community College, Ivy Tech Community College, North Seattle College, Salt Lake Community College, Pasadena City College, and Northwest Vista College.

NPDP Workshop Data 2018 & 2019

100+
Participants

4
Introduction to Nanotechnology for Educators Workshops

4
Nano Curriculum Materials Workshops

Fourteen educators were awarded travel scholarships to attend hands-on nanotech labs at NPDP partner colleges.

UVUNanotech

Utah Valley University, Orem, UT
https://uvu.edu/physics/nanotech

Students Help Develop Nanotech Course

Students at Utah Valley University have been involved from inception and planning to development and testing of the UVUNanotech project's new nanotechnology course curriculum, textbook content, labs, and virtual reality (VR) modules. They instituted a successful in-simulation VR instructional menu system. Students have given presentations about their contributions to the project at local, regional, and national conferences. Students also assist with teaching nanotechnology to their peers.

In addition to highly developed VR simulations, another distinctive project element is the use of more environmentally friendly photolithography methods. This technology enhances laboratory safety and reduces costs, making nanotechnology education programs more feasible at two-year colleges.

Students test VR simulations that reinforce proper techniques for operating delicate nanotechnology machines.

ATE Technician Employability Skills

SRI Education, Menlo Park, CA
http://employabilityskills.org

Handbook Explains How to Develop the Top Five Employability Skills

The ATE Technician Employability Skills project created *Working Stronger and Smarter*, a practitioner handbook that focuses on the top five employability skills for technicians. The handbook is based on SRI researchers' systematic scans of 273 studies and their in-depth interviews with 40 educators, employers, and recent graduates.

High-priority Employability Skills for Technicians

Capacity to build relationships	1. Interpersonal skills 2. Communication skills
Personal qualities for career success	3. Orientation to lifelong learning 4. Meeting workplace expectations
Business fundamentals and knowing your business value	5. Situational awareness

After identifying the most important employability skills for technicians, researchers tailored the skills to support more diversity in technical fields.

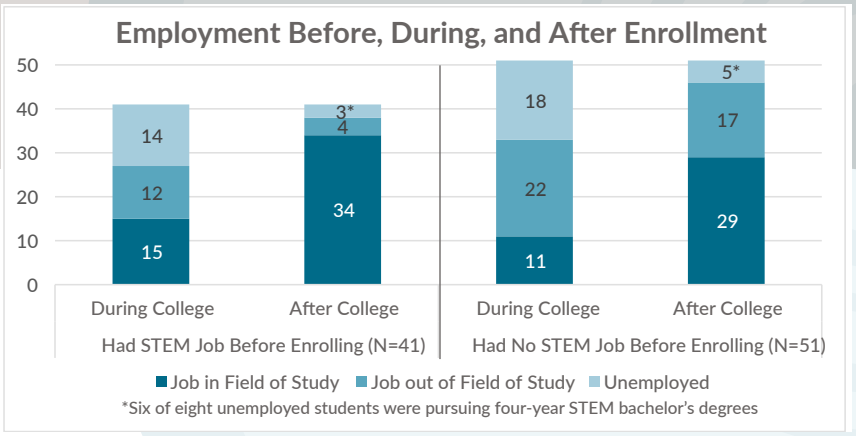
The researchers concluded that employability skills take years to develop in adults and that both educators and employers can improve technicians' skills by following two key approaches: (1) coordinating how they develop these skills, and (2) using a broad range of learning principles and methods.

The researchers focus on seven key learning principles to design instruction and share 140 practical instructional ideas for developing employability skills.

PathTech LISTEN

University of South Florida, Tampa, FL
https://ate.is/pathtech

Longitudinal Study Finds Tech Ed Programs Effectively Growing STEM Workforce



Twenty-six of the 92 interviewees had jobs in their fields of study while enrolled; 63 did after college.

PathTech LISTEN aims to survey and conduct two interviews with former advanced technology students to learn about their transitions into the workforce and/or continuation of their education.

As of summer 2019, 92 interviews were conducted with alumni of engineering technology, advanced manufacturing, micro and nanotechnology, and energy and environmental technology programs. Participants were recruited from the 3,216 students who completed the PathTech LIFE survey. They include recent high school graduates, bachelor's degree recipients, and non-traditional age, first-time-in-college students. Most planned to complete AS/AAS degrees, certificates, and/or licenses.

Overall, findings indicate LISTEN participants successfully transitioned into the workforce. Most participants reported that their college programs provided excellent preparation for their current jobs.

Acknowledgements

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Internet Scout Research Group (http://scout.wisc.edu) is home to ATE Central, which acts as an information hub and archive for the ATE community. Please visit ATE Central (http://atecentral.net) to access materials and services that showcase the work of the Advanced Technological Education program. Internet Scout Research Group is part of the Computer Sciences Department of the University of Wisconsin–Madison, located at 1210 West Dayton Street, Madison, WI 53706.

The American Association of Community Colleges (http://www.aacc.nche.edu) is the primary advocacy organization for the nation's community colleges. The association represents nearly 1,100 two-year, associate degree-granting institutions and more than 12 million students. The American Association of Community Colleges is located at One Dupont Circle, NW, Suite 410, Washington, DC, 20036.

Help us gather data about ATE's impact—tell us how you use this publication by completing a brief survey at http://ateimpacts.net/booksurvey

Legend

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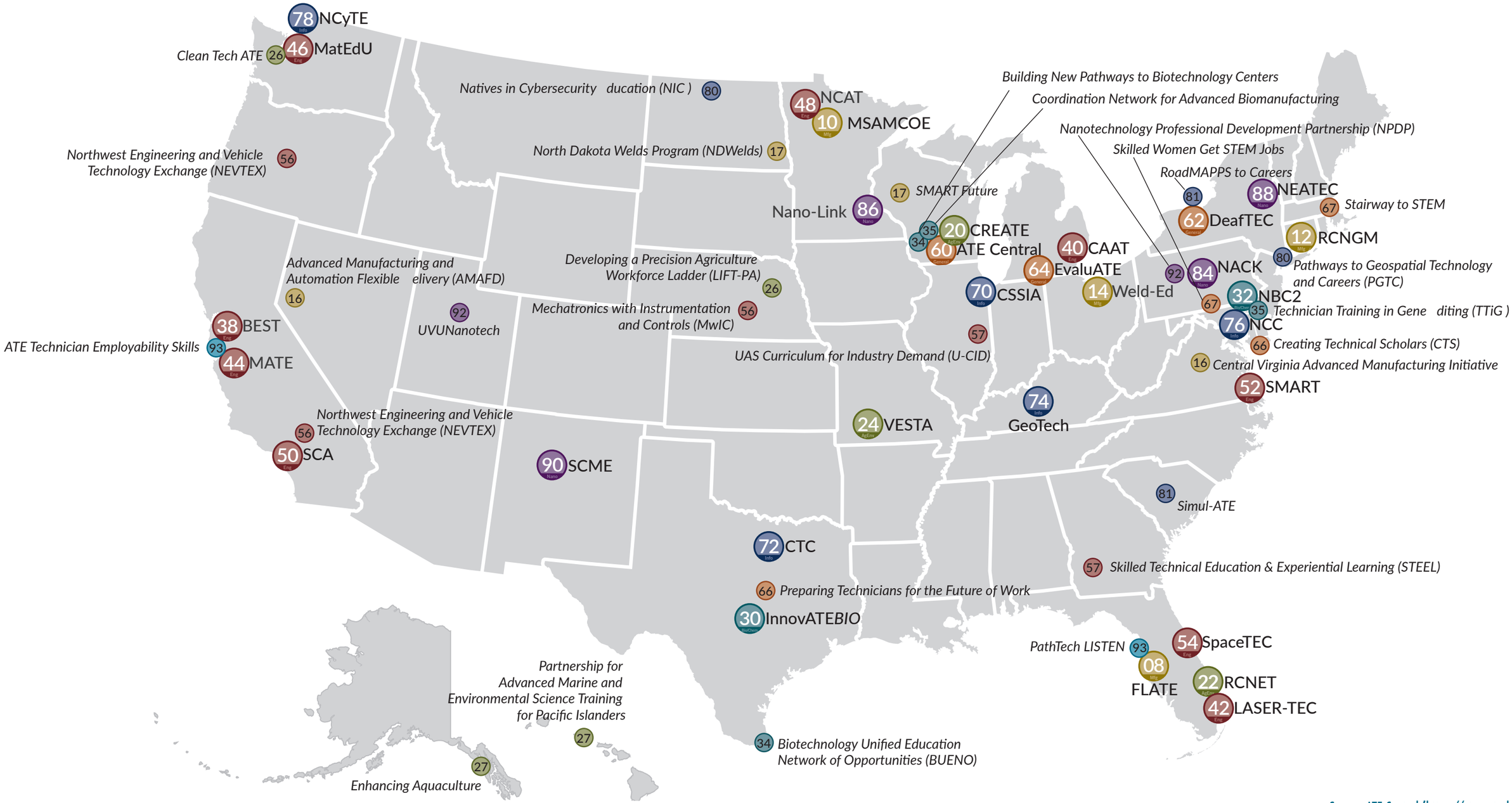
Information and Security

Micro and Nanotechnologies

Targeted Research

ATE Projects and Centers



Source: ATE Central (https://atecentral.net)

Advanced Technological Education (ATE) projects and centers lead efforts to improve technician education across the United States with support from the National Science Foundation. The two-year college educators who have leadership roles in ATE projects and centers work in partnership with industry and across education sectors to increase the knowledge and skills of technicians and the educators who teach them. By working together, educators and employers are developing and testing innovations that strengthen the skilled technical workforce—the workforce that is critical to the nation's prosperity and security.

Advanced Manufacturing
Agricultural and Environmental
Biological and Chemical
Engineering
Information and Security
Micro and Nanotechnologies

Materials and resources created by ATE centers and projects can be found on the websites listed inside or via ATE Central (http://atecentral.net).

More information about ATE student successes, program innovations, and other outcomes is available on the ATE Impacts blog (http://ateimpacts.net).

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