



AATE @20

Two Decades of Advancing Technological Education

ATE@20: **Two Decades of Advancing Technological Education**

**A Report on the Transformation of Technician Education
by the National Science Foundation's
Advanced Technological Education Program**

Madeline Patton and Internet Scout Research Group



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Internet Scout, a research center at the University of Wisconsin-Madison, created and maintains ATE Central (<http://atecentral.net>), a freely available online portal and collection of materials and services that highlight the work of the Advanced Technological Education (ATE) projects and centers. These National Science Foundation funded initiatives work with educators from two-year colleges to develop and implement ideas for improving the skills of technicians and the educators who teach them. ATE Central is designed to help educators, students, and the general public learn about, and use materials from, the entire depth and breadth of the Advanced Technological Education program.

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Preface

ATE@20 is a story about a program that has transformed the education of technicians in the United States and beyond. It is a story about the vision of the early advocates of technological education in community colleges; the persistence of the American Association of Community Colleges in making the case; visionary policy makers who shepherded authorizing legislation; the leaders in the National Science Foundation (NSF) who turned the Scientific and Advanced Technology Act of 1992 into the Advanced Technological Education program; and the educators and industry leaders who developed the programs and make them work. It is a story told by both the faculty who lead the programs and the students who have the opportunity to follow these rewarding career paths.

Traditionally, education in the United States has been seen as a state and local responsibility. As a result, the evolution of a federal role has been challenging. With the publication of *A Nation at Risk* in 1983, the public began to awaken to the need to strengthen educational programs nationally in order for our country to remain strong and competitive. The 1986 National Science Board report, *Undergraduate Science, Mathematics, and Engineering Education* (NSB 86-100), identified serious problems in undergraduate education. Its recommendations for improving the quality of science, mathematics, and engineering education included community colleges. In the years that followed, the National Science Foundation convened several workshops focused on science, technology, engineering, and mathematics (STEM) education in community colleges: *Workshop on Science, Engineering, and Mathematics Education in Two-Year*

Colleges (NSF 89-50), *Partners in Progress* (NSF 93-64), and *Gaining the Competitive Edge: Critical Issues in Science and Engineering Technician Education* (NSF 94-32). At the July 1993 workshop that led to the *Gaining the Competitive Edge* report, there was an overriding concern that the United States could not be internationally competitive and environmentally responsible without a better-prepared technological workforce. The report listed a series of recommendations to recognize technicians' critical roles in advanced technology fields, to develop alliances with employers, to develop faculty, to design curriculum, to provide continuing education to technicians, and to develop partnerships with secondary schools. There was consensus that two-year college educators should play a lead role in creating and offering STEM technician education programs. These recommendations helped to shape the ATE program. The leadership at NSF, which at first resisted the program, became its champion. Two-year community and technical colleges, which had previously not received much support from NSF, became the designated leaders of its technological education initiative.

Today, ATE programs prepare technicians in strategic areas including agriculture, environmental technology, biotechnology, engineering technology, manufacturing, information technology, telecommunications, cybersecurity, space technology, nanotechnology, and process technology. ATE-supported programs are offered at hundreds of locations and over the past two decades have reached hundreds of thousands of students at community colleges, technical colleges, secondary schools, and baccalaureate

institutions. ATE programs have been effective in including women and students of color. NSF has documented that ATE programs encourage students to enroll in mathematics and science courses that prepare them for careers in advanced technology fields; deliver well-qualified technicians to the workforce; improve the STEM curricula at community colleges and secondary schools; refine classroom instruction based on the latest research about how people learn; and reach out to middle school and high school students to inform them of technical career opportunities.

While the ATE program has been a great success, there are still concerns about the future economic competitiveness of the nation. Too many obstacles to a technological career path remain. Many students graduate from high school unprepared for college and must take remedial or developmental classes. Even if the students are generally prepared for college, they may not have taken the math and science classes in high school that would enable them to be successful in college STEM classes. Students also have little knowledge of or perhaps inaccurate perceptions of STEM careers. Popular movies and television shows often portray scientists and technicians as socially isolated individuals who work alone in laboratories with equipment instead of with other people. Furthermore, STEM jobs are not seen as directly helping other people like a career in allied health. Students need better and more accurate information about STEM careers and they need to see role models, people who look like them who have chosen STEM career paths.

The successes of the ATE program should be celebrated and the remarkable stories of its impact should be appreciated, but there is more work to be done to improve partnerships with K-12 schools, to increase the number of STEM fairs and summer STEM camps for prospective students, and to get more K-12 students and parents on campuses to tour STEM facilities and to talk with college students and faculty.

Community college leaders can overcome the barriers to student access to and success in these programs through concerted action.

STEM technician careers are rewarding and job opportunities are plentiful. Encouraging students to pursue these careers is important for the future of our country. Congratulations to the advocates, policy makers, leaders, and educators who have made ATE such an exemplary and vital program. The challenge now is to take ATE to the next level.

George R. Boggs

George R. Boggs is President and CEO Emeritus of the American Association of Community Colleges and Superintendent President Emeritus of Palomar College in California. He is a member of the Board on Science Education of the National Academy of Sciences and chaired the 2011 National Research Council/National Academy of Sciences Summit on Community Colleges in the Evolving STEM Landscape. He chaired the first evaluation panel for the NSF ATE program and has served on several ATE National Visiting Committees.

1 History

For 20 years the National Science Foundation's Advanced Technological Education (ATE) program has transformed the education of science and engineering technicians in fields vital to the nation's security and economic competitiveness. Technicians are essential workers of the Information Age. Their tasks vary by discipline, yet all require sophisticated technical skills and understanding of math and science. Technicians' capacities to learn throughout their careers and adapt to new technologies matter because these abilities influence the pace of innovation throughout the economy.

By focusing on the associate degree programs offered by two-year colleges—primarily public community and technical colleges—ATE provides technicians with a solid academic foundation that enables them to learn throughout their careers. ATE enhancements to science, technology, engineering, and math (STEM) courses enable students to move more efficiently on career paths from high schools to two-year colleges, from two-year colleges to technical careers, and from two-year colleges to four-year institutions.

ATE professional development opportunities for community college educators, secondary school teachers, university faculty, and pre-service teachers strengthen instruction at every education level.

ATE support of targeted research on technician education provides information on the changing role of technicians in the STEM workforce and expands knowledge about the attributes of effective technician education programs.

As the National Science Foundation's (NSF) largest community college investment, ATE has broadened the federal government's definition of the STEM workforce. The innovative ATE initiatives established throughout the nation, and the free information available to anyone who wants to emulate these model educational programs, improve the nation's prosperity.

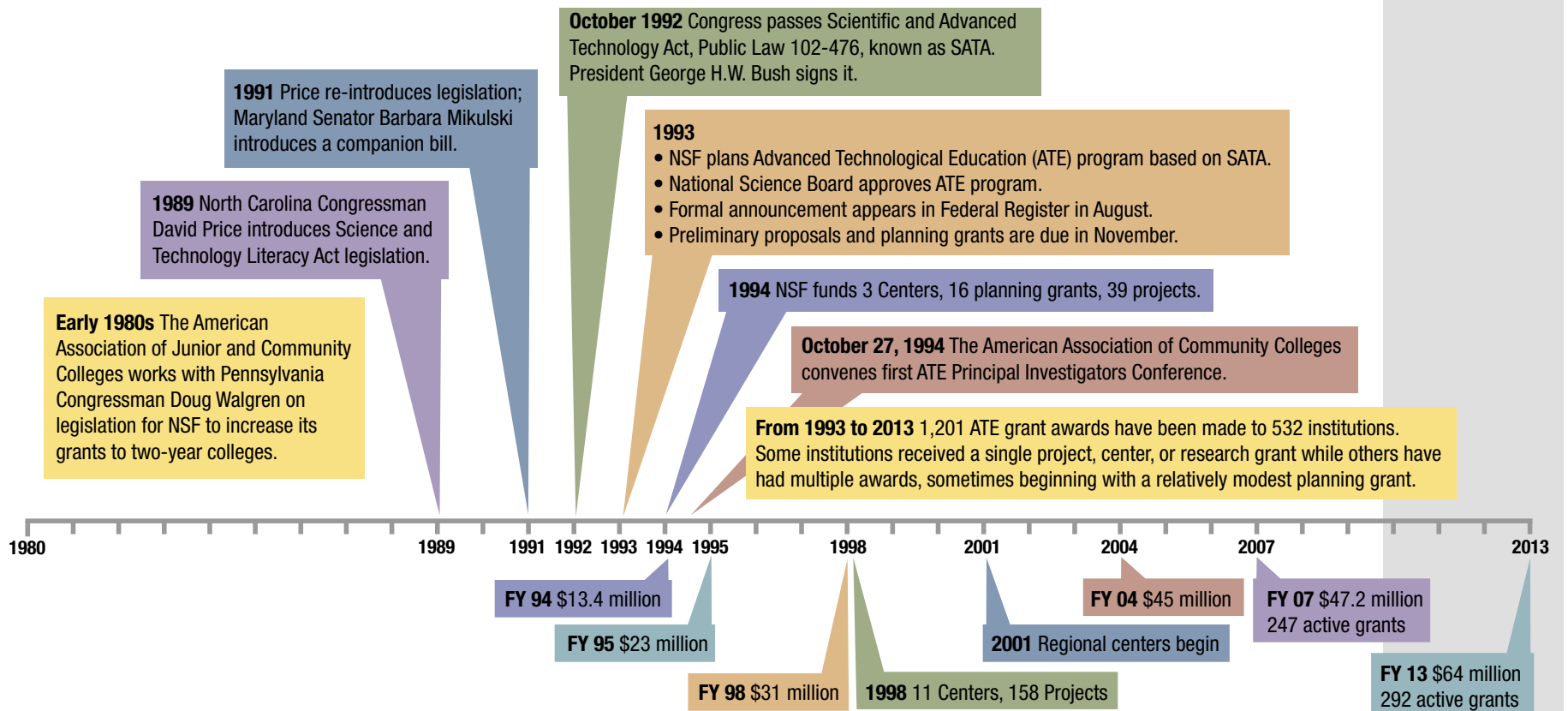
The Scientific and Advanced Technology Act of 1992

The National Science Foundation launched the Advanced Technological Education program in 1993 in response to the Scientific and Advanced Technology Act (SATA) of 1992. SATA was the first mandate that Congress ever gave to the independent federal science agency. Historically, Congress reacted to NSF's proposals rather than making its own. However, a decade-long effort to increase NSF support for technician education at associate-degree-granting colleges attained sufficient bipartisan support by 1992 to win passage in both the U.S. House and Senate. President George H.W. Bush signed the legislation on October 23, 1992, making it Public Law 102-476.

The goal of the legislation was to increase the number of well-qualified technicians to work in advanced technology fields of vital importance to the nation's security and competitiveness. The act directed "utilization of the resources" of associate-degree-granting colleges, which were traditionally two-year public institutions now known as community or technical colleges. The competitive grant program that NSF developed in response to SATA involves two-year college educators in leadership roles. Grant recipients, however, are not limited to community colleges or other two-year postsecondary institutions.

ATE initiatives span the breadth of the nation's industries and inventiveness, yet share connections to degree programs that emphasize math and science. Prospective and employed technicians and the educators who prepare them for careers—not just short-term jobs—in

Advanced Technological Education Timeline





Elizabeth J. Teles and Gerhard Salinger served as the co-lead program directors of ATE from 1993 to 2009.

the science, technology, engineering, and math (STEM) workforce are the primary beneficiaries of ATE grant activities. Employers, communities, and entire industries also benefit from the partnerships and economic development that ATE projects and centers create.

The ATE program's success is widely acknowledged today, but the idea of expanding NSF's involvement in technician education was not an obvious fit when the American Association of Community and Junior Colleges (AACJC) began the push for it in the 1980s. Then, as now, community colleges educated nearly half of the nation's undergraduates. University-based research was the NSF's priority,

however. Other NSF initiatives to cultivate the next generation of scientists focused on elementary and secondary schools.

The first legislative proposal for NSF to increase its support for STEM technician education at two-year colleges came from Andy Korim, vice president of development at Allegheny County Community College, and Don Garrison, a South Carolina technical college president, according to Frank Mensel. He was vice president of federal relations for AACJC and director of federal relations for the Association of Community College Trustees from 1981 to 1992. The three men took their legislative proposal to Congressman Doug Walgren of Pennsylvania. Walgren revised the language of the bill before he introduced it. Hearings were held, but the bill languished in committee during the 1980s. Throughout this period and until SATA was signed, Mensel kept the bill at the forefront of AACJC and ACCT legislative priorities.

In 1989, Congressman David Price of North Carolina introduced the Science and Technology Literacy Act with bipartisan support. Price, a Duke University political science professor before he was elected to Congress, wanted NSF to support workforce development in a way that complemented U.S. Department of Education tech-prep activities and Department of Labor short-term training. He added curriculum revision and development of innovative instructional technologies to the Walgren plan for funding technician education projects and centers.

When Walgren lost in the 1990 general election, Price became the champion of the legislation. Price describes his proposal as "a modest program that was quite sharply targeted at a gap in NSF's program." In 1991, Price reintroduced the legislation and Maryland Senator Barbara Mikulski introduced a companion bill. Mikulski, a social worker before she began her political career on Baltimore's City Council, wanted government investments in high-tech fields to include economic development for diverse populations. North Carolina Congressman Tim Valentine, chair of the House Subcommittee on Technology and Competitiveness, boosted the legislation's prospects with his support.

While NSF's top leaders made the case that community colleges could access support through existing programs, in the late 1980s NSF's Division of Undergraduate Education began supporting meetings for educators and scientists to discuss ways to improve STEM programs at community and technical colleges.

Robert Watson, division director of Undergraduate Education at NSF, understood that having skilled and knowledgeable technicians in STEM workplaces required strong education programs at two-year colleges that provided certificate and degree programs. Watson had personal familiarity with community colleges through relatives who attended two-year colleges. As a chemist, he had first-hand experience working with lab technicians. He also understood that in addition to educating STEM technicians, two-year colleges were the places where

many scientists and teachers started college before transferring to four-year colleges.

Perhaps the most important of the various meetings on the subject of STEM education was the Workshop on Science, Engineering, and Mathematics Education that NSF convened on May 13 and 14, 1991. The report from this workshop, *Matching Actions and Challenges*, led to more involvement of two-year colleges with NSF. Interestingly, the workshop participants included Elizabeth J. Teles, Gerhard Salinger, and David Pierce. Teles was then a member of the mathematics faculty at Montgomery College, in Montgomery County, Maryland, and chair of the Mathematical Association of America's Committee on Two-Year Colleges. Salinger was one of six NSF staff members in attendance. Two years later Teles and Salinger, who did not meet at the workshop, became the co-lead program directors of ATE. Pierce was chancellor of the Virginia Community College System and later in 1991 became chief executive officer of AACJC. During Pierce's tenure the association changed its name to the American Association of Community Colleges (AACC). Since 1994, AACC has convened the annual conference of ATE principal investigators with NSF support.

In the fall of 1991, Teles was one of seven community college educators who started as fellows at NSF. Her first assignment was to write "talking points" about why the legislation that became SATA, then under consideration by Congress, was not needed. Salinger, a program director in the Division of Materials Development, Research, and Informal Science Education, was assigned to help her because he had previously examined what NSF could do for students in high school technology programs.

Luther S. Williams, assistant director of the Education and Human Resources Directorate at NSF, used their talking points when he testified before the House Subcommittee on Technology and Competitiveness on September 17, 1991. Williams was concerned

about "set asides" and that the proposed legislation's focus on technician education was too narrow. However, Congress remained convinced that a new technician education program was needed, given that NSF's grants to two-year colleges amounted to just \$300,000 in 1991.

How Williams fared on Capitol Hill did not diminish what Teles gained from that first assignment. Though she did not know it at the time, the stage was being set for her career to take a different path. This change has influenced the career paths of innumerable other people.

"For me it was wonderful because I met Gerhard and we had a common vision or at least complementary visions of where this should go. And we worked on it together," she said. For that first assignment she learned about every NSF program that had or could have had a two-year college component. During the rest of the fellowship, she had the opportunity to think about what else NSF could do for two-year colleges.

In 1993, when Teles, Salinger, Watson, and the other program directors at NSF began shaping the program in response to SATA, Teles incorporated the best features of the programs she had learned about in her first days at NSF into what became the ATE program. The team followed the language in SATA. It also incorporated recommendations contained in *Gaining the Competitive Edge*, the report from a critical issues workshop on science and engineering technician education that NSF hosted with the American Chemical Society and the Federal Coordinating Council for Science, Engineering, and Technology in 1993.

The pillars they crafted 20 years ago continue to serve the ATE program well. They include development of curricula for technical courses as well as core mathematics and science courses; collaborations with business and industry; professional development for community college faculty and high school teachers; and career pathways from secondary schools to two-year colleges and from two-year colleges to four-year institutions.

ATE Structured as Program, Rather Than as Series of Grants

Substantial collaborations are a hallmark of the Advanced Technological Education program.

These collaborations with employers and with educators were a central goal for Elizabeth Teles and Gerhard Salinger when they crafted the first ATE grant solicitation to develop high-quality technician education programs. Teles and Salinger served as co-lead program directors for the ATE program from 1993 to 2009.

Early in their discussions about how to create the competitive grant program, they agreed on the importance of structuring ATE in a way

that connected educators with employers and cultivated connections among the grant leaders, known as principal investigators (PIs). So in addition to the goals listed in the Science and Advanced Technology Act of 1992, Teles and Salinger added the requirement that ATE principal investigators work in partnership with employers and educators from secondary schools and four-year colleges and universities.

They did this, Salinger said, simply because they thought “we could get more done if people collaborated.”

“We wanted it to be a program and not just a series of grants,” Teles said. They hoped that a network of partnerships beyond the particular college department or campus receiving an ATE grant would help sustain activities and lead to other innovations after the NSF grant funding ended. The duration of most ATE grants is two or three years.

“I just saw too many people acting in isolation, not realizing there were components in other projects. I had worked in a

few projects at my college, and I felt like we did them, but we didn’t have any idea what other people who were being supported were doing,” Teles said. She taught mathematics at Montgomery College before her selection in 1991 for NSF’s community college fellowship program, which the American Association of Community and Junior Colleges facilitated with NSF support. When the one-year fellowship ended, NSF asked Teles to stay on and to help develop the ATE program.

Evidence that Teles and Salinger succeeded in their collaboration goals comes from the high level of industry involvement in ATE projects and centers; the cooperation among ATE PIs within the same discipline; and the cross-disciplinary activities of many ATE PIs. (For more on this, read *Collaboration: The Ethos of ATE and Crosscutting ATE Projects & Centers* in Chapter 4.)

ATE Develops Technician Education Leaders

Twenty years ago, the ATE program created a unique professional development opportunity for community college educators. No other program at the time focused on the professional development of two-year college faculty across all science, technology, engineering, and math (STEM) disciplines. But Elizabeth Teles and Gerhard Salinger, the co-lead program directors from 1993 to 2009, believed that the program could offer even more: a network of education leaders. From the outset, Teles and Salinger looked for ways to support interactions among the ATE principal investigators (PIs), to help PIs build on each other’s work, and to create a community of collaborators.

They saw the importance of NSF investment in the development of ATE PIs as leaders in STEM education. With 44 percent of students who receive baccalaureate or master’s degrees in STEM fields attending a community college at some point in their careers, Teles and Salinger recognized that the ATE PIs could strengthen general math and science education while improving technician education.

“The ATE program serves as a major incentive for workforce and economic development. Through the National Science Foundation’s ATE grants, Indian River State College has been able to take a lead role in meeting the nation’s need for nuclear energy technicians, and is now establishing a Regional Center for Lasers and Fiber Optics to create high-paying jobs and maintain global competitiveness.”

Edwin R. Massey

*President, Indian River State College
Fort Pierce, Florida*

During the past 20 years, ATE PIs have become STEM education leaders who represent their disciplines and community colleges in national and international forums. This is a testament not only to the PIs themselves, but also to several elements of the ATE program that were designed to build leadership capacity.

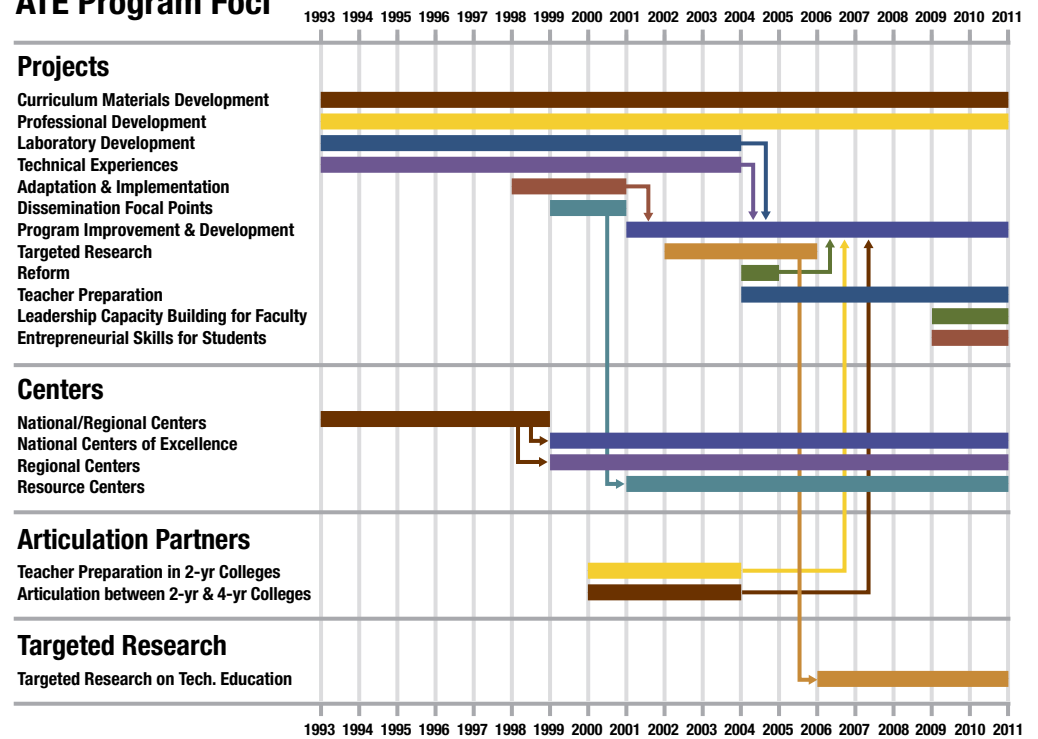
Teles and Salinger's first capacity-building effort was to ask the American Association of Community Colleges (AACC) to convene a meeting for the first 16 recipients of planning grants. Lynn Barnett, retired AACC vice president, remembers Teles' request for a "little meeting" that quickly grew to 100 people.

The meeting had a dynamic give and take. The community college educators received encouragement and guidance to prepare full grant proposals; NSF program directors got suggestions from the community college educators on ways to make ATE a cohesive program. Of the 16 community colleges in that first cohort, all but one eventually won a center or large project grant.

That meeting was so successful that AACC has received NSF grant support to convene ATE PI conferences every year since. About 800 people attended the 2012 conference; participants included educators and ATE industry partners, as well as students. Participants share information about their work during formal sessions and high-energy showcases. Countless conversations and presentations at ATE PI conferences over the years have led to new productive collaborations.

The challenges involved in starting new technician education programs led to the NSF's funding of two formal mentoring programs. The MentorLinks program, created in 1999 and administered by AACC, helps community colleges develop or strengthen technician education programs with mentoring, professional development opportunities, and technical assistance. Each two-year grant establishes a long-distance mentoring relationship between a community college STEM expert and a mentee team at a selected community college. Mentor-Connect, launched in 2013,

ATE Program Foci



Source: EvalATE

Since the ATE program began in 1993, its foci have evolved to address student and faculty needs, and to respond to technological advances within various disciplines.

is growing the next generation of STEM education leaders by helping two-year college educators learn to prepare competitive grant proposals. Its services include assisting colleges that are new to the ATE program and offering special encouragement to faculty who work at rural community colleges, as well as those who serve populations underrepresented in STEM fields. Mentor-Connect is a partnership of the South Carolina Advanced Technological Education Center (SC ATE) and AACC. SC ATE is located at Florence-Darlington Technical College in Florence, South Carolina.

SC ATE also operates TeachingTechnicians.org, an online database of exemplary professional development opportunities for technician and related STEM educators. As a forum for announcing ATE professional development events and activities, the site informs all educators of opportunities to learn about ATE initiatives that improve the success of diverse learners and that align advances in science and technology with employer expectations.

ATE Builds Capacity for Innovation at Community Colleges

In the mid-1990s, the staff members of the Advanced Technology Environmental and Energy Center (ATEEC) learned that their experience as one of the first ATE centers sometimes put them ahead of their target audience of community college educators.

ATEEC Principal Investigator Ellen Kabat Lensch remembers that when she and ATEEC staff members initially spoke with groups of community college faculty about adopting ATEEC's curriculum to educate hazardous materials technicians they encountered resistance. ATEEC is located at the Eastern Iowa Community College District in Davenport, Iowa.

The problem was that most two-year colleges at the time did not use labor market assessments, seek advice from industry advisory committees, or employ external evaluators. All three activities are key components of ATEEC's curriculum development and program enhancement process.

In response, ATEEC developed a best practices publication that helped community college educators take several capacity-building steps in advance of adopting curricula generated by the ATE program.

Capacity-building steps are necessary because the ATE program expects community colleges to partner with industry and business, collaborate with educators in other sectors, and learn from an

objective evaluation of their work. These requirements help sustain the work started with ATE grants after the funding from the NSF ends.

ATE's Role in the Naming of STEM

When Judith A. Ramaley stepped up to the podium at the ATE Principal Investigators Conference in 2001, she had not planned to share her opinion about SMET, the acronym then used for collective references to science, math, engineering, and technology.

However, something at the meeting prompted her seemingly spontaneous comment that she did not like "SMET" and thought it should change to "STEM." It was the first time she or anyone else is known to have suggested STEM as the acronym for science, technology, engineering, and math in a public setting.

In a 2013 phone interview, Ramaley said she had been thinking about alternatives to SMET before the ATE PI conference, which occurred a few months after she started as assistant director of the National Science Foundation's Education and Human Resources Directorate. "STEM sounds better to me and it also has an image of branching development, perhaps, and continued innovation, while SMET just sort of sits there. The real reason was it made more sense to me to have science and math holding in alignment engineering and technology," she said.

After the ATE meeting, Ramaley said she talked to NSF Director Rita R. Colewell and Deputy Director Joseph Bordogna about adopting STEM as the acronym that encompasses the disciplines the federal science agency focuses on. They agreed, and over the next few years STEM replaced SMET in NSF solicitations and publications.

Ramaley, president emerita of Winona State University and distinguished professor of public service at Portland State University, is happily surprised that STEM has become a part of the nation's vocabulary. She admits to grinning to herself a few years ago when she passed a large museum display encouraging youngsters to consider STEM careers. "You know if it said 'SMET' it wouldn't be as appealing," she said.

2 Robust Business and Industry Partnerships Distinguish ATE Program

Robust partnerships between educators and advanced technology businesses and industries distinguish the ATE program from other educator-employer alliances.

The shared purpose of developing well-prepared technicians now and in the future drives ATE's partnerships with employers. There is a mutuality to the relationships between employers and ATE educators, so much so that some ATE projects and centers started with conversations that employers initiated with educators.

ATE partnerships with business and industry are also much more substantial than occasional chats over coffee. Revising curricula, establishing internships, and creating faculty professional development programs are challenging endeavors that involve significant investments of time and resources by all stakeholders. Many times the stakeholders are business competitors who set aside their proprietary interests to work with ATE projects and centers to improve the nation's advanced technology workforce.

The ATE program engages with business and industry in the following ways:

- *Small projects typically interact with groups of local employers who are all involved in the same industry or business sector.*
- *Large projects have broader goals and may involve organizations like professional societies in the development of programs for technicians in a particular field, or educators in a particular discipline.*
- *Regional centers focus on a particular field of technology in a defined geographic area.*
- *Resource centers focus on a particular field of technological education or cut across several technology fields to promote best practices in areas such as recruitment and industry partnerships.*

- *National centers catalyze broad national networks of academic institutions and industrial entities to develop innovative, nationwide programs in particular technological fields.*

MATE Center ROV Competitions Build Excitement for Marine Tech Careers

Jill Zande never has a problem finding officials for the Marine Advanced Technology Education (MATE) Center's competitions for remotely operated vehicles (ROVs).

For MATE's 12th Annual International ROV Competition in June 2013, she had lots of volunteers from the Marine Technology Society (MTS) and dozens of corporate sponsors to serve as judges. More than 50 teams with about 500 students demonstrated their ROV-building and maneuvering skills while troubleshooting underwater challenges in the Olympic-size pool of the Weyerhaeuser King County Aquatic Center in Seattle, Washington. Zande is the co-principal investigator, associate director, and competition coordinator of the MATE Center at Monterey Peninsula College, Monterey, California.

"Our member response has been nothing short of outstanding. In fact the only complaint I have ever heard is when some of our members, or member companies, have been jealous because they thought their rivals or competitors were more visible than they at competitions," said MTS President Drew Michel.

Marine technology professionals have many opportunities to interact with students during a Career Expo, poster session, and engineering evaluations of students' ROVs. Employers also get the chance to see



Three students who were part of the Long Beach City College team that won MATE's 2009 International ROV Competition were employed a year later piloting ROVs involved in the response to the Deepwater Horizon oil spill. In 2011, another team member was hired by Woods Hole Oceanographic Institution.

how secondary school and college students perform under stress, as their robots perform tasks that mimic undersea workplace challenges.

Zande reports that the marine industry and professional societies contribute more than \$100,000 in funds to the MATE Center's ROV competitions each year. The MTS ROV Committee alone provides \$40,000 to \$50,000 annually. She estimates that in-kind contributions of facilities, equipment, personnel time, and expertise exceed \$1 million.

Educational and Fun for Students

"I have been in the marine industry for 46 years and active in helping with scholarships and other student programs during most of that time. No program I have ever seen comes close to the MATE ROV Competition for getting kids involved. Attending one competition and witnessing firsthand the sense of competition, enthusiasm, and just plain joy will make anyone a believer," Michel said.

"It really is the greatest program I've ever seen for getting kids involved," he added.

An independent evaluation of middle school students' participation in MATE's ROV competitions found that 92 percent of the middle school students were more excited to study math, science, computer science,

or engineering after participating. Teachers saw improvements in students' learning, teamwork, and critical thinking. Parents reported significant improvements in students' grades.

Zande's anecdotal impact data are compelling:

- A year after winning the MATE's 2009 International ROV Competition, members of the Long Beach City College, California, team were piloting ROVs for a contractor cleaning up the Deepwater Horizon oil spill.
- The Stockbridge, Michigan, Advanced Underwater Robotic Team has helped the BentProp Project search for evidence of missing World War II veterans in the Republic of Palau.
- Because the ROV events are "more camaraderie than gut-wrenching competition," Zande said older students mentor the younger students.
- Many friendships, including international ones, have formed among the competitors.
- The Purdue University, West Lafayette, Indiana, team was organized by a student who thoroughly enjoyed his high school ROV team experience and took that expertise with him to college.

Organic Growth of ROV Competitions

The growth of MATE's ROV competition "happened organically" from the professional development workshops MATE offered for teachers and college instructors, Zande said. The educators liked the idea that she and Michel devised to generate student interest in marine technology and other STEM (science, technology, engineering, and math) careers.

MATE started the competition as a pilot project with ATE support in 2001. The next year, nearly 50 teams joined the ROV competitions. In 2013, a total of 620 teams participated in the international event or the 22 regional events that led up to it. The majority of participants in

regional competitions are middle and high school students. Community college and university teams qualify for the international competition based on demonstrations at regional events or submit to demonstrate that their ROVs meet MATE's performance requirements.

MATE purposefully uses ROVs as a means to capture students' attention. With ATE support, MATE created a curriculum, textbook, professional development model, ROV kits, and regional competition materials to support the ROV competition and to help teachers, parents, industry professionals, and students organize teams.

Employer-Educator Alliance Promotes Use of ATE Curriculum

The North American Process Technology Alliance promotes the use of the Process Technology (PTEC) curriculum that the Center for Advanced Process Technology (CAPT) at the College of the Mainland in Texas City, Texas, developed when it was funded as a national ATE center. The alliance, known as NAPTA, is made up of industry representatives and education providers who helped develop the curriculum with CAPT.

NAPTA maintains and updates the standardized curriculum for associate of applied science degree programs in process technology. Process technicians work in the chemical manufacturing, refining, oil and gas production, and pharmaceutical manufacturing industry sectors.

NAPTA encourages its members to hire graduates of programs that use the PTEC curriculum by pointing out that these technicians improve the bottom line of companies by an average of \$16,000.

NAPTA reports that PTEC graduates have this positive impact on companies' bottom lines by:

- Decreasing employee selection costs by 80 to 90 percent.
- Reducing two-year new employee turnover by 50 percent.
- Lowering job-training costs by 40 percent.
- Being involved in 37 percent fewer safety-related incidents.

Nuclear Technician Career Appeals to Young Woman

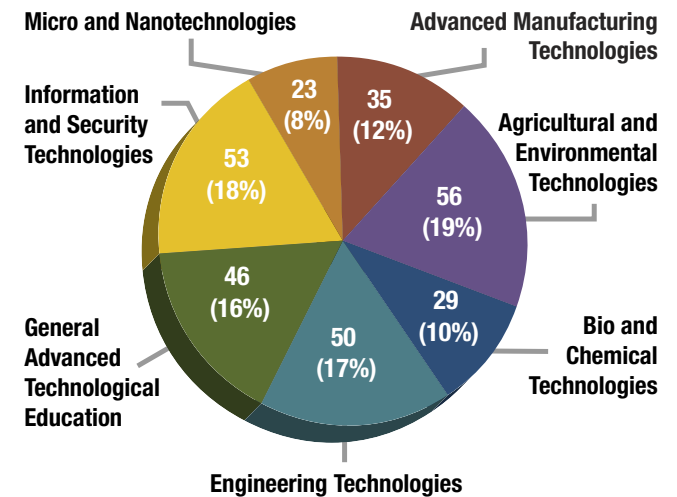
Casey Kraus, a third-year apprentice at Florida Power & Light's St. Lucie Nuclear Power Plant, "loves" her work.

"I've always wanted to work with my hands, not have a desk job. I wanted to have a job where I could continually learn new things," Kraus said. The \$30 per hour starting wage was "absolutely" part of the appeal of a nuclear technician career, as well.

Kraus' apprenticeship is part of the curriculum of the Power Plant Technology Institute that Indian River State College (IRSC), Florida Power & Light, and the International Brotherhood of Electrical Workers created together. In 2013, the American Association of Community Colleges recognized this collaboration as one of the Top Five College and Corporate Training Partnerships in the U.S.

The institute is not IRSC's only major effort in nuclear energy education. The Fort Pierce, Florida, college is home to the Regional Center for Nuclear Education and Training (RCNET), an ATE Center that is developing a standardized, systematic

ATE Projects and Centers 292 Active Grants in Spring 2013



There were 292 active ATE grants in Spring 2013. The number of active grants changes throughout the year as individual grants expire and new proposals receive funding.



IRSC Graduate Casey Kraus enjoys her work at a commercial nuclear power plant.

approach to educating technicians for a broad range of nuclear careers.

Kraus, who was home-schooled, learned about IRSC's Power Plant Technology Institute from a newspaper advertisement. She went to an information session at the college and was thrilled when her score on the college's mechanical aptitude test qualified her for admission to the program.

The two-year associate degree that she completed at IRSC in 2012 included a six-week internship at Florida Power & Light's St. Lucie Nuclear Power Plant. Upon her graduation, Kraus was hired by the plant as a third-year apprentice. From September 2012 to September 2013, she worked in the power plant's mechanical maintenance department for three days each week. Two other days each week, she attended classes at IRSC for hands-on instruction in the valves and pumps used at the commercial nuclear facility.

"You have to study. It's not something you can just sit in class and pass. You have to work at it. You have labs where you have to perform what you've learned and do it properly. It's more than just tests... They teach you how to take apart a valve, and then they watch you go take it apart and put it back together," Kraus said. She aspires to become a mechanical maintenance journeyman, the designation of a career technician at Florida Power & Light (FPL).

Kraus' mechanical skills and career ambitions have made a positive impression on Ken Hall, the FPL employee who is the subject-matter expert for mechanical maintenance. "She's been doing fantastic. She's very mechanically inclined. She's very smart," Hall said. He also praised Kraus for performing complex procedures and articulating the rationale behind them.

Kraus understands the importance of mastering the technical skills she has learned during her degree program and apprenticeship.

"All the work we do at the plant has to be done correctly because, if not, it could put the public or us in jeopardy, and cause millions of dollars in damage to the unit. There's a lot of bad stuff that could happen if we do not do our job correctly. We have procedures we have to follow and if we do not follow them we are breaking federal law," she said, adding, "If you do not take your job seriously, you do not work out here."

ICT Center Collaboration Educates Technicians for Changes in Telecommunications Industry

The Information and Communications Technology (ICT) Center at Springfield Technical Community College in Springfield, Massachusetts, participated in an extraordinary collaboration between a business, two labor unions, and 25 educational institutions for the Next Step Program. The competency-based, contextualized curriculum that the collaboration developed weaves "umbrella competencies" such as teamwork, leadership, critical thinking, and problem solving with technical skills into every course.

Through the Next Step Program, 4,860 contract-qualified Verizon associates who are members of either the Communications Workers of America (CWA) or the International Brotherhood of Electrical Workers (IBEW) earned Associate in Applied Science in Telecommunications

Technology degrees from one of 25 community colleges in New York and New England. During 2013, about 750 Verizon associates were enrolled as part-time students in the Next Step Program.

The idea for the ICT Center actually began with discussions in the mid-1990s between the company, its partner unions, and several community colleges about the curriculum for the Next Step Program. (A technical-focused degree program for technicians was part of the 1994 agreement the unions negotiated with NYNEX in New York. The company later became Bell Atlantic; it is now Verizon.)

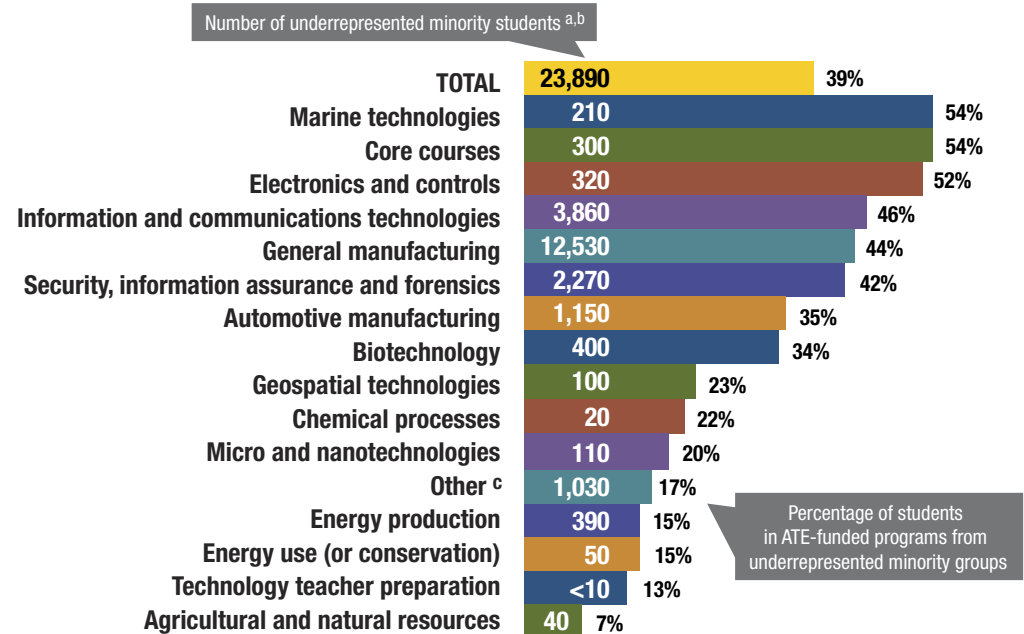
Springfield Technical Community College submitted the ATE center grant proposal that was funded in 1995. The ICT Center jointly coordinated the Next Step Program with Hudson Valley Community College in New York. Gordon Snyder, executive director of the ICT Center, led telecommunications curriculum efforts in New England and helped transition the program as the industry moved from voice-centric telephone networks to the Internet protocol-based voice, video, and data networks currently in use.

“A radical shift in telecommunications technologies has taken place during the life of the Next Step Program. Our goal is to keep current with technological advances and that would not have been possible without the input provided by the ICT Center,” said Charles F. Zipprich, Next Step’s curriculum development coordinator and the first project director for New York.

Snyder pointed out that everyone involved in the Next Step Program agreed that U.S. technicians needed broader skills and deeper knowledge to respond to the intense competition that accompanied deregulation, globalization, and technological advances.

The Next Step Program has received national recognition. Robert Reich, when he was U.S. secretary of labor, commended the company and its unions for setting up a program that treats workers as “assets to be

Underrepresented Minority Students Enrolled in ATE Programs: 2011



Source: EvaluATE

^a Underrepresented minorities in STEM include Hispanic/Latino, American Indian or Alaska Native, Black or African American, Native Hawaiian or other Pacific Islander, and multiracial individuals. See the NSF report *Women, Minorities, and Persons with Disabilities in Science and Engineering: 2011* (<http://www.nsf.gov/statistics/wmpd/pdf/nsf11309.pdf>)

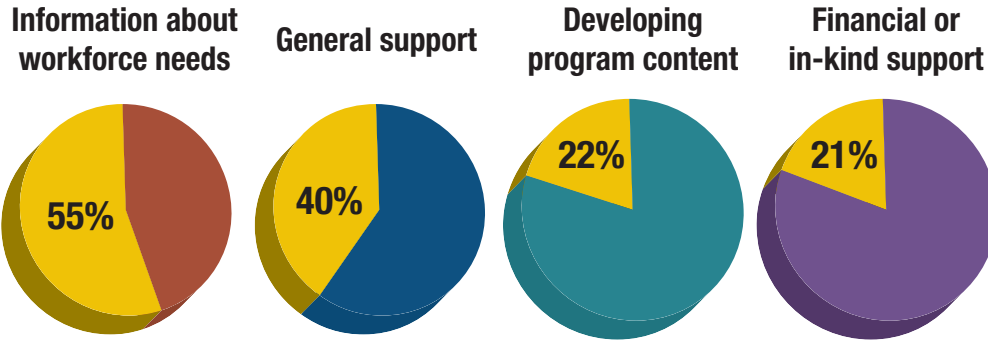
^b Numbers are rounded to the nearest ten.

^c Respondents who defined their program area as “other” primarily were involved in multiple disciplines.

Underrepresented minority students comprise almost 40 percent of all students in ATE-supported programs. This compares quite favorably to minority enrollment in other undergraduate STEM programs. For instance, about 15 percent of undergraduate degrees in engineering went to African Americans, Hispanics, or Native Americans in 2010. These three groups account for 34 percent of the nation's population. By discipline, the percentage of students from underrepresented minority populations who are enrolled in ATE programs ranges from 7 percent to 54 percent.

8,000 Business & Industry Collaborations in 2012

Reported purposes of collaboration



Percentage of respondents indicating collaboration served this purpose.

Source: EvaluATE

ATE projects and centers reported 8,000 collaborations with business and industry during 2012. This number does not reflect the many collaborations that continue after ATE grants expire.

developed rather than costs to be cut.” Former Vice President Al Gore cited the program for promoting lifelong learning. Hudson Valley Community College won the “Stevie” Award for Best Human Resource Team in the 2007 American Business Awards for its role as the New York state lead institution.

The ICT Center has used what it learned from the Next Step Program to cross barriers and utilize emerging technologies to reach, support, and educate students, educators, and business people throughout the United States.

Commercial Space Exploration Creates New Priorities for SpaceTEC

As space exploration becomes more of a commercial enterprise in the United States, the need for well-qualified aerospace technicians may be even greater than it was when NASA and its contractors were the primary employers in this field.

NASA’s decision to enter into commercial space partnerships for the Space Station while it focuses on research for asteroid and solar system missions has opened human space flight to commercial companies. About 100 U.S. companies are now engaged in some aspect of space vehicle construction. Many of these companies are start-ups with small technical workforces.

As with many other advanced technological fields, work as an aerospace technician requires “a broad skill set, a particular level of attention to detail and a thorough understanding of safety,” said Steve Kane, managing director and program manager for the SpaceTEC® ATE National Resource Center in Cape Canaveral, Florida.

Kane explained that aerospace technicians must be constantly aware that they deal with materials and equipment that can harm them, and must build products that work properly to avoid endangering the public.

NASA continues to recognize SpaceTEC’s performance-based credentials. For instance, aerospace technician students enrolled at Thomas Nelson Community College in Hampton, Virginia, must earn SpaceTEC credentials to participate in paid internships at NASA’s Langley Research Center in Hampton, Virginia. The internships often lead to NASA technician jobs in the various shops and labs at Langley.

A top priority for SpaceTEC is making sure that the technicians employed by the various commercial space exploration companies are aware of the hard lessons learned by NASA and its contractors during the Space Shuttle program.

As part of its emerging role as “keeper of the flame” of U.S. space exploration, SpaceTEC® Partners, Inc. (SPI)—the non-profit corporation that oversees SpaceTEC—was authorized by NASA to hold a database of 80,000 documents of technical education and certification materials developed during the 30-year Space Shuttle program. SpaceTEC is currently developing a process to share the information in the database with U.S. citizens per NASA security requirements.

“The future is pretty bright,” said Albert M. Koller, principal investigator and executive director of SpaceTEC® Partners, Inc. He pointed out that the center is adjusting outreach activities for its curriculum and certifications to fit the more diffuse realities of the aerospace industry, as regional entities and small companies become more involved in the economic development of space exploration.

For instance, SpaceTEC’s staff is exploring ways to adapt aspects of its two-year degree curriculum for the Virginia Commercial Space Flight Authority at the Mid-Atlantic Regional Spaceport on Wallops Island, Virginia. The state authority operates the spaceport in partnership with NASA.

“We wanted to build on the excellent training that was developed for the Shuttle program, and SpaceTEC looks like a good resource to help us do that,” said Dale K. Nash, executive director of the Virginia Commercial Space Flight Authority. The flight authority’s stated mission is to provide “low-cost, safe, reliable, schedule-friendly space access.”

SpaceTEC is also adapting its aerospace technician certification programs to serve a wider array of technical employers and to help veterans as they reenter the civilian workforce. Its CertTEC® web-based exams test technicians’ performance in basic electricity and electronics, mechanical assembly, and composites. Its VetTEC™ program will help U.S. military personnel adapt their skills and training to civilian technical workplaces. SpaceTEC also offers knowledge and skills inventories for employers to use as screening tests.

SpaceTEC credentials are among the industry credentials that Mark A. Miller, operations manager for Embraer Executive Aircraft, Inc., looks for when he screens applicants for the company’s Melbourne, Florida, facility. Miller explained that he does this because SpaceTEC-certified technicians have a solid foundation in the fundamentals of working in an aerospace environment that helps them “come up to speed much faster.”

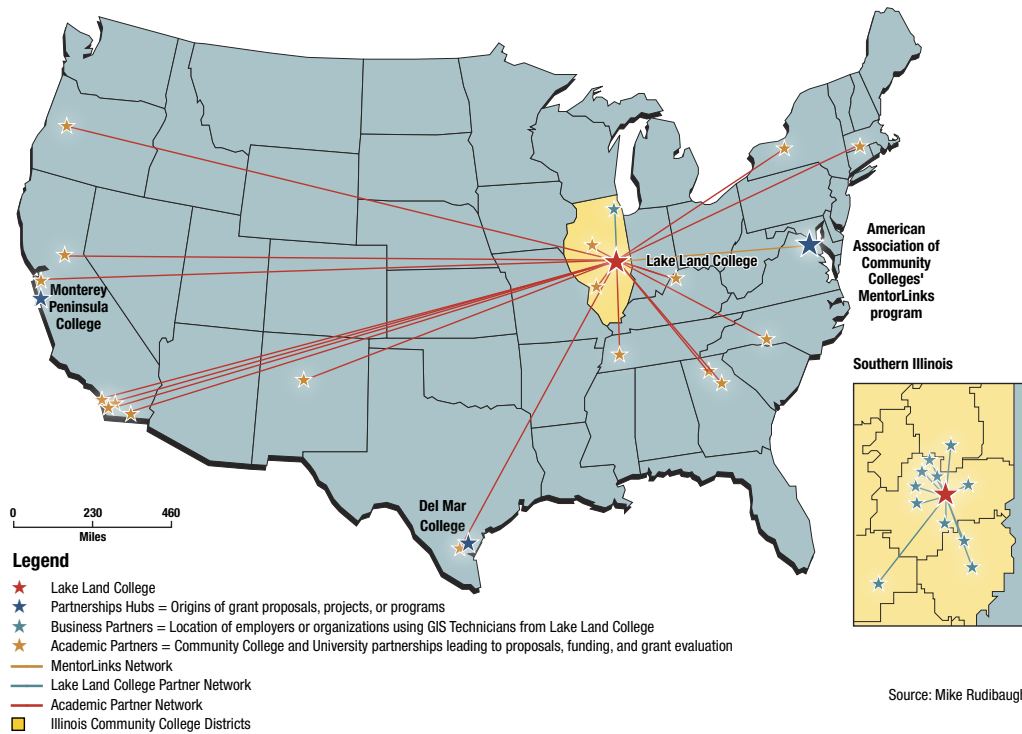
Miller said, “We find that these technicians are anxious to take what they have learned in the classroom and apply it to their real-world careers, and they enter into the workplace with greater enthusiasm. We also find that the SpaceTEC-certified employees typically are more detail oriented and show more eagerness to get things done than most entry-level technicians without the certification.”



Embraer Executive Aircraft, Inc., finds that SpaceTEC-certified technicians have a solid foundation in aerospace fundamentals and are eager to work.

3 ATE Transforms STEM Education at Two-Year Colleges

Networks Lake Land College Developed with MentorLinks



Source: Mike Rudibaugh

Since receiving a MentorLinks grant in 2002, Geography Professor Mike Rudibaugh has developed a professional network that has helped him improve his curriculum, fill his classes, and become involved in regional and national geospatial education initiatives.

ATE grants transform two-year colleges by providing educators with funds to develop their ideas for innovative advanced technology programs. ATE grants are among the rare sources of funds that community and technical college educators can access to pay for release time to plan, test, and execute their ideas for improvements to curricula, outreach activities, professional development, and virtual laboratories.

Evaluation processes built into each ATE grant provide insights from external experts about what parts of these educational experiments work and what can be improved. NSF requires that each ATE grant involve partnerships with employers and other educators. These collaborative relationships provide structure and systems that help sustain initiatives after ATE grants end.

The community college educators featured here are among the thousands of ATE principal investigators (PIs) who have used ATE grants to create programs that have become part of colleges and communities throughout the nation. These educators demonstrate the many ways that successful ATE projects and centers become catalysts for larger, more complex initiatives that reach even more students.

From Small Grant, Educator Grows Big Geospatial Technology Network

Thanks to the ATE program, Mike Rudibaugh's high-level collaborations with educators and with geospatial industry leaders in Illinois appear on a map like a giant spider web stretched across the country.

For Lake Land College students in Mattoon, Illinois, Rudibaugh's professional network puts the most current geospatial technologies in their hands. It keeps the small, rural college's geographic information

systems (GIS) program up-to-date in ways that help students get jobs—often directly from internships that are part of the college’s GIS certificate program—or transfer smoothly to four-year degree programs. The geography professor’s ATE activities have also brought \$540,000 in NSF funding to Lake Land College.

All these are big changes since 2002, when Rudibaugh was selected to receive a \$7,500 grant through MentorLinks, a program development initiative the American Association of Community Colleges provides with its ATE grant. At that time, Rudibaugh’s one GIS course had only a few students. He was confident that GIS skills could improve students’ employment opportunities, but he was struggling to persuade others of this when he applied for the MentorLinks grant.

Through MentorLinks, he met other community college educators who shared his enthusiasm for emerging geospatial technologies.

“The main benefit was it hooked me up nationally with a group of people who thought like I did. And I wasn’t on an island. That kind of gave me more security that I wasn’t the only one... I found out through MentorLinks that there was a group of other faculty around the country in the ATE program who were thinking the same thing,” he said. Over the next several years, that group of educators collaborated and submitted a successful ATE grant proposal for what is now the National Geospatial Technology Center of Excellence (GeoTech Center) at Jefferson Community and Technical College in Louisville, Kentucky. The center helps community colleges analyze their local workforce needs and design academic programs that teach geospatial skills.

The community college educator who served as Rudibaugh’s formal mentor during MentorLinks informed his curriculum development and student recruitment efforts. Today, Rudibaugh’s GIS classes are growing and he receives almost daily inquiries from educators who want to replicate Lake Land College’s 15-credit certificate program and employers who want to hire graduates from it.

Since MentorLinks, Rudibaugh has participated in numerous ATE initiatives. He has served as a co-PI for both the GeoTech Center and an ATE project that is preparing geospatial technology graduates for employment in Southern Illinois. He has also served as a MentorLinks mentor to a California college and advised two Illinois colleges on their MentorLinks grant applications.

Rudibaugh received the 2011 Illinois Community College Faculty Association Award for his ATE work.

Tribal College Fellows Institutes Bring Native American Context to Science Pedagogy

ATE professional development programs for tribal college educators blend Native American perspectives on natural resources with modern technologies for teaching in-person and online science courses.

“Including culture is a challenge when the focus is pure science,” said Kirk Laflin, principal investigator of several ATE grants that have strengthened advanced technological education programs at tribal colleges. But, he says, the mix of cultural context with effective science pedagogy helps tribal college educators, who work on reservations and are often not Native Americans, engage their students.

Laflin is executive director of the National Partnership for Environmental Technology Education (PETE) of South Portland, Maine. PETE offered Tribal College Fellows Institutes in 2009 and 2010 with ATE support and in collaboration with the Advanced Technology Environmental and Energy Center (ATEEC), an ATE center at the Eastern Iowa Community College District in Davenport, Iowa.

While all the Tribal College Fellows reported positive student outcomes as a result of what they learned during the weeklong summer institutes, Sharyl Majorski had outstanding results. As an adjunct chemistry, physics, and environmental science instructor at



Educators from Tribal and Pacific Rim Colleges received professional development and technical assistance at PETE's Indigenous Fellows Institute in June 2013. A lesson on trees' adaptations to salt water in Guam was led by Joni Kerr, (center foreground) assistant science professor at Guam Community College and co-principal investigator of PETE's latest ATE grant. Dan Buresh, an environmental science instructor at Sitting Bull College, Fort Yates, North Dakota, and Jennifer Berry, a teacher at George Washington High School in Mangilao, Guam, were among the participants in the five-day institute.

Saginaw-Chippewa Tribal College, she attended the 2009 Water on the Reservation program at Sitting Bull College in Fort Yates, North Dakota, and the 2010 Water Management and Pollution Prevention program at Salish Kootenai College in Pablo, Montana.

Following the 2009 institute, Majorski added a water research project to the Mount Pleasant, Michigan, tribal college's chemistry course; it required students to examine nitrates and phosphate levels in the Chippewa River. The mini research project grew even stronger as a result of the 2010 Water Management institute as Majorski incorporated a multi-disciplinary approach and asked students to examine macroinvertebrates in the river water samples they collected. Class

attendance was consistently higher on the field test days and students scored an average of 94 percent on exams about the field tests, Majorski reported.

Majorski helped Saginaw-Chippewa Tribal College obtain a \$400,000 grant from the U.S. Department of Agriculture in 2010. With part of the grant, she created a new program that channeled students' concern about the environment into fun family math and science activities for the tribal community near Mount Pleasant, Michigan.

At Central Michigan University (CMU), where Majorski is a full-time chemistry laboratory coordinator and part-time doctoral student, she incorporated ideas from the institutes into a successful Course, Curriculum, and Laboratory Improvement grant from the National Science Foundation that she wrote with several colleagues. The equipment purchased with the grant is used by undergraduates to answer authentic, research-based laboratory questions.

Educator Leverages ATE Grants for Additional Funding

Two ATE project grants provided "mezzanine funding" for Diego James Navarro to implement his ideas for an affective learning model at the Academy for College Excellence (ACE) at Cabrillo College in Aptos, California. The ACE model, which Navarro describes as a heartfelt approach to, "Man, you gotta pull yourself up," helps economically disadvantaged, low-performing students advance quickly to college-level courses.

Navarro said the NSF grants helped him prove his ideas. The positive evaluation of his first ATE grant convinced several private foundations to provide millions of dollars in funding, enabling him to replicate the program originally called the Digital Bridge Academy.

The prestige of NSF and the structure of the ATE grant created expectations at the northern California college that the college would scale and sustain

the program. With the college incorporating the program in its operations, Navarro was able to gather evidence of the curriculum's effectiveness with multiple cohorts of students over several years.

"The other thing NSF helped me with was legitimacy, because I was kind of on the edge doing this affective work," Navarro said.

The ACE semester begins with a two-week, eight-hours-per-day Foundations of Leadership course to develop intrinsic self-management skills so the students take responsibility for their learning. The balance of the semester is a group of courses, including English and pre-statistics, that uses a social justice research project to facilitate students' learning in teams on multiple academic subjects simultaneously.

Navarro's current ATE project uses the ACE model for an integrated science program that accelerates students from developmental education courses to college-level chemistry, biology, and physics in one semester.

Student Finds Perfect Fit in Laboratory Science Program

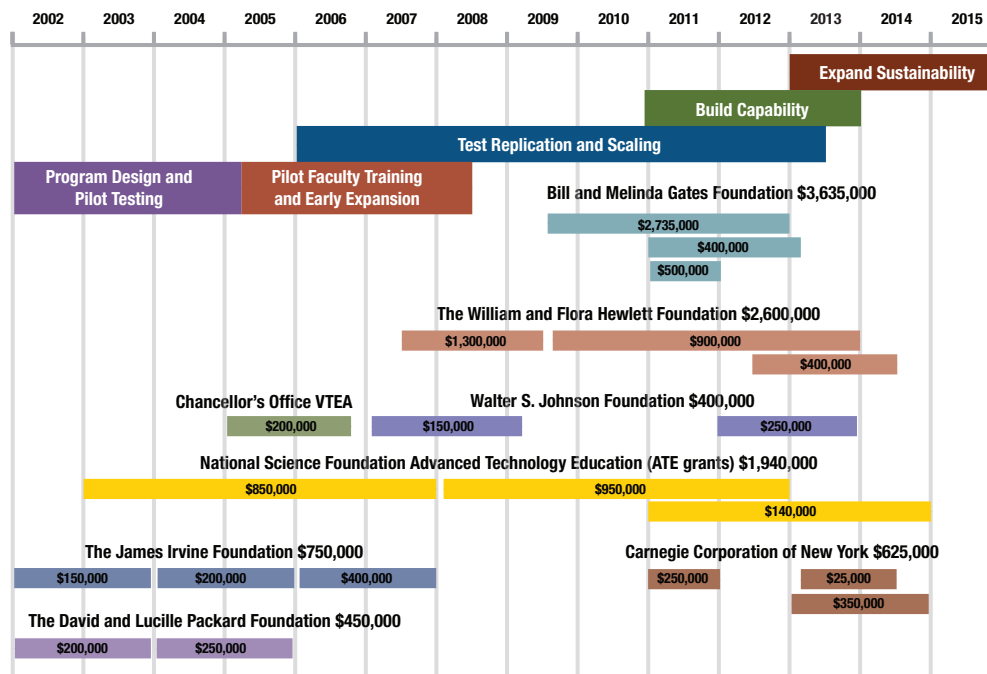
The Laboratory Science Program at Northern Essex Community College was a long-awaited "perfect" fit for Lindsey Curole.

Curole always wanted to work in a laboratory. But when Hurricane Katrina destroyed her New Orleans apartment, it forced a several-year delay in her education plans as she relocated with relatives in different parts of the country and worked to get back on track financially. Six months after settling in Massachusetts and getting a job as a hardware store cashier, Curole was able to enroll as an in-state student at Northern Essex Community College (NECC) in Haverhill, Massachusetts.

She chose NECC's Laboratory Science program, after looking at other colleges, because of the versatile skills it teaches. "We spent a lot of time in the lab and working on projects. I liked it that it was more hands-on," Curole said.

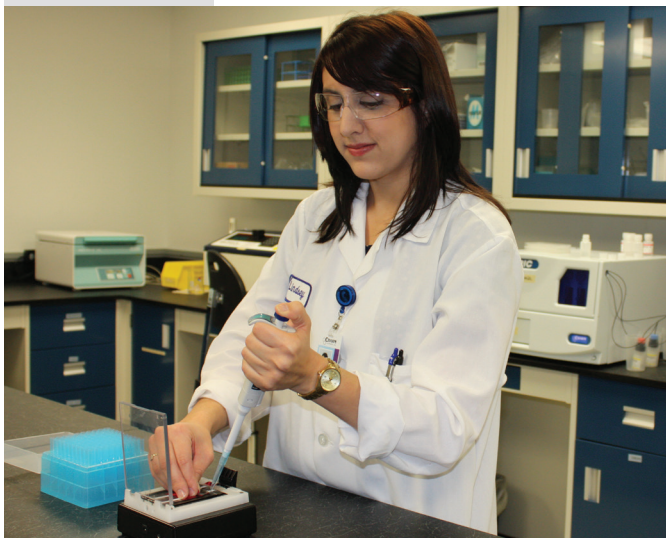
ATE Grants Provide "Mezzanine" Funding

Total Is Over \$10 Million



Source: Academy for College Excellence and Diego James Navarro

Diego James Navarro used two ATE grants to test and gather evidence about his model curriculum. These results helped him obtain additional funding for the Academy for College Excellence from other sources. Since 2002, Navarro has raised more than \$10 million to develop and replicate the program that helps economically disadvantaged, low-performing students advance quickly to college-level courses.



Lindsey Curole checks the diagnostic tests that Charm Sciences, Inc., makes for the food industry.

NECC professors Noemí Custodia-Lora, Marcy Vozzella, and Mariana Melo created the Applied Science Associate Degree program with an ATE grant. Their goal was to prepare students for entry-level laboratory technician positions at drug companies, cellular technology companies, manufacturing companies, and small environmental testing companies, as well as medical labs and government agencies. The professors are also using the ATE grant to support outreach efforts that target the growing Hispanic community in eastern Massachusetts.

Curole called the faculty and staff at NECC “amazing” and explained that their mentoring placed her on track in her dream career. NECC faculty designed the Laboratory Science Program to prepare students to enter the workforce immediately or to transfer to four-year colleges. Curole is doing both.

The internship she got at Charm Sciences, Inc., through the NECC program, led to paid employment as a quality control technician. As a student at the University of Massachusetts Lowell—she transferred immediately after completing her associate degree at NECC—Curole works part time during the school year and full time in the summer.

For her job, Curole checks the diagnostic tests that the company makes for the food industry. Her duties included mixing and testing various chemical solutions, calculating statistics from the results, and

charting these data in Excel®. In addition to employing her full time during the summer of 2013, Charm Sciences allowed Curole to use its facilities for a research project she is completing for college credit.

“I really enjoy where I’m working,” Curole said. Her long-term career goal is to become a clinical microbiologist.

Institute of Virtual Enterprise Adds Entrepreneurial Mindset to Technicians’ Skills

An entrepreneurial mindset is a skill technicians need to combine with technical competency for their intellectual tool belts.

This is because technical innovations in the future will require more adaptability, whether a technician works for a large company or operates his or her own business, according to Christoph Winkler, associate and curriculum director of the Institute for Virtual Enterprise (IVE) and Assistant Professor in Entrepreneurship at City University of New York’s (CUNY) Baruch College.

With ATE support beginning in 2005, IVE developed Virtual Enterprise (VE) curriculum at CUNY’s Kingsborough College in Brooklyn, New York, to infuse business and entrepreneurship skills into STEM programs. At the heart of VE is the IVE MarketMaker software, which enables students to exercise entrepreneurial skills by setting up virtual businesses and engaging in e-commerce in a safe, closed market. Students and educators in the U.S., Europe, Australia, and Africa participate in the IVE Global Collaborative.

More recently, IVE has used ATE support to teach educators in various STEM fields how to add entrepreneurial skills to their courses. At workshops and through a video series, IVE staff members teach other educators the process for incorporating entrepreneurial activities in ways that fit students’ interests and local economic realities. The teaching approaches that IVE recommends range from adding awareness of

entrepreneurship to classroom lessons, to having students develop virtual business ideas and pitch them on IVE's simulated global marketplace, to incubating actual start-up businesses on campus.

IVE's broad interpretation of entrepreneurship in STEM anticipates the outcome of shifts in the business landscape that increasingly push technicians to think of themselves as entrepreneurs rather than just wheels within the machinery of a particular industry.

"There is a high expectation of our graduates now that they become more integral components of business ventures," Winkler said, adding that good workplace communication skills have evolved to mean contributing ideas to help businesses grow.

He points out that this more reciprocal relationship between technicians and employers "requires the ability to adapt to change, to be proactive, to facilitate change."

Photonics Program Sharpens Student's Academic Plan

Conor Delaney describes himself as "a very hands-on kind of learner." During a mechanical engineering internship in the summer after his freshman year at a four-year college, Delaney found himself much more interested in the work going on in the machine shop than in checking designs at his desk.

"I knew that I didn't want to do something like sit in a cubicle and just design stuff that might work. I wanted to be the guy that builds those theoretical designs or tests [them]. . . and then if it's impossible tell them it's impossible, or even make it so it can be possible," he explained.

The Lasers, Photonics, and Optics program at the College of Lake County in Grayslake, Illinois, taught Delaney how to use his hands-on aptitude in cutting-edge science. Photonics involves the interaction of optics and electronics in state-of-the-art technologies. Photonics includes the use of lasers, fiber-optics, and electro-optical devices in many fields including healthcare and homeland security.

Steven L. Dulmes, chairman of the Lasers, Photonics, and Optics Program at the college, started the program with help from OP-TEC, the national ATE Center for Optics and Photonics Education in Waco, Texas. OP-TEC personnel told Dulmes about the job opportunities for students who know how to use photonics technology. They also advised him about how to contact employers and inquire about their needs for photonics technicians. Dulmes attended a summer curriculum workshop that OP-TEC offered to educators at no cost, thanks to funding from its ATE center grant.

What Delaney learned about lasers and other photonics devices in College of Lake County classes and during an internship at Domino Amjet, Inc., not only inspired him to pursue additional degrees, but also help him pay for them.

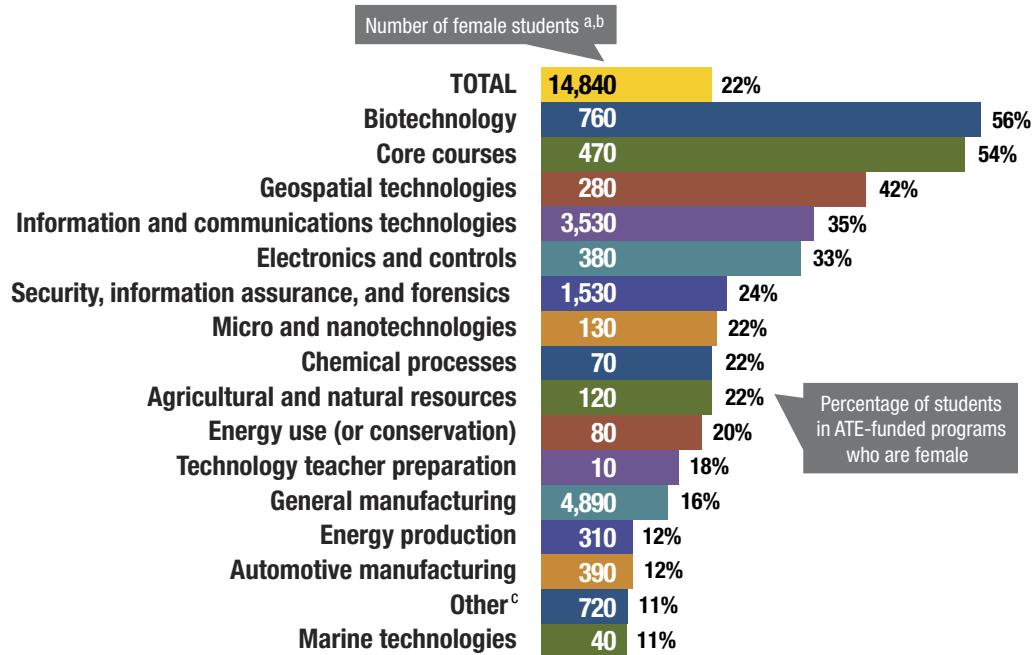
Delaney is now a physics major in a University of Northern Iowa program that provides a stipend for him to use optical spectroscopy for nanoplate research. "It was kind of like I was sought out because of my background," he said. He has co-authored papers for scientific journals and made presentations at academic conferences based on this undergraduate research.

"I'm not the greatest when it comes to theory, but when you put me in a lab environment, that's when I feel like I really shine and am able to come up with creative solutions on problems, and actually apply what I learn in classes," Delaney explained.



The photonics skills that Conor Delaney acquired at the College of Lake County inspired him to pursue additional degrees; the same skills are also helping him pay his tuition.

Women Enrolled in ATE Programs: 2012



^a Numbers are rounded to the nearest ten.

^b 120 respondents reported that their ATE grants supported instructional programs; of these, 109 reported gender data. With gender data not provided by 11 respondents, the number of women in ATE is being undercounted.

^c Respondents who defined their program area as "other" primarily were involved in multiple disciplines.

Source: EvalUATE

The percentage of female students in several ATE-supported programs exceeds the 24 percent proportion of women in the STEM workforce nationally. By discipline, the percentage of female students ranges from 11 to 56 percent. In ATE programs and in higher education nationally, it is an ongoing challenge to attract women to advanced technology fields.

IWITTS Shares Strategies for Recruiting & Retaining Women in STEM

For many female students even to consider a STEM career, they need personal encouragement from instructors or counselors. Women also need to see what a typical day looks like for women employed as technicians in STEM workplaces.

"It really helps if you have a counselor or instructor saying, 'This could be a good career area for you... I would like to see you check this out,'" explains Donna Milgram, executive director of the National Institute for Women in Trades, Technology, and Science (IWITTS) in Alameda, California. She was the principal investigator for two ATE projects that focused on effective recruitment strategies for women. The CalWomen Tech Project identified key aspects of successful recruitment and retention programs; the CalWomen Tech Scale Up Project shared the lessons IWITTS learned in the first CalWomen Project. The CalWomen Tech Scale Up Project converted two-day workshops at ATE centers into 10-week online learning communities for college faculty members.

IWITTS' professional development takes administrators, faculty, and support staff step-by-step as a team through the process for improving recruitment and retention. Its Women in Technology Outreach Kits contain customizable marketing materials, posters, and websites for community colleges to generate STEM career ambitions.

During the CalWomen Tech Project from 2006 to 2011, the enrollment of women in the targeted introductory technology courses increased at six of the seven participating colleges. Five of the colleges significantly surpassed their enrollment goals. The colleges also closed the gap between women and men on completion rates, and six of the colleges reported improved retention of male students as well as female students.

The strategies the colleges used to recruit and retain women included teaching students time management skills, teaching mathematics in the context of STEM workplace activities, and having labs open for extended hours for all students, with staff support from men and women of different races.

Milgram noted, “Many of these strategies that work well for women also work well for minorities.”

Colleges Adapt Bridge to Biotech to Help Students through Gatekeeper Courses

Community colleges around the country are adapting the Bridge to Biotech (B2B) program that the City College of San Francisco (CCSF) in California has used for a decade to help aspiring biotechnicians succeed in gatekeeper math and science courses.

Initial results from these new programs show more students persisting from semester to semester, a key milestone for degree completion initiatives. The hallmarks of the B2B are its three-course core of math, language, and science courses taught in the context of biotechnology workplace skills; team teaching of the core courses; and the placement of students in cohorts that take the core courses together during their first semester.

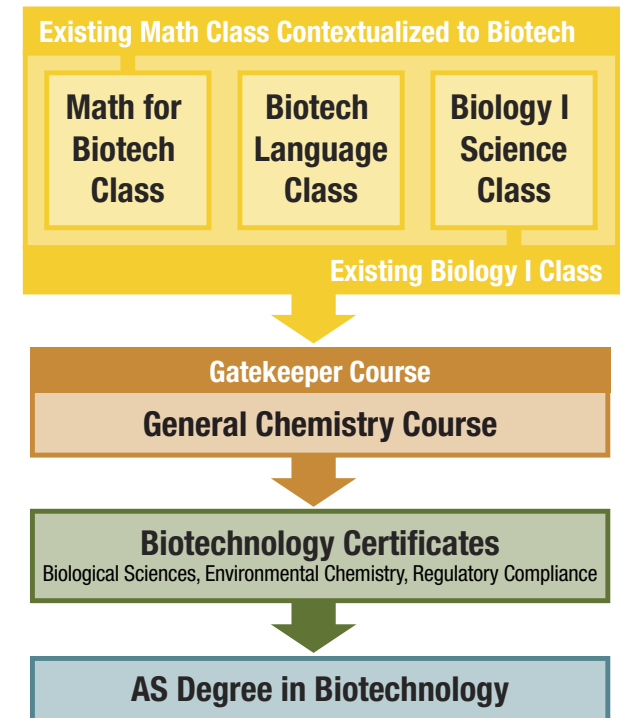
ATE grants to CCSF and Bio-Link, the National Advanced Technological Education Center of Excellence focused on Biotechnology and Life Sciences at CCSF, have supported the expansion of the B2B at CCSF and facilitated adaptations of the program at two-year colleges in the United States and Puerto Rico. SYNERGY, the ATE project that helped Bio-Link and 12 other ATE centers scale innovative programs, provided guidance for colleges to use the basic structure of B2B to improve students’ success in gatekeeper math and science courses.

Gatekeeper or gateway courses are the prerequisite courses students must complete before taking courses in their majors. Nationally, dropout rates are high in math and science gatekeeper courses for aspiring STEM majors. The colleges adopting B2B modified aspects of the program to fit the unique needs of their students.

“It’s not a cookie cutter,” Elaine Johnson, Bio-Link executive director, said of the learning community that has formed around the B2B. “We’ve learned that scale does not mean duplicating. We’re working with other colleges and learning from them and changing our bridge as well... They are adapting and using our materials and giving us feedback.”

Jeffrey C. Rapp, Biotechnology Program chairman at Athens Technical College in Athens, Georgia, said he modified the laboratory science requirement for a few students whose work schedules could not accommodate the three-course

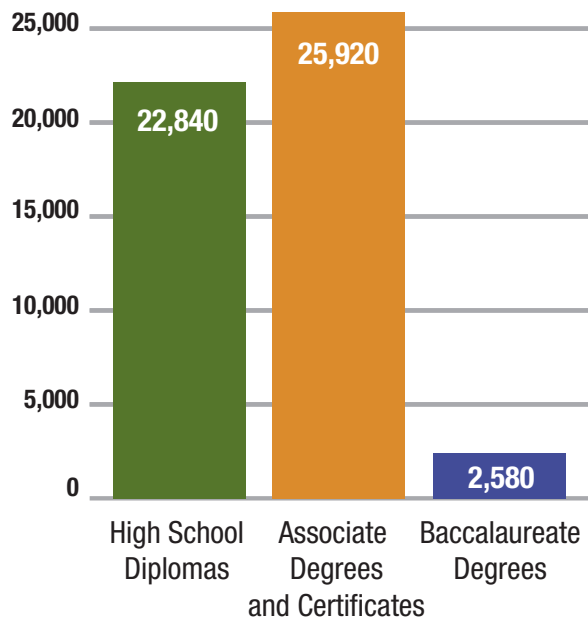
Bridge to Biotech Program at Athens Technical College, Georgia Launched Fall 2012



Source: Athens Technical College

Athens Technical College adapted the Bridge to Biotech’s model of teaching three core courses in the context of biotechnology workplace skills to improve students’ persistence.

Credentials Awarded to Students Enrolled in Programs with Active ATE Grants 2006-2012



Source: Evaluate

Students enrolled in programs with active ATE grants earned 22,840 high school diplomas, 25,920 associate degrees and certificates, and 2,580 baccalaureate degrees between 2006 and 2012.

core. Those students and the others in the first two cohorts of Bridge to Biotech at Athens Technical College in 2012-2013 did well.

All but one of the 21 students in the first two cohorts completed the core courses for credit. Four of the eight students in the fall 2012 B2B cohort are enrolled for fall 2013. Nine of the 13 spring 2013 B2B students are enrolled for fall 2013. The 50 percent and 69 percent retention rates from the first year of the program contrast to the high dropout rates aspiring biotechnicians previously had in Introduction to Biotechnology, College Algebra, and Chemistry I at Athens Tech. Prior to the designation of the B2B as the prerequisite to Chemistry I for biotechnology majors, students interested in biotechnology took the gateway courses with the general college population.

"It's very much improved. I think the biggest improvement has been starting the cohort early, the very first semester rather than after chemistry," Rapp said. In the past,

most biotechnology students at Athens Technical College moved through biotech courses together after they completed Chemistry I.

Unfortunately, many students who hoped to become biotechnicians never made it that far because Chemistry I was an insurmountable hurdle for them.

During 2013-2014, Rapp plans to add a Biotech Mentor program similar to the one CCSF has used successfully. Until he has more quantitative data, Rapp finds it encouraging that B2B students are voluntarily coordinating their schedules to take Chemistry I and other classes together. Though the program is new and small, he sees this as promising evidence that one of the lingering effects of B2B will be that students will help each other persist.

Compendium of Research on Technician Education

A searchable Compendium of Research on Technician Education is available on <http://www.TeachingTechnicians.org>.

When the compendium was launched in 2013 by the South Carolina Advanced Technological Education (SC ATE) National Resource Center for Expanding Excellence in Technician Education, it contained more than 300 entries of published research on technician education and related topics. More entries will be added when they appear in peer-reviewed journals and other sources.

"This is information that has never been pulled together before," said Elaine Craft, director of SC ATE. "These are the kinds of things we think people should look at, know about, and use to inform their work." As more educators learn what works from the research included in the compendium, Craft said she hopes it will influence educational program formation, grant proposals, and future research on technician education.

4 ATE Sparks State, Regional, and Crosscutting Initiatives

In addition to facilitating transformations on community and technical college campuses, the ATE program has sparked numerous statewide, regional, and crosscutting initiatives that improve student outcomes and technician performances in their workplaces.

Improvements have occurred in many fields over the past 20 years because ATE principal investigators have effectively used their ATE grant funds and the prestige associated with receiving support from the National Science Foundation to engage business and industry leaders in meaningful conversations and purposeful activities that get results.

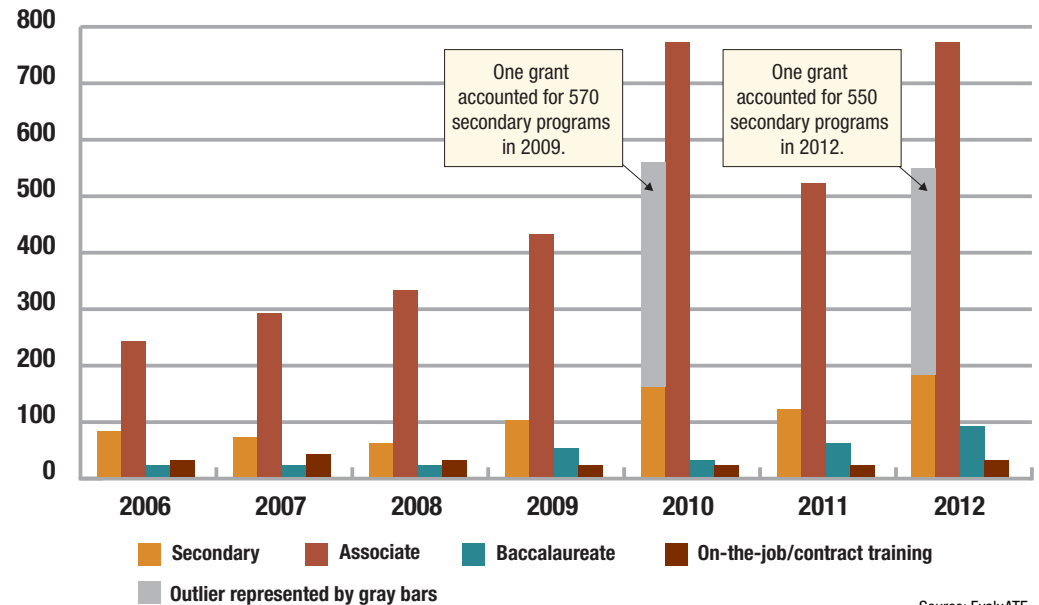
Educators from every sector—kindergarten to university-level—have joined community college educators in the development of innovative education programs because ATE’s broad definition of technician preparation encompasses all types of science, technology, engineering, and math (STEM) education and career paths.

By convening meetings of these various stakeholders, ATE principal investigators facilitate open dialogue and lay the groundwork for processes to accomplish ambitious goals. Persistent effort by many people is necessary to establish seamless articulation agreements from high schools to two-year colleges to universities, or to standardize curricula for an entire technical field, or to build courses that “stack” for industry-recognized credentials and degrees. ATE-led initiatives have overcome the bureaucratic hurdles involved in multi-institution and interstate agreements. ATE programs have also challenged educators to adjust their pedagogy and update the topics they cover in their courses, and provided the professional development for educators to make these changes.

Recognizing that developing outstanding programs involves recruiting students to enroll in them, ATE projects and centers include recruitment

and retention in their outreach activities. The high quality of ATE’s statewide, regional, and crosscutting initiatives strengthens career paths that prepare technicians not just for jobs with particular employers, but for careers that can evolve with new technologies.

ATE-Supported Programs by Education Level 2006-2012



Source: Evaluate

The number of programs with ATE support has grown steadily throughout the program’s history.

FLATE Leads Partnership for Stackable Statewide Credentials that Meet National Manufacturing Industry Standards

Thanks to Florida's Engineering Technology degree, 11 Florida community colleges made it on the Manufacturing Institute's "M-List" for offering credentials that align with the National Association of Manufacturers' (NAM) Endorsed Manufacturing Skills Standard Certification (MSSC). Only 16 states made the charter M-List in 2013, and most of the states have only one or two colleges with curricula and credentials aligned to NAM's expectations.

"We market the ET degree to students and industry as a statewide degree so industry has a better idea of what they are getting in the programs," said Marilyn Barger, principal investigator and executive director of the Florida Advanced Technological Education Center (FLATE) at Hillsborough Community College in Brandon, Florida. The NAM endorsement means students' credentials are recognized by manufacturers throughout the U.S. if students want to re-locate outside of Florida.

In Florida, manufacturers are beginning to list the ET degree as a preferred credential when they hire technicians.

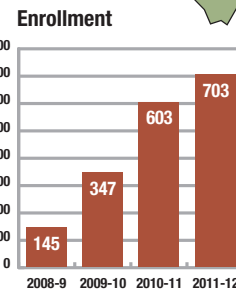
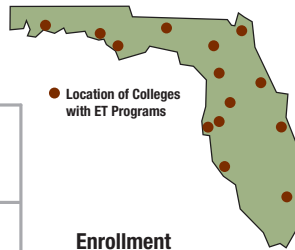
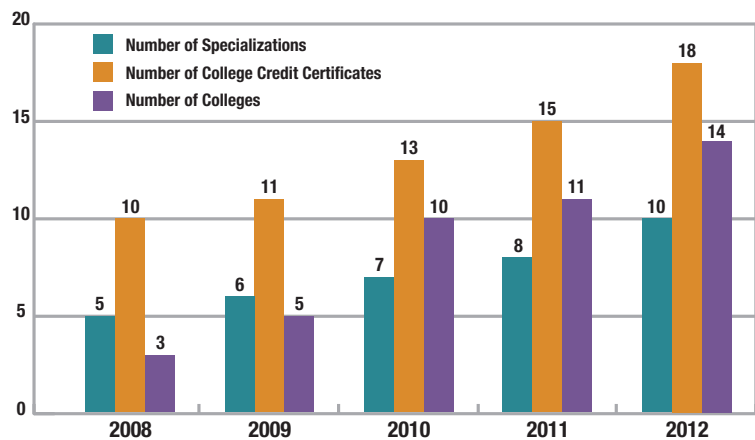
Michael Ennis, a manufacturing engineer who manages environmental health and safety at Harris Corporation, said, "Harris values the ET degree program graduates. The knowledge they gain from classes and the experience they gain in the lab gives them a thorough understanding of the subject matter. They come to the manufacturing floor with a higher level of confidence and self-assurance. Graduates of the ET program also increase their opportunity for doing more challenging work."

Barger said the ET degree that now serves students and employers well would not have been possible without the ATE funding that created FLATE in 2004. Developing a uniform system for manufacturing education among the two-year colleges in Florida was one of the center's goals because "individual schools were working in silos rather than collaborating."

Students and employers were confused by the competition and lack of coordination among the colleges. Students had difficulty transferring credits because the programs used different course names and numbers; employers were unsure what skills students had acquired.

With the imprimatur of the National Science Foundation, FLATE convened a meeting with manufacturing educators from across Florida to discuss how to coordinate manufacturing education. A color-

Engineering Technology AS Degrees Key Milestones 2008-2013



Source: FLATE

In 2014, two more Florida colleges will join the network of 14 colleges that offer the Engineering Technology degree with stackable credentials for aspiring and employed technicians.

coded display of all the colleges' manufacturing courses made the commonalities obvious and helped the colleges reach consensus on how to proceed.

By 2013, FLATE's Engineering College Network included 14 colleges. The ET programs at three of the colleges were too new to qualify for the M-List with the 11 others in the network. FLATE markets all the network colleges' manufacturing education programs together, and it individually lists each college's manufacturing specializations. Two additional colleges are slated to adopt the ET degree in 2014.

The specialized courses that students take in the second year of the program fit the needs of employers near the colleges. The specializations available in different locations include alternative energy, digital manufacturing, electronics, and biomedical systems.

FLATE's partnership with colleges, high schools, the Florida Department of Education, and industry to create the ET degree opened up significant new career pathways for high school students and employed technicians.

High school students can earn 15 college credits by completing high school courses that fulfill the requirements of the ET core.

Employed technicians may take the MSSC Certified Production Technician (CPT) exam, which covers the content of the ET core. Those who pass the MSSC-CPT exam earn 15 credits toward their ET degrees, once they enroll in the degree program. Sun Hydraulics is one of the large manufacturers that works with colleges to adapt its in-house educational programs to prepare experienced technicians for the MSSC-CPT exam. The statewide articulation agreement also allows any U.S. resident who holds a valid MSSC-CPT credential to complete the ET degree by earning 45 credits, rather than 60 credits.

Many large companies pay for their employees to continue their education. The multiple ways of earning credits toward the ET degree

help employed technicians in Florida earn raises or promotions more quickly, and help newcomers get an accelerated start on a degree that will help them advance in their careers. For students who want to go beyond the two-year degree, the Associate of Science in Engineering Technology articulates seamlessly with Florida state colleges' Bachelor of Science degree in Engineering Technology and Bachelor of Applied Science degrees.

Bellevue College Leverages Federal Grants and Industry Association Partnership to Open Pathways to Health IT Careers

Bellevue College's Life Science Informatics Center meshed an ATE project grant with two large federal grants to create an industry-recognized credential, preparatory curriculum, and set of career pathways for people who want to become health information technology (IT) technicians.

The three grants—totaling nearly \$20 million since 2010—build on the expertise that the college gained by operating the National Workforce Center in Emerging Technologies. This national ATE center was funded by the National Science Foundation at the college in Bellevue, Washington, from 1995 to 2002.

"All of our efforts were informed by that center. It was a huge stimulus to our college and for our learners," said Patricia Dombrowski, director of the Life Science Informatics Center. "It's been almost astounding how all these pieces have fit together," she added.

Health-care providers' demand for IT technicians is high and is expected to remain strong in the future due to federal government incentives for hospitals and physicians to switch from paper to electronic medical records. However, the information technologies

used in health care are so new and the variety of employers so great that navigating this field is difficult even for people who have IT skills from other fields or who are already employed in health care.

As evidence of the unmet demand for health IT skills and documentation of incumbent worker skills, Dombrowski cites the tremendous response to an online course that the college developed for Veterans Administration (VA) employees. The VA had expected a few hundred employees to take the online course on their own time. But by the middle of the first day that VA employees nationally could enroll in the 10-week introduction to health IT course, all 1,000 slots were filled, and another 1,000 people were placed on the waiting list.

ATE Grant Supports Development of CAHIMS Credential

With the \$509,638 ATE project grant that Bellevue College received from NSF in 2010, it developed a course and certification exam for aspiring entry-level IT technicians to gain entry to this promising IT sector, and for those already working in health IT to document their skills.

NSF's mission does not include the medical sciences, which are the realm of other federal agencies. Bellevue College's ATE grant, therefore, focused on the IT technicians who work on databases, networks, and the IT infrastructure of health-care providers. It does not involve technicians who use advanced technologies to provide patient care directly.

For the ATE project, Bellevue College personnel developed the Certified Associate in Health Information & Management Systems (CAHIMS) credential with the Health Information and Management Systems Society (HIMSS). The society is the world's largest IT professional health association. CAHIMS is a stackable, industry-recognized credential that provides a pathway to an upper management credential the society offers.

The National Training and Education Resource website, <http://www.nertraining.org>, offers the free, online preparatory course for the CAHIMS

exam. Applied Measurement Professionals, Inc., administers the CAHIMS exam at its assessment centers nationwide.

Two Other Grants Complement ATE Project

At the same time that Bellevue College was working on its ATE project, it received a \$6.7 million grant from the U.S. Department of Health and Human Services' Office of the National Coordinator for Health Information Technology to lead implementation in a 10-state region of IT health curricula developed by the federal government. "It worked out beautifully. One [grant] very much referenced the other. One very much strengthened the other," Dombrowski explained.

Then in 2012, the Department of Labor (DOL) awarded Bellevue College \$11.8 million to lead a consortium of nine community colleges in a national effort to help develop a much-needed health IT workforce. The consortium aims to improve the skills of health IT technicians, to welcome military veterans into the sector, and to boost the uptake of the CAHIMS curriculum by community colleges.

As part of the DOL grant, the Bill and Melinda Gates Foundation provided funding to Carnegie Mellon University's Open Learning Initiative to work with Bellevue faculty on metrics for every aspect of the online CAHIMS preparatory course. This complete "wiring" of the course will provide immediate feedback to students, who can take the course on their own, and analysis for faculty who choose to incorporate the course into their college's IT curriculum.

Bellevue College is also using the DOL grant to work with HIMSS on an initiative to welcome, assist, support, and help place veterans into health IT employment positions. In 2013, 600,000 veterans were unemployed and another 300,000 service members were expected to reenter the civilian workforce. A HIMSS Hero's Welcome to Health IT program will complement the federally registered apprenticeship program in health IT that the consortium is developing.

Finally, the consortium is developing and piloting additional IT health certificate courses and offering professional development for allied health faculty and IT faculty. “Both of them are charged with teaching IT in health care, but few [members of either faculty] have experience within the other’s domain,” Dombrowski said.

Four ATE Centers Build Cybersecurity Workforce

Four ATE centers focus on providing technicians with the hands-on skills and academic knowledge necessary to work on the front lines of defending the nation’s computer networks.

Each of the ATE cybersecurity centers develops and disseminates high quality curricula and faculty professional development programs that meet government and industry standards. Each center also offers unique programs and brings particular strengths to ATE collaborative activities that build the cybersecurity workforce. The centers, for example, worked as a team with the National Initiative for Cybersecurity Education to develop model articulation agreements. Three of the four centers partnered with another ATE center to create the National Cyber League for student competitions.

Because the threat of malicious activity poses a significant economic and national security risk to the nation’s computer networks and the vast infrastructure connected to them, cybersecurity has long been an NSF priority. Recognizing that highly skilled technicians are vital to the security of these critical assets, the ATE program provided support to the American Association of Community Colleges in 2002 to convene a workshop on community colleges’ role in cybersecurity education. The recommendations from the experts who attended the meeting have influenced the NSF’s investment in community college programs.

The National CyberWatch Center at Prince George’s Community College in Largo, Maryland, was an early developer of model

information assurance curricula for associate degree and certificate programs. It focuses on network security: preparing technicians to secure the software that runs on computers and the devices that connect to computer networks.

As the national center for cybersecurity education within the ATE program, CyberWatch serves as the focal point for the community college voice in cybersecurity. CyberWatch also supports extensive K-12 outreach activities, including curricula as well as in-school, after-school, and summer programs.

Since it began as a consortium of 10 institutions in the Washington, DC, metropolitan area, CyberWatch has grown to include 56 community colleges and 59 universities in 33 states and the District of Columbia. The center interacts frequently with the National Security Agency (NSA) and the Department of Homeland Security (DHS) on cybersecurity education issues.

CyberWatch’s first principal investigator, Vera Zdravkovich, provided the leadership that resulted in the addition of two-year colleges to NSA/DHS’s prestigious certification program. Colleges must meet a rigorous set of standards to qualify for the National Centers of Academic Excellence in Information Assurance 2-Year Education Program known as CAE2Y. CyberWatch mentors community colleges through the federal application process and developed a structure to help institutions keep their curricula up-to-date as standards change.

The National Resource Center for Systems Security and Information Assurance (CSSIA)

at Moraine Valley Community College in Palos Hills, Illinois, began with six institutional partners in the Midwest. It now has collaborative partnerships and affiliations with colleges and high schools throughout the U.S.

CSSIA’s Virtualization Data Center serves as a secure, centralized, remote online library of learning objects with a safe environment



A program security specialist with the Oklahoma Department of Community and Technology Education prepares equipment to teach the Oil Pipeline Structure and Operation course in the Control Room Training Center of Central Technology Center, a CSEC partner in Cushing, Oklahoma.

for cybersecurity students to practice their skills. Faculty from across the nation use CSSIA's materials in their courses or as supplemental lab exercises for students. CSSIA's virtual gymnasium provides real equipment like routers, switches, and firewalls running on real operating systems in an environment safely separated from colleges' computer systems. CSSIA expands this environment into a virtual competition stadium for student cybersecurity competitions.

The Cyber Security Education Consortium (CSEC) is a partnership of community colleges and career and technology centers in Oklahoma, Arkansas, Colorado, Kansas, Louisiana, Missouri, Tennessee, and Texas, and the University of Tulsa. The university serves as the principal training entity and mentor to 49 two-year institutions.

Over the past several years, CSEC institutions have designed and implemented rigorous cybersecurity curricula encompassing five core areas: information assurance principles, secure electronic commerce, network security, enterprise security management, and digital forensics. These core areas cover the breadth of the discipline, including its technical, operational, and managerial dimensions, and legal and ethical issues. New CSEC institutions model degree and certificate programs based on the five core areas.

CSEC's newest curriculum is for Supervisory Control and Data Acquisition (SCADA) Systems that control large automated systems in everything from "smart houses" to nuclear power plants. Its Control Room Training Center at the Central Technology Center in Drumright, Oklahoma, educates entry-level technicians and technicians who are already working at energy companies throughout the United States. The center is near Cushing, Oklahoma, a small city known as the "Pipeline Crossroads of the World" because of the interconnected pipeline systems and many large storage tank facilities located in and near it.

CyberWatch West at Whatcom Community College in Bellingham, Washington, is developing programs to strengthen the cybersecurity workforce in 14 western states. The large populations of minority students enrolled at four core education partner institutions are the primary focus of the center's cybersecurity career recruitment efforts. The consortium also has affiliations with 30 other postsecondary institutions.

CyberWatch West has tailored its professional development programs in response to educators' requests. It added mentoring to online programs, which it developed so faculty do not have to travel to improve their cybersecurity skills. Its "My Own Course" program allows educators to develop distinct cybersecurity courses and labs with the help of an instructional designer. The center allows participants to use its facilities to host online labs for the new courses they develop.

The National Cyber League was created by CSSIA, CyberWatch, CyberWatch West, and the Mid-Pacific Information and Communications Technology Center of the City College of San Francisco. Unlike other cybersecurity competitions, the league provides a sequence of competitions in cyber stadiums that allow for more competitors than can usually be accommodated in one-day, in-person events. The competitions are currently aligned with preparations for industry certifications. In response to the National Initiative for Cybersecurity Education and market trends, National Cyber League competitors may soon compete within particular “job roles.”

Collaboration: The Ethos of ATE

For ATE principal investigators, collaboration is not a buzzword: it is an ethos.

As a group, ATE principal investigators routinely and openly share ideas, results, and the other “products” of their ATE grants. This spirit of connectivity frequently leads to new activities and partnerships intended to lift the entire community.

“Success in ATE ultimately invokes collaboration; either it requires it or somehow develops it,” said Michael Lesiecki, executive director since 1996 of the Maricopa Advanced Technological Education Center (MATEC) at the Maricopa Community College District in Phoenix, Arizona. Lesiecki dates the ATE centers’ collaborations to 1999 when the 11 centers that existed at that point decided to exhibit together not only to showcase their work but also “to convey this message that we’re more than each of us.”

The shared experience of exhibiting their ATE programs together at education and industry conferences reinforced the common goal to improve advanced technological education. Other collaborations followed, usually involving two or three centers working together. Then in 2009, 26 centers decided to produce a major conference together and the annual HI-TEC conference was launched. It was modeled after

“At Jefferson, NSF ATE grants over the past 20 years have had a significant impact on our work in a number of areas, including math, physics, and information technology, as well as geospatial and automotive technology. Without ATE funding, it is unlikely Jefferson would enjoy its position on the leading edge of technology education.”

Anthony Newberry

*President and CEO of Jefferson Community and Technical College
Louisville, Kentucky*

the SAME-TEC conference that MATEC had run to connect technical educators with representatives of the semiconductor, automated manufacturing, and electronics industries. HI-TEC has become the place where ATE program leaders inform technical educators about the ATE program. “The development line was clearly from MATEC, but then quickly grew into something that no single center alone could manage or produce, and then the consortium of centers took it on,” Lesiecki said.

In recent years, MATEC has leveraged the experience it gained as an early designer of professional development webinars for semiconductor instructors to create and host webinars for ATE projects and centers as well as other Maricopa community colleges. Other ATE centers have done similar outreach in their own fields.

At the 2010 HI-TEC Conference, the ATE principal investigators honored Lesiecki for his work as the unofficial mentor and facilitator of many ATE collaborations. Lesiecki insists that he has acted much like the other ATE center principal investigators who provide the “glue” that holds together collaborations within and across disciplines. He points to the annual ATE Principal Investigators Conference, ATE Central, and EvaluATE as other program-wide entities that foster collaborations.

All these collaborations are critical connectors that stimulate new avenues for learning and expanding STEM opportunities for faculty and students.

"In any technology topic today the skills that students need are often at the intersections of disciplines," Lesiecki said. Citing MATEC's partnerships with OP-TEC and the ICT Center as an example, Lesiecki said, "By having those collaborations among those disciplines it really helps faculty and students see the crossing of the disciplines. That's where they're going to work. They're not going to be isolated in their single world of photonics. They really are going to need that."

These crosscutting collaborations, he said, "expand faculty horizons and ultimately that translates to students' abilities, as well."

Crosscutting ATE Projects & Centers

ATE Central is a program that supports and showcases the work of the ATE community through its online portal, customized technologies, and other services. It helps connect educators, students, and the general public to the free curriculum, resources, and events created by ATE projects and centers. Its weekly blog brings the work of ATE-affiliated educators and the accomplishments of students enrolled in ATE-supported programs to wider audiences. <http://atecentral.net>

EvaluATE is a center designed to strengthen the ATE community's evaluation knowledge base and expand the use of exemplary evaluation practices by providing guidance, materials, webinars, and workshops to the ATE community. <http://evalu-ate.org>

HI-TEC is the annual High Impact Technology Exchange Conference that encourages educators, counselors, workforce development advocates, technicians, and industry professionals to learn more about ATE materials, model programs, and faculty development opportunities. <http://highimpact-tec.org>

Mentor-Connect is a mentoring program that helps colleges new to the ATE program learn to prepare competitive National Science Foundation grant applications.

<http://teachingtechnicians.org/MentorConnectLanding.aspx>

MentorLinks is a mentoring program to help two-year colleges start or improve a technical education program.

<http://aacc.nche.edu/Resources/aaccprograms/mentorlinks/>

TeachingTechnicians.org is a website that lists professional development programs for technical educators.

<http://www.teachingtechnicians.org>

5 ATE Fosters Collaborations Among Education Sectors

The National Science Foundation recognizes that educators in every education sector—elementary, secondary, community college, or university—bring unique talents that can help the ATE program achieve its goal of improving the quality of technician education. By involving educators who interact with students at every level of schooling, ATE smoothes matriculation processes, builds continuity in programs, and helps innovations take root.

As a complement to its focus on technician education at two-year colleges, the ATE program provides funds to support middle school and secondary school summer programs and after school activities that improve adolescents' math and science skills. These activities also increase teens' and parents' awareness of technician career opportunities in science, technology, engineering, and math (STEM). ATE professional development for pre-service teachers and experienced instructors simultaneously builds educators' pedagogical skills and the math and science knowledge of the next generation of STEM technicians and teachers.

Tech Apprentice Program Has Strong Record in Boston

The Tech Apprentice program is an example of an effective career outreach program ATE supports for high school students.

Since launching the Tech Apprentice program in 2006, program administrators have secured 758 paid summer internship placements with major corporations and non-profit organizations throughout the metropolitan area for Boston Public high school students interested in information technology (IT) careers.

From 2006 to 2013, 597 students have participated in Tech Apprentice, with males making up 63 percent of the racially diverse interns; 37 percent have been females.

Of the 123 interns in 2012, 47 were seniors, and all 47 went on to college. Of the 131 interns placed with employers in 2013, 54 were seniors and 98 percent of them were enrolled in postsecondary education by the end of summer. This is an extremely high college-going rate for students from an urban district where the four-year high school graduation rate ranged from 59 percent to 66 percent from 2006 to 2012.

The Tech Apprentice program is operated jointly by the ATE-supported Broadening Advanced Technological Education Connections (BATEC), the Boston Public Schools' TechBoston, and the Boston Private Industry Council.

BATEC, an ATE National Center of Excellence for Computing and Information Technologies at the University of Massachusetts Boston, uses the successful Tech Apprentice program as a model for IT internship programs at high schools, community colleges, and universities in other cities.

"Our research indicates that the regional focus on the centers is an important one, and that it plays out differently at each center because the regions differ in size, heterogeneity of labor markets, and economy... The workforce expansion focus undoubtedly has the widest impact, by providing training to large numbers of faculty who in turn could teach courses and content to students that would otherwise not have been available."

*ATE Regional Centers: Community College Research Center Final Report (2007)
by Monica Reid, Jim Jacobs, Analía Ivanier, Vanessa Smith Morest
Community College Research Center
Teachers College, Columbia University, New York*



These Tech Apprentices got top-notch work experiences during their summer 2013 internships. From left to right in the front row, Ivana Pham worked as a help desk technician at John Hancock; Safwa Ali was a technical intern at Fidelity Investments; Janice He was a graphic design intern at Divya Energy, a startup company. On the far right is Teresa Alleyne, the career specialist at Boston Latin Academy who refers students to the Tech Apprentice Program. In the middle row, Bonnie To worked as a Boston Public Schools Cyber Safety Mentor; and Dan Minh Chu did database management for the Global Product and Platform Solutions Department at State Street Corporation. While a student at Boston Latin Academy, Chu was the student representative on the Boston School Committee. In the back row, Jonah Saunders gained network experience at Boston Financial Data Services; Victoria Okafor worked as a Boston Public Schools Cyber Safety Mentor; Janemary Okafor worked in the Client Technology Services Management Department at State Street Corporation.

BATEC Adapts Tech Apprentice Model for Community Colleges and Universities

BATEC adapted the Tech Apprentice program to serve students at Quinsigamond Community College, MassBay Community College, and Bunker Hill Community College in Massachusetts. Support for the expansion of the IT internship program to community colleges came

from SYNERGY, the ATE grant that helped 13 ATE centers scale innovative programs. Based on this experience, BATEC is now working with partners in Chicago, San Francisco, and Las Vegas to develop internship programs for underserved high school, community college, and university students.

Deborah Boisvert, BATEC Executive Director, said each Tech Apprentice program helps students acquire the higher-order skills that employers want. She said, "New IT jobs demand sophisticated and imaginative computing knowledge combined with the ability to think and act in an entrepreneurial fashion."

Austin Community College Biotech Teacher Preparation Program Continues to Grow

Partnerships built to meet ATE grant requirements are keeping an ATE teacher education program going and growing long after NSF funding for it ended.

In 2000, biotechnology faculty at Austin Community College (ACC) used an ATE grant to adapt their introductory course as professional development for high school teachers. The grant expired in 2006, but the department's high school education efforts have continued to grow and reach a new generation of teachers.

In 2009, ACC's Introduction to Biotechnology course was adopted as the standard curriculum for a yearlong elective; the course counts toward the four years of science that are required to graduate from high school in Texas. More recently, the Texas Education Agency awarded ACC's Biotechnology Department a grant to develop an online biotechnology certification program for high school teachers.

"I took very seriously the part of the grant application that said it had to be sustainable, because I didn't want it to go away," said Linnea Fletcher, principal investigator and chair of the Biotechnology Department at ACC.

As she worked to create a program that would last, Fletcher followed the advice of her project evaluator: to treat the high school teachers as collaborators. The first essential partnership was with the veteran and pre-service teachers who took the three-week summer institute Fletcher created with NSF support. At the project evaluator's suggestion, Fletcher focused her instruction on biotechnology and lab skills, and she let the teachers devise the best ways to convey this material to teenagers in high school classrooms.

Teachers involved in the ACC Biotechnology High School Teacher Network would soon take even more responsibility for implementation. They came up with a plan whereby teachers who had gone through the institute could mentor new biotechnology teachers.

The teachers also recommended allowing novice teachers to borrow equipment from ACC's lending library for three years until their districts' incremental purchasing fully equipped their high school labs. After three years, the novice biotech teachers become mentor teachers.

"It's a huge network that has a life of its own that doesn't need me to coordinate," Fletcher said. "It's reaching a second generation of teachers."

One of those mentoring the second generation is Jennifer Keelen Lazare. Lazare attended the ATE-supported professional development program as a pre-service teacher when she was enrolled in The University of Texas at Austin's UTeach program. She quickly learned that "biotech was really fun to me."

Lazare was hired by Anderson High School in Austin when she completed her master's degree and teaching certificate. After a year of teaching a prescribed version of Integrated Physics and Chemistry, Lazare obtained district approval to teach a biotechnology course. Lazare also became active—first as a mentee, now as a mentor—in the ACC Biotechnology High School Teacher Network. She has gone on to develop iBook content for ACC's online teacher certification course.



Ellen Lynch (left) and Rachel Hall (right) are among the second generation of Texas high school teachers being prepared to teach biotechnology by a program Austin Community College started in 2000 with an ATE grant. Their mentor is Jennifer Keelen Lazare (center), who attended ACC's professional development program more than 10 years ago as a pre-service teacher.

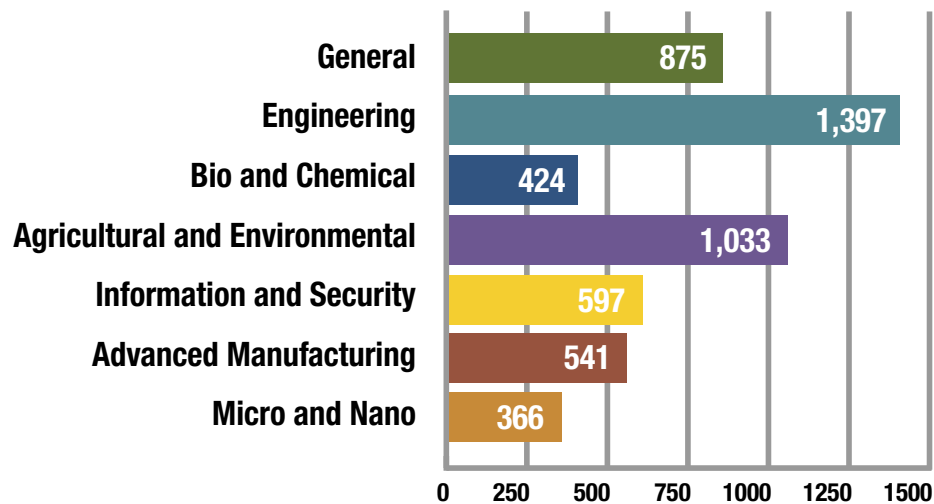
Today Anderson offers eight sections of biotechnology, appealing to a wide variety of students. "Through my biotech program and my dual-credit [biology for non-science majors] program, I've kind of created the perfect classroom for everyone," she says. "I have AP [Advanced Placement] students that take biotech, and I also have kids who've never taken a weighted science class in their life, and they're all successful in here. And they all want to be here."

One student who especially thrived in Lazare's biotechnology class was Ellen Lynch, who returned to Anderson High School as a student teacher in the spring of 2012. Lynch said she sought this placement because Lazare's instructional style was the most student-centered she had ever experienced.

Lynch was hired immediately after her 2012 graduation from The University of Texas at Austin by the Spring Branch Independent School District near Houston to teach biology. At Lazare's advice, she waited to complete her first year of teaching before starting a biotech program at Spring Woods High School.

Meanwhile back at Anderson, another passionate young teacher is learning about biotechnology from Lazare. Rachel Hall interned with Lazare during 2012-2013 and attended Lazare's biotech workshop in the summer of 2013. Hall currently teaches biology at Anderson, but Lazare expects her to be ready to teach biotechnology classes in the near future.

5,036 ATE Resources in ATE Central



Some resources appear in more than one classification, so numbers in bars add up to more than total resources.

Source: ATE Central

In 2013, ATE Central's collection contained 5,036 resources created by ATE centers and projects for educators and the general public to use for free.

ATE Principal Investigators Are Authors Too

Career Pathways for STEM Technicians, written and compiled by Dan M. Hull, offers a practical solution to America's technician shortage in science, technology, engineering, and mathematics (STEM) fields.

Hull likens the technical workforce to a three-legged stool, consisting of scientists, engineers, and technicians. The shortest leg of this stool is technicians, whom Hull calls "the geniuses of the labs and masters of the equipment."

Hull is executive director of the National Center for Optics and Photonics Education (OP-TEC), an ATE Center in Waco, Texas. He is a registered professional engineer with over 13 years of experience in laser engineering and management, and 30 years in technical education research and development.

In the book, Hull and several ATE principal investigators as well as other contributors describe how ATE initiatives and other education programs can help solve the nation's pressing need for more technicians. The book advocates for clearer career pathways from the 4,000 STEM high schools already in existence to community college associate degree programs in emerging technologies.

NACK Network Develops Novel Ways to Share Nanotechnology Equipment

The Nanotechnology Applications and Career Knowledge (NACK) Network makes research universities' nanotechnology equipment available to community college students and educators.

The network's model of sharing expensive nanotechnology facilities is based on a Pennsylvania-wide partnership the Center for Nanotechnology Education & Utilization (CNEU) at Pennsylvania State University developed with ATE support.

"We believe that utilizing the resources the U.S. government has invested in is a really good thing to do... for the good of the national workforce, doing this is the right thing to do," said Robert K. Ehrmann, managing director of CNEU. The center operates both the statewide partnership and the national NACK Network from Penn State's campus in State College, Pennsylvania.

Beginning in 1998 as an ATE regional center, CNEU utilized Penn State's nanotech facilities as the basis for the research university's first statewide initiative with Pennsylvania's community and technical colleges. The resulting Pennsylvania Nanofabrication Manufacturing Technology (NMT) Partnership created a four-semester technician program that culminates with two-year college students completing a six-course, capstone semester in the teaching cleanroom at Penn State's flagship campus. The state government covers the difference between the students' community college tuition and Penn State's more expensive tuition.

The success of the two-year college program led Pennsylvania's system of four-year colleges and universities to join the NMT partnership in order to provide baccalaureate students with nanotechnology capstone experiences.

By mid-2013, 774 students from 42 postsecondary institutions had completed the nanotechnology capstone semester.

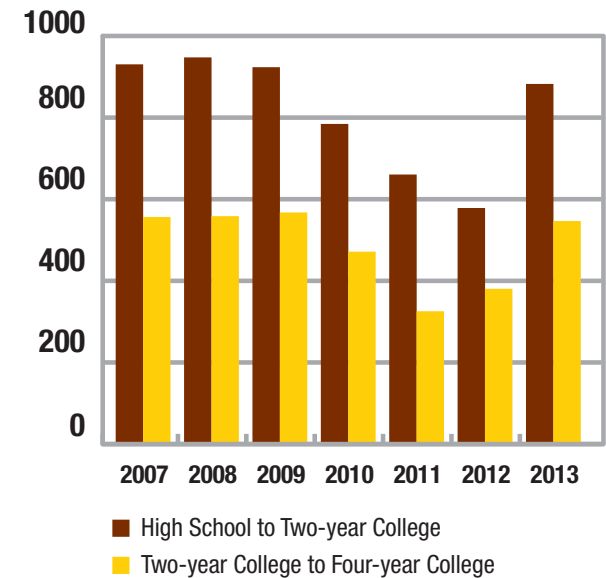
Ehrmann reports that more than 140 companies employ capstone graduates. Some graduates work as nanotechnicians, but most have jobs that require nanotechnology skills but do not have "nano" in their titles. These include lithography technicians, scanning electron microscope operators, solid state technicians, scanning probe operators, quality control technicians, and test technicians. A 2011 survey of capstone graduates found that 69 percent were employed in nanotech-related industry, and 95 percent were either employed or enrolled in degree programs.

With further support from NSF in 2008, the Penn State center became the NSF Center for Nanotechnology Applications and Career Knowledge (NACK) Network. The nationwide network maximizes the strengths of the other ATE centers that focus on micro- and nanotechnologies. For instance, the Midwest Regional Center for Nanotechnology Education (Nano-Link) at Dakota County Technical College in Rosemount, Minnesota, provides curricula that infuse nanotechnology in STEM courses; the Southwest Center for Microsystems Education at the University of New Mexico produces toolkits that provide students with hands-on microtechnology experiences.

The NACK Network's "nodes" also include institutions that started nanotechnology programs as a result of faculty attending NACK professional development workshops. For instance, Ivy Technical College faculty initiated an NMT-type partnership with the University of Notre Dame. It utilizes the private university's nanotech equipment to give students enrolled in Indiana's public two-year college system a capstone experience.

With webinars and other remote access tools developed with the

Number of New ATE-Initiated Articulation Agreements



Source: EvaluATE

ATE projects and centers establish articulation agreements with other education sectors as they develop curricula for new STEM programs. The agreements allow students to transfer credits seamlessly. Once in place, articulation agreements become part of institutions' standard operations.



A graduate of the Nanofabrication Manufacturing Technology capstone program at Penn State University demonstrates how to image a biological sample, in this case a spider, using a field emission scanning electron microscope. Students from around the country use remote access technologies for real-time interactions with people and equipment in the nanotechnology lab at University Park, Pennsylvania.

Maricopa Advanced Technology Education Center (MATEC), the NACK Network puts very expensive equipment and complex lessons within the reach of high school and college educators and their students.

The newest, most sophisticated remote access tools allow community college educators and their students to schedule time to watch and control tools that manipulate materials 1 to 100 nanometers in size. These real-time interactions between distant classrooms and engineers in clean rooms are available via the NACK Network website: <http://nano4me.org/>.

By mid-2013, several pairs of community college and research university partners in the NACK Network were testing implementation of the remote access tool. Ehrmann said the network participants think remote access to nanotechnology equipment will enhance learning and recruitment for STEM fields.

The NACK Network provides opportunities, Ehrmann pointed out, “to bring students at all levels into STEM, to show them the wonders of what’s out there, and what can be done, and what’s being done.”

Matriculated Students

34,328 from High Schools to Two-Year Colleges



15,941 from Two-Year Colleges to Four-Year Colleges



Each capped person = 1,000 people

Source: EvaluATE

The total number of students who matriculated between 2003 and 2012 as a result of active ATE grants and their articulation agreements.

6 ATE Interacts with Other Federal Programs

As successful ATE projects and centers become established throughout the nation, their interactions with other federal programs maximize taxpayers' investments.

A particularly beneficial example of these interactions are ATE centers' and projects' partnerships with the government's national laboratories. These relationships add the latest research findings to the working knowledge of technicians employed in a wide array of advanced technology fields.

By virtue of their workforce development efforts, ATE principal investigators (PIs) work with multiple employers, government agencies, and education systems. This gives ATE PIs a well-informed "big picture perspective" that makes it possible for them to identify gaps in existing government programs and develop solutions that meet student and faculty needs in communities and across disciplines.

The ATE program's multifaceted collaborations have also positioned ATE PIs to compete for funding from other government agencies. This benefits the individuals directly served by these programs and the nation as a whole as it strives to address unmet STEM workforce needs. Leveraging effective ATE programs, as the U.S. Department of Labor and other organizations have done, means that new, larger programs are built from practices, policies, and programs that were tested and proven to be effective by the ATE program.

A goal of the National Science Foundation from the outset of the ATE program has been that ATE innovations will be imitated, replicated, and adapted by others.

ATE and U.S. Department of Education Interact in Areas of Mutual Interest

Career paths and the hands-on aspects of contextual learning to benefit students are areas of "mutual interest" for the U.S. Department of Education (ED) Office of Vocational and Adult Education (OVAE) and the ATE program.

Calling ATE "one of the premier programs in technological education," Peirce Hammond, senior advisor for Special Initiatives at OVAE where he is also the STEM lead, said that ATE informs and inspires the work of people at the federal K-12 education agency.

Hammond and his colleagues in OVAE also interact directly with ATE program directors at NSF. Currently, the two groups are discussing the idea that STEM knowledge is a foundational skill, which—like literacy—is necessary for people to be able to do any work. While it is not clear if these discussions will lead to new federal policies, government actions have evolved from informal conversations in the past.

Hammond more formally interacted with ATE principal investigators and NSF program directors on the Framework for Rigorous Programs of Study that ED developed a few years ago for its work with states on policy, educator professional development, and workforce preparation. Some ATE PIs have since told him that they used the framework to assess the progress of their ATE initiatives.

Hammond and others from OVAE are among the representatives of federal agencies who attend the ATE PI conference, held each October in Washington, DC. Hammond said that he goes to the meetings because he likes learning what ATE educators are doing to get students ready for both

college and careers. While many educators have only recently started talking about this dual goal for education, ATE principal investigators have shown for years how to make career pathways and postsecondary education happen in a broad array of technology areas. Hammond finds it fascinating and inspiring to hear about the latest progress from ATE programs, especially those that are helping students in difficult circumstances.

While not every ATE program formally connects with the Career and Technical Education (CTE) Pathways that are part of state education systems, Hammond said that ATE student recruitment efforts over the past 20 years have meshed with these pathways and other efforts to start career conversations with youngsters so that they do not miss opportunities. He also pointed out that ATE programs' outreach to adults in the workforce provides the validation some people need to go back and forth between work and postsecondary education throughout their lives.

Hammond, who worked during the 1990s on systemic educational improvements in an NSF directorate that is not connected to ATE, said that he is particularly impressed by the accomplishments of the various consortia that ATE centers and projects have created. These consortia show that community colleges can make meaningful connections with industry, four-year institutions, school districts, and government agencies.

"Pulling that off is not an easy feat," he said.

RCNET Enhances Connections Between Navy, Community Colleges, and Nuclear Industry

The 42 community colleges affiliated with the Regional Center for Nuclear Education and Training (RCNET) are part of the two-way career path cemented with a formal agreement between the Nuclear Energy Institute (NEI) and the U.S. Navy.

Under the 2012 memorandum of understanding (MOU), sailors completing their duties in the U.S. Navy's nuclear propulsion program will get "articulated credit" toward associate of science (AS) degrees for their experiences operating nuclear submarines and aircraft carriers, according to Kevin Cooper. Cooper is principal investigator and director of RCNET, the ATE center at Indian River State College in Fort Pierce, Florida.

With AS degree holders considered a workforce "strength" by the Institute of Nuclear Power Operations (INPO), navy veterans who have historically found employment in the commercial nuclear industry have more impetus to earn college credits and graduate from AS degree programs, Cooper explained. While not yet required, he said, the AS degree is becoming important just to get a job in the commercial nuclear industry.

RCNET was involved in the development of the MOU. INPO is one of the RCNET's partner organizations, and encouraged the enhanced connection between community colleges and navy veterans.

Military veterans comprise about 10 percent of the students enrolled in the nuclear technician education programs at the 42 community colleges and nine universities in RCNET's education consortium. "It's a great relationship we've built with the navy," Cooper said.

The agreement allows the navy to recruit graduates of Nuclear Uniform Curriculum Programs (NUCP), which are offered at RCNET partner community colleges. Prior to RCNET's creation by the National Science Foundation with an ATE grant in 2011, the NEI nuclear industry organization helped set up the uniform college curriculum to provide a consistent course of study for two-year college nuclear energy generation programs. The curriculum prepares technicians for assignments in operations, radiation protection, and maintenance.

While RCNET now provides the materials to the nuclear energy technician programs, its focus also encompasses preparing technicians

for employment in supply chain, nuclear manufacturing, vendor support, fuel manufacturing, safety, and security. RCNET's articulation agreements with two-year and four-year colleges extend beyond the scope of the NUCP as well.

Machinist Mate Chief Timmothy Harper said he uses the "step in the door" provided by the MOU in his work as nuclear field program coordinator for the Miami Navy Recruitment District. For graduates of the nuclear technician degree programs, the MOU helps with their job assignments if they enlist in the navy. For recruits who do not have AS degrees, the MOU provides a mechanism for them to document the skills they acquire while in the military. The MOU also gives navy veterans the option to request that the navy share their contact information with commercial nuclear industry recruiters at the conclusion of their service commitment.

The nuclear industry estimates it will need about 40,000 skilled workers in the next decade.

To help meet this demand, RCNET facilitates interactions between community colleges and universities, the nuclear industry, federal agencies, and non-governmental organizations. To build a more systematic approach to nuclear technician education, RCNET:

- shares simulations from its flow loop laboratory with students and instructors across the country via remote technologies.
- provides professional development for faculty.
- gathers academic and industry experts to review curricula developed by community colleges with grants from the Nuclear Regulatory Commission to identify best practices.
- convenes annual meetings of nuclear industry representatives and educators from the U.S. and five foreign countries to share best practices.

- partners with the United Negro College Fund, Nuclear Regulatory Commission, American Nuclear Society, and Department of Energy to provide scholarships to increase the number of African Americans and women in the nuclear workforce.

BEST Center Deploys Two National Labs' Research to Improve Skills of Building Technicians

The education of building technicians—people who operate the electrical and mechanical systems within skyscrapers and industrial facilities—is critical for long-term energy conservation and efforts to reduce the nation's dependence on fossil fuels. Forty percent of the nation's energy use and 40 percent of its carbon dioxide emissions come from buildings.

The energy management of buildings depends largely on the skills of building technicians, because even new buildings will not run efficiently if technicians do not operate their systems properly.

For this reason the Building Efficiency for a Sustainable Tomorrow (BEST) Center at Laney College, in Oakland, California, has developed close partnerships with scientists at Lawrence Berkeley National Laboratory and Pacific Northwest National Laboratory. These partnerships add the latest energy efficiency research to the working knowledge of technicians who operate large commercial buildings and the community college instructors who teach building technicians.

The BEST Center uses *The Energy Information Handbook* by scientists at Lawrence Berkeley National Laboratory as a primer on how to analyze and use the data from energy management systems for maximum energy efficiency. The BEST Center introduces this handbook to community college instructors at workshops, so that they in turn can use up-to-date information to teach aspiring and employed building technicians.



Lessons for building technicians in the BEST Center's laboratory at Laney College utilize research from Lawrence Berkeley National Laboratory and the Pacific Northwest National Laboratory.

The Pacific Northwest National Laboratory's research on building technology and sustainable systems is the basis of BEST Center programs to help experienced technicians "re-tune" their skills so that they can run highly automated building systems.

Both national laboratories are part of the preeminent federal research system managed by the Department of Energy's Office of Science.

The BEST Center's curricula also use problem-based learning scenarios developed by Laney College faculty to foster technicians' critical thinking skills.

"We want to create technicians who will be putting on their critical-thinking caps in their daily routines so that they don't just go through

a building turning dials and what have you in rote, cookbook fashion. Building systems are so sophisticated now that you really have to be at the top of your game to manage them effectively," said Larry Chang, BEST Center manager.

Lawrence Berkeley National Laboratory previously collaborated with Laney College administrators and faculty on two ATE projects. The scientists created software for a computer simulation that allows students to see how energy use is affected by modifications to heating, ventilation, and air conditioning systems. They also supported the Physics of Building Science course (which Laney College offers to high school students at Green Energy Academies in the East Bay metropolitan area) by providing material for basic thermodynamics lessons, serving as guest speakers, and hosting field trips to the national laboratory.

In addition to working with Laney College faculty on curricula, scientists from the national labs make presentations to community college instructors at BEST Center professional development workshops. At one such workshop in the summer of 2013, a scientist from the Pacific Northwest National Laboratory took advantage of the collegial relationship that the national labs and Laney College have with the University of California, Berkeley: during his lessons for community college faculty, he used university buildings as demonstration sites.

Business and Industry Leadership Teams Identify Trends to Keep Curriculum and Educators Current

Since it was funded in 2004 as an ATE regional center, the Convergence Technology Center (CTC) has used a Business and Industry Leadership Team (BILT) to identify new technologies and economic trends that influence what technicians need to know.

The CTC's BILT has taken on a national flavor since 2012, when it received funding as a national ATE center. That same year, Collin

College in Frisco, Texas, where CTC is based, received a \$19.9 million Department of Labor grant for the National Information, Security, and Geospatial Technologies Consortium (NISGTC). The large Department of Labor grant program is known as TAACCCT for Trade Adjustment Assistance Community College and Career Training.

The NISGTC Consortium extends the work of CTC and three other ATE centers: the National Resource Center for Systems Security and Information Assurance (CSSIA), the National Center for Geospatial Technology Center of Excellence (GeoTech Center), and Broadening Advanced Technological Education Connections (BATEC).

How BILTs Work

CTC asks its BILT members to meet face-to-face annually and via teleconferences quarterly to provide input on technology trends.

At the face-to-face meeting, the business and industry representatives, who are sometimes technicians, are asked to assign points to an extensive list of knowledge, skills, and abilities. BILT members consider the complexity of tasks and how much time it will take entry-level technicians to do them. They add emerging technology skills, and remove those that are no longer needed.

The knowledge, skills, and abilities deemed most important by the BILT ranking are then shared with instructors at the 32 colleges in CTC's network. Faculty cross reference the list with their existing courses. Topics not covered in existing courses become the subject of instructional modules that CTC develops and disseminates for use with students. These topics and curriculum for software updates are also covered in CTC's faculty development program known as Working Connections.

Working Connections was established in 1997 with support from the American Association of Community Colleges and Microsoft Corporation to build long-term programs in information technology.

Ann Beheler, executive director of Emerging Technology Grants at Collin College, calls the BILT process the "secret sauce" of CTC's up-to-date curriculum and faculty development programs.

"That is integral," she said. "If you pick one thing that absolutely has to be there to keep up with curriculum that changes as much as ours does, the BILT leadership has to be there."

CTC focuses on keeping instructors well-informed about the technologies that encompass voice, data, video, and image communications transmitted over the same network. Convergence technology programs prepare students for an array of information technology careers, including network administration, network installation, help desk troubleshooting, and cybersecurity.

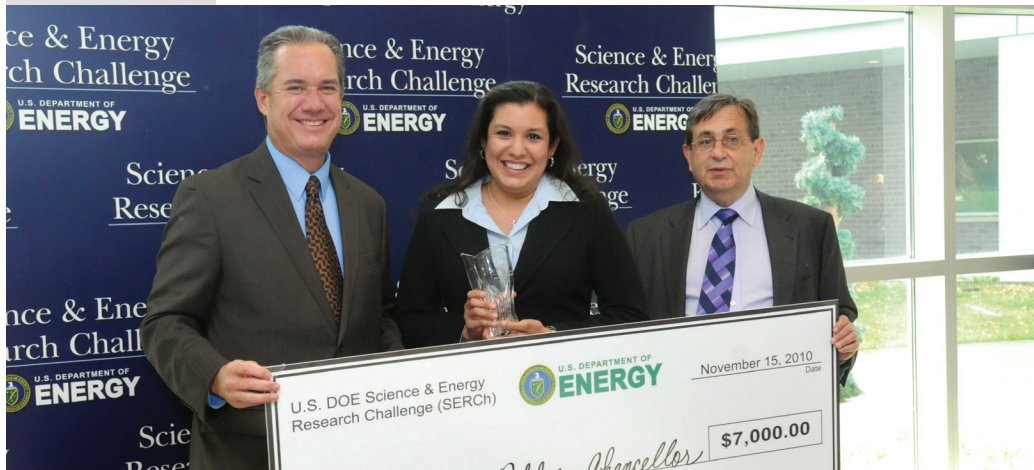


Mobile application development and ethical hacking were among the topics covered at the Working Connections Information Technology Faculty Development Institute that the Convergence Technology Center held at Lansing Community College in Lansing, Michigan. Since 2009, more than 1,000 educators, who have gone on to instruct more than 36,000 students, have learned about new technologies and how to teach them at CTC's Working Connections programs.

ATE Practices Spread with Department of Labor Grant

The seven colleges participating in the Department of Labor NISGTC Consortium also participate in four national BILTs for their particular technologies. These BILTs focus on cybersecurity, programming, networking, and geospatial technologies. About 60 business and industry representatives currently serve on the combined BILT that informs both the CTC network colleges and NISGTC Consortium colleges regarding networking and convergence technologies. The BILTs for the three other technology areas are of similar size.

Beheler, the principal investigator of both the CTC National Center and the NISGTC Consortium, explains the overlap of the two federal grants:



For research she did as a student at Del Mar College, Jennifer Robles Chancellor won the two top prizes at the 2010 Science and Energy Research Challenge Poster Competition sponsored by the Department of Energy. Chancellor's summer internship at Lawrence Berkeley National Lab in Berkeley, California, was part of an ATE project Del Mar College Biology Professor J. Robert Hatherill developed to infuse authentic research experiences into his bioscience courses in Corpus Christi, Texas. The success of Chancellor's first research experience encouraged her plans to become a PhD scientist.

"We had good things going in ATE and we've now disseminated them out to the colleges in our Department of Labor NISGTC Consortium and to the 32 colleges participating in the network for our national CTC."

Del Mar College Student Excels in National Science Competition

While enrolled at Del Mar College in Corpus Christi, Texas, Jennifer Robles Chancellor won the two top prizes at the 2010 Science and Energy Research Challenge Poster Competition sponsored by the Department of Energy. Chancellor did her award-winning research—on a technique to detect radiation sensitivity in the cells of immunosuppressed individuals—as a summer intern at Lawrence Berkeley National Lab in Berkeley, California.

The knowledge, skills, and confidence Chancellor gained from the internship and the experience of competing against undergraduates from research universities surpassed the cash prizes (which totaled \$10,000) and the crystal trophies.

"The internship taught me how to think like a scientist, to recognize a problem, formulate a hypothesis, design the experiment, execute the design, and analyze the information obtained," Chancellor said.

By the end of the summer internship, she had decided to become a PhD scientist. Since completing her associate degree at Del Mar, Chancellor, who is a single parent, earned dual bachelor of science degrees in biochemistry and biomedical science at Texas A&M University-Corpus Christi (TAMU-CC). She is now pursuing a master's degree there and conducting research on the effects of non-thermal plasma on cells that heal wounds.

From the competition, Chancellor said, "I learned that I am capable of accomplishing anything that I work hard for. That even though the

work may have been difficult and stressful, I did not quit; that the end result is worth it all!”

Those are the type of results that Biology Professor J. Robert Hatherill hoped to achieve with two ATE project grants he obtained to infuse authentic research experiences into bioscience courses at Del Mar College, a Hispanic-serving institution. TAMU-CC, the Life Sciences Division of Lawrence Berkeley National Laboratory, and BioFirst Pharmaceuticals are partners in the ATE projects, which are known as SUCCESS and REVISION. SUCCESS stands for South Texas Undergraduate Curriculum Consortium for Environmental and Biological Science Students, and REVISION stands for Revising Science Education with Vision.

The Del Mar students who major in biology and biotechnology and who choose the courses that involve undergraduate research persist at higher rates and participate in science-related campus activities more often than students who enroll in traditionally taught science courses.

By 2012, 80 SUCCESS students had participated in the external internships required for Del Mar’s biotechnology certificate and associate degree: all 80 SUCCESS students had presented their research at regional or national scientific meetings. Ninety percent of the SUCCESS students had transferred to four-year degree programs or found employment. The REVISION program started in 2012-2013 and engaged 20 more students in undergraduate research.

Chancellor said, “Dr. Hatherill changed my life the day he asked me if I wanted to attend an internship in Berkeley... Throughout my internship and competition experience, he was there every step of the way. He was an advisor, a motivator, a mentor, and a friend. And he is still all those things to this day. And because of the way he helped me, I hope that I can be the same for my students.”

7 ATE Earns International Recognition and Tests International Experiences for Technology Students

As the stature of the ATE program has grown throughout the United States, international opportunities for students and faculty have followed.

Successful ATE programs have been highlighted by the U.S. State Department as model programs and the potential source of new international education relationships.

The National Science Foundation has also provided funding for ATE centers to test their ideas for adding international components to their programs. While many undergraduate institutions offer study abroad experiences for liberal arts students, international programs are extremely rare for students in technology programs. With even small U.S. manufacturers selling products internationally and operating overseas facilities, however, ATE educators are exploring new ways to provide students with skills that will help them navigate global workplaces.

U.S. Government Showcases AMTEC to International Educators

The U.S. State Department and U.S. Department of Education showcase the Automotive Manufacturing Technical Education Collaborative (AMTEC) as a model to foreign government and education leaders.

With exceptionally productive partnerships between auto industry rivals, 32 community colleges, and five vocational schools, AMTEC led the development of modular, hybrid online lecture and in-person lab curriculum. It simultaneously meets international occupational skill standards and teaches technicians the nuances of operations in particular manufacturing facilities in 10 states from Detroit to the Deep South.

AMTEC, a national ATE center, is located at the Kentucky Community and Technical College System (KCTCS) in Versailles, Kentucky.

A National Governors Association case study identifies AMTEC as an excellent model. A *Sharper Focus on Technical Education*, the association's report, finds AMTEC's "main lesson is that if technical education is carefully targeted to skills that important industries need and [if it] focuses on flexible learning of skills required by all the players



During the showcase session at the 2011 ATE Principal Investigators Conference, representatives of competing automakers staffed AMTEC's booth with their education partners. Starting second from left: Annette Parker (then AMTEC executive director), Carol Crawford, campus coordinator of Bluegrass Community & Technical College's Advanced Manufacturing Center, JoAnne Pritchard of General Motors, and Willy Kailfresch of Ford Motor Co.

in that industry, then it is possible to scale up a workforce education program in any industry." It points to AMTEC's requirement that colleges, automakers, and auto parts suppliers form local partnerships and attend AMTEC meetings together as a critical success strategy.

Annette Parker, as AMTEC principal investigator and executive director, participated in a 2012 meeting held on the U.S.-India Strategic Dialogue. Other participants in this meeting included U.S. Secretary of State Hillary Clinton, Assistant Secretary of Vocational and Adult Education Brenda Dann-Messier, and India's Minister of External Affairs Shri S.M. Krishna.

As a result of the information Parker shared about AMTEC, she was invited to attend a meeting hosted by the Indian government in New Delhi, India, in February 2013. At this meeting, Parker presented information about AMTEC's curriculum and its collaboration with the automakers and auto parts suppliers to educators from India, New Zealand, Germany, Canada, and Australia.

Parker became president of South Central College, a Minnesota State Community and Technical College, in July 2013. In this new role, she plans to use her AMTEC leadership experiences and international connections to enhance the global emphasis of the college's programs.

AMTEC's international work actually began with AMTEC's founding leaders: KCTCS Chancellor Keith Bird and James White, the original principal investigator.

AMTEC's new executive director, Danine Alderete-Tomlin, continues the legacy of hosting and continuing conversations with international educators who express interest in partnering with AMTEC.

In the summer of 2013, a delegation from Aliat, a private network of 50 universities and high schools in Mexico, toured Bluegrass Community and Technical College's educational facilities within Toyota Motor Manufacturing, Kentucky, Inc. The Aliat leadership team wants to develop work readiness programs for specific industries, including auto manufacturing, and explored a potential collaboration with AMTEC.

MPICT Runs Three Tests of International Technician Education Course

The Mid-Pacific Information and Communication Technologies (MPICT) Center's three international pilot projects have yielded positive results for students and faculty. While study-abroad programs are common for liberal arts students, MPICT's multiple international experiences are rare for technology students.

Each of MPICT's pilot projects utilized Cisco's Network Academy curriculum because it is an industry standard taught uniformly around the world. For the two most recent experiments, with a school in France in 2011 and a school in China in 2012, MPICT's faculty partners developed a problem-based scenario that gave students roles in a fictitious company that was merging international units with incompatible network systems. The mixed teams of American and international students had to integrate the systems.

"We wanted them to get the experience of doing the project, doing an international project using the tools they were learning, modern tools to collaborate across the ocean. A lot of work in our field is performed this way," said Pierre Thiry, MPICT principal investigator. He pointed out that all the course materials and lectures MPICT faculty developed are available for other educators to adapt and adopt for their programs.

MPICT is based at the City College of San Francisco in California. Its mission is to coordinate, promote and improve information and communications technology (ICT) education, with an emphasis on two-year colleges, in California, Nevada, Hawaii, and the Pacific Territories.

History of International Projects

MPICT's experiments with international ICT courses began with an inquiry in 2008 from a Cisco Academy leader who knew that Thiry, a native of Belgium, speaks French. He asked if MPICT would be willing

to partner with a school in France that wanted its students to interact remotely with students in an English-speaking country.

Thiry describes the two lessons he delivered using the tele-presentation system in Cisco's Downtown San Francisco facility as "a little spontaneous and not well-supported financially."

But the experience came in handy in 2010 when NSF requested proposals from ATE centers to develop international technician education experiences in Europe. MPICT's proposal for an ICT capstone course with Centre des Formations Industrielles in Paris received one of five \$100,000 grants. Michael McKeever, a computer and information sciences instructor at Santa Rosa Junior College in Santa Rosa, California, and MPICT faculty partner, developed the ICT capstone course.

In 2012, Thiry obtained NSF permission to use \$50,000 of MPICT's funds to adapt the ICT capstone course for a collaboration with the SIP Institute of Services Outsourcing in Suzhou, China. Richard Grotegut, an Ohlone College faculty member and MPICT faculty partner in Fremont, California, suggested the project based on his experience teaching Cisco courses to faculty in China. Another MPICT faculty partner, Richard Graziani of Cabrillo College in Aptos, California, taught the course simultaneously to Chinese and American students using translation software. The Chinese students were all between 19 and 21 years old. The 13 American students who traveled to China ranged in age from 19 to 49.

Student Uses International Lessons Immediately

Working remotely and then in-person on a class project with students in Suzhou, China, taught Justin Niu that when "working with people from different countries and cultures: be friendly, open minded, willing to teach and learn." Niu reports that he applied those lessons immediately to his work at a tech company that manufactures and sells networking solutions.

"As a global analyst, I use my experience from the China trip every day at work. I communicate and work with employees from all over the world including England, Switzerland, India, Singapore, China, and Japan," he said. The computer networking courses Niu took leading up to the ICT capstone course helped him get the analyst position at the company where he was already working.

Niu was one of 13 northern California community college students who traveled to China in the summer of 2012 for the collaboration project with SIP Institute of Services Outsourcing in Suzhou.

As an American-born Chinese who learned Mandarin growing up, Niu was able to facilitate conversations between the two groups of students because he could translate cultural concepts and phrases, both American and Chinese, that would normally not make sense if translated literally.

"The most valuable experience was the opportunity to learn and communicate with our Chinese student peers about their culture, debate technical concepts, discuss the economy and tech job market in China," he said.

Instructor's Perspective

McKeever, the Santa Rosa Junior College instructor who developed the ICT capstone course for use with the school in France, said the French and American students were "ecstatic" to work together in person. The student teams had worked on Cisco's Packet Tracer simulation equipment via Blackboard Collaborate throughout the semester. However, the timing of the joint class sessions at the end of the French students' eight-hour class days created some challenges. Language was not a barrier because the French students spoke English.

During their first week together in France, the students worked intensely to finalize their projects. The students' presentations to college professors and Cisco executives at Cisco's video conference suite in Paris

were transmitted to California in order to include the MPICT faculty and students who could not make the trip. During the second week in France, the students visited four IT work sites including the Société Générale, a large financial services company.

The American students who traveled to China followed a similar schedule of academic work their first week in the country and tours of businesses the second week.

"I think there were some very positive results there," Thiry said, referring to both projects. Although the cost of international travel makes the projects difficult to scale, Thiry thinks the in-person contact between students is important.

McKeever agrees, and said, "What they learned about other cultures, respect for other people, and a greater awareness of the world was something that can't be replicated by technology. It's something that you have to go there and do."



A team of American students from various California community colleges and Chinese students from SIP Institute of Services Outsourcing in Suzhou, China, finalized their solution for bridging two incompatible networks. A problem-based scenario and simulation software were part of the international capstone course tested by the Mid-Pacific Information and Communications Technology Center in 2012. Thirteen American students between the ages of 19 and 49 spent two weeks in China at the end of the semester course that was taught simultaneously to both groups of students using remote and translation technologies.

8 Moving Forward: The Future of ATE

ATE Program Leads Plan for Future

In the future, the ATE leadership team plans to continue its practice of using two-year college educators and their industry partners as an “expanded advisory board” whose insights and suggestions help shape the program.

The National Science Foundation’s ATE leadership team is composed of Celeste Carter, lead program director of ATE in the Division of Undergraduate Education; David B. Campbell, lead program director of ATE in the Division of Research on Learning in Formal and Informal Settings; and Duncan E. McBride, co-lead ATE program director in the Division of Undergraduate Education. The team works collaboratively to enhance two-year college programs within the ATE program and to raise the profile of two-year colleges in other NSF divisions and federal agencies.

Carter explained the benefits of paying close attention to community college educators and their industry partners: “They often see, particularly regionally, the new and emerging fields and opportunities well before I would. That’s when they will call or email me, or sometimes I’ll just find a new proposal and go, ‘This is really interesting; here’s a complete new area that I hadn’t really thought about.’ So I would love to see the ATE program continue to expand that way based on the faculty and industry partnership.”

Campbell added that the ATE program was designed to be responsive to emerging technologies, and was intended to help community colleges meet the needs of new industries that create jobs for technicians.

“One thing I’ve always liked about ATE is that it’s kind of nimble or flexible because the community colleges are able to come up to speed

very quickly when new technologies become available, like geospatial technologies or additive manufacturing, things like that. It has been the community colleges that have usually developed the courses and worked with the industry to develop the career skills first, before almost anybody else,” he said.

The ATE leadership team also plans to continue structuring ATE to reach a wide array of institutions and students.

McBride pointed out that the Small Grants for Institutions New to the ATE Program track was added a few years ago to increase the variety of institutions that receive grants. The intent is to involve rural colleges as well as under-resourced urban institutions that have never received NSF funding or have not received funding in the past 10 years.

“We have a responsibility to improve the quality of education in a wide variety of institutions,” he said.

Structuring ATE to encourage more faculty to submit proposals to the NSF, he said, “is one way that we can involve people in a community outside their own college or outside their own region. There are good faculty doing good things, but [they] tend to be pretty isolated; and part of this is just getting them into the [ATE] community, which I think will help their programs.”

Increasing the diversity of the nation’s technical workforce is an NSF mission, and the ATE program is the largest NSF effort to improve programs at the nation’s nearly 2,000 public community and technical colleges.

“There’s a tremendous range of students. That’s one of the things that I think is a real strength of the ATE program. All of those people who

walk into those ATE programs have a real desire to move forward and to gain the skills and competencies and the educational background and concepts that will allow them to be successful on the job. They're just really motivated and dynamic people. So one of the things I want to keep supporting through the program is the diversity of people and the kinds of programs that faculty have put together that I think really are on the cutting edge of industry," Carter said.

Campbell agreed, adding, "The more diversity there is in the workforce the better off we are as a nation."

MIT Report Recommends ATE Grow

The Massachusetts Institute of Technology's *Review of the NSF's Advanced Technological Education Program: ATE's Role in Advanced Manufacturing Education and Training* recommends that the ATE program grow and target technology areas that align with the crosscutting technologies identified by the Advanced Manufacturing Partnership (AMP) Steering Committee. The federal government started AMP in 2011 to increase its collaborations with industry and universities, to drive innovations in advanced manufacturing, and to close skills gaps.

Given that the ATE program is an established, active platform that covers eight of the 16 areas mentioned in recommendations that the AMP Steering Committee made in its 2012 report to President Obama, the review by Maggie Lloyd, a policy fellow at the Massachusetts Institute of Technology's Washington, DC Office, concludes that "ATE's offerings could be expanded to provide implementation platforms for AMP policy proposals."

To accomplish this, the MIT review suggests the ATE program:

- increase the supporting role of four-year colleges and research universities (while retaining community colleges' leadership of ATE initiatives) and utilize these institutions' access to advanced technologies for the preparation of technicians.

- focus on the 11 crosscutting technologies that the AMP Steering Committee identified for federal government research and development support. Several ATE centers and ATE projects currently target these technologies.
- expand ATE centers devoted to advanced manufacturing to develop a more diverse workforce in more states.
- link with the Manufacturing Extension Program, which the National Institute of Standards and Technology funds with states, to increase the dispersal of education opportunities in emerging technologies for technicians who could be employed by small and medium-sized manufacturers.
- obtain additional funds in order to support more proposals than the 75 to 90 grants the ATE program awards each year.

Carnevale Says ATE at Cutting Edge

Anthony P. Carnevale describes the ATE program as "pretty much cutting edge in the American system" for teaching both high-level technical skills and soft skills like critical thinking and problem-solving.

As director and research professor of the Georgetown University Center on Education and the Workforce, Carnevale has advocated for greater alignment between postsecondary education and careers to encourage student success.

At a Senate Budget Committee hearing in February 2013, Carnevale summarized the findings of several of his center's studies on the intersection of education, work, and skills. "What you make depends more and more on what [courses] you take. Oftentimes, lower-level programs can outperform higher-level programs. For example, some workers with one-year certificates in fields like information technology, electronics, and drafting earn more than a substantial share of people with AAs and BAs."

In a 2013 interview for his perspective on ATE's two decades of innovation, Carnevale postulated that the program's focus on technology is key to its effectiveness. "We know that more applied and focused learning, first of all, tends to teach the skills, because the applied focus itself we know is one of the conditions necessary if not sufficient to help people learn these general skills," he said. "The applications are superior learning modes. Using head and hand is always more powerful than doing one or the other."

Carnevale agrees with the National Science Foundation's (NSF) investment in ATE and the grants it provides for educators to test their ideas for improving technician education, boosting STEM teaching, and encouraging more interest in preparing for STEM careers.

"My own bias is that the ultimate purpose of education is to allow people to live more fully in their time. In the end, in a modern society, in a capitalist economy, if you can't get a job, you can't live fully in your time," Carnevale said.

He points out that about 44 percent of U.S. jobs require mastery of math through Algebra II, and that when middle and high school students do not stay on track in math they limit their career options. "If you don't start talking to people about science and math and other skills of that sort when they are in grade school, or at least when they are in high school... we know that they effectively close off a third of the careers they might follow," he said.

During the past 20 years with ATE, Carnevale said, NSF has used an approach that some other funders have adopted only recently to effect change amid tight budgets. NSF supports experimentation; captures what is effective in order to learn from it; and encourages efforts to scale innovations that have generated positive outcomes.

"Extra money is the tail that wags the dog," Carnevale said. The \$64 million the federal government appropriated for ATE in 2013 is

dwarfed by the \$320 billion spent annually on higher education in the U.S. Nevertheless, Carnevale said, ATE grants generate positive changes because they get like-minded people to work together on initiatives that do not fit within colleges' regular operating budgets.

"Money that comes in from the outside can have a lot of leverage because it adds value where the systems themselves would have trouble," he said.

Conclusion

During the 20 years it has existed, the Advanced Technological Education program has improved the development of highly qualified technicians whose work is vitally important to businesses and industries critical to the nation's security.

At its core, ATE improves the science, technology, engineering, and math (STEM) curricula at two-year colleges and secondary schools, and invigorates teaching in many disciplines.

ATE also directly helps students of all ages by informing them of excellent STEM career opportunities and equipping them with the competencies and perspectives they need to succeed in advanced technology workplaces. By creating robust STEM career pathways, the ATE program saves students time and money. Articulation agreements and STEM educational enhancements developed with ATE grants help students move more efficiently through various education sectors and ensure students attain meaningful academic credentials that facilitate their life goals.

ATE's multifaceted, collaborative approach generates meaningful, enduring partnerships among employers and educators, too. Working with business and industry to improve the alignment between what students learn in classrooms and what they need to know for STEM careers saves employers time and money. ATE is helping cultivate new generations of ingenious technical workers in the United States whose knowledge, skills, and abilities will shape the nation's economic future.

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Madeline Patton & Rachael Bower
September 2013

The National Science Foundation's **Advanced Technological Education** program is an evolving source of educational improvements for technicians and the educators who teach them.

ATE programs involve two-year college faculty and other educators in collaborations with employers. The results of these creative, ambitious initiatives are strengthening advanced technology businesses and industries throughout the nation: they improve the knowledge and skills of people beginning technical careers and employed technicians. ATE innovations also influence classroom lessons and career awareness activities in middle and high schools.

Inside read about:

- A biotechnology project that influences teacher preparation throughout Texas.
- A California community college educator who leveraged ATE grants to expand programs that help low-income students progress from developmental classes to high-tech careers.
- How the acronym STEM got its start.
- An Illinois educator's development of a national geospatial network from a small ATE grant.
- Students who enjoy exciting careers in advanced technology fields like biotechnology and photonics.

