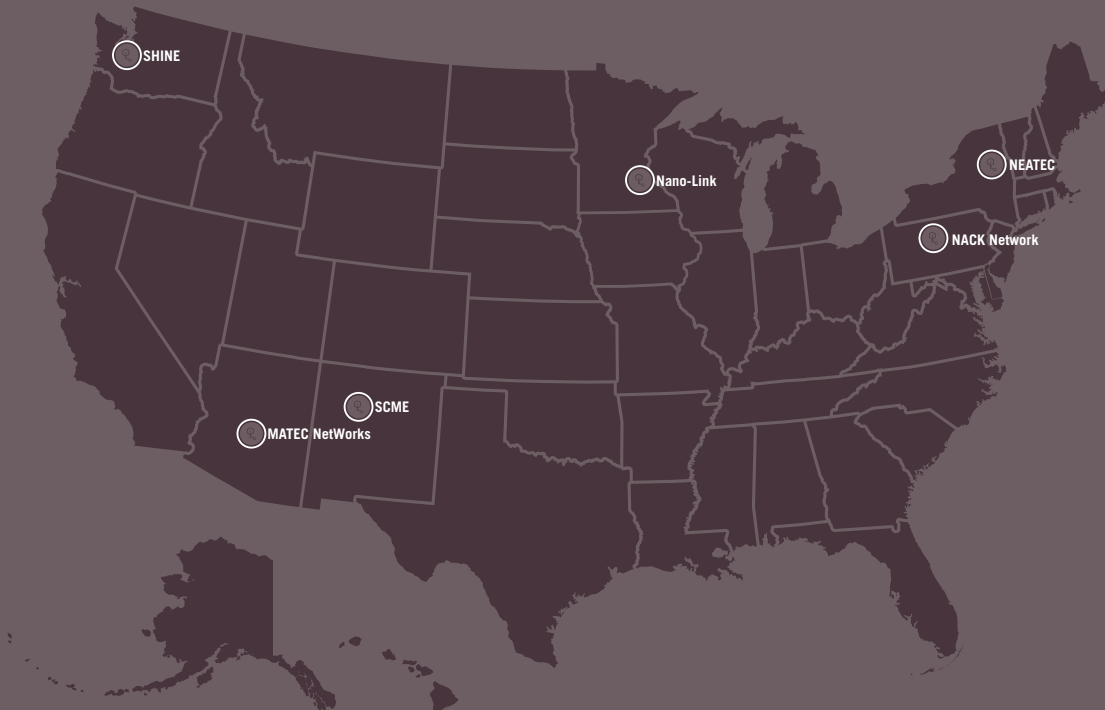




ATE CENTERS FOR MICRO & NANO TECHNOLOGY





This publication was produced by the Division of Academic and Student Affairs of the Maricopa County Community College District with support from the National Science Foundation under grant **DUE-1261893**.

For additional information about the ATE program, visit www.nsf.gov/ate.

For additional information about the ATE centers and projects, visit www.atecenters.org, www.atecentral.net, and www.aacc.nche.edu/ateprogram.



The National Science Foundation's Advanced Technological Education (ATE) program provides grants that support the development of innovative approaches for educating highly skilled technicians for the industries that drive the nation's economy. The program funds educational initiatives across the full range of high-tech fields—biotechnology, chemical technology, engineering technology, advanced manufacturing, energy and environmental technology, information technology, and others.

Two-year college educators lead most ATE initiatives because public community and technical colleges are the major sources for technician education in the United States. The program also encourages partnerships with employers, universities, and secondary schools. As a result, the innovations that ATE grantees devise and test are model programs that reach students from secondary schools to community colleges and universities. They also generate career pathways for students to follow from certificate and degree programs to employment in established and emerging industries.

ATE grantees focus on boosting both the quantity and quality of technicians in the workforce. They test new ways of teaching about established and emerging technologies. Results include new instructional modules, new courses, and entire certificate and degree programs. In tandem with creating products to improve students' learning, many ATE grantees offer professional development for faculty. Through these opportunities, community college instructors and secondary school teachers learn about cutting-edge technologies and how to utilize proven teaching techniques to meet a wide array of industry-identified needs for the workforce.

The ATE program funds large, comprehensive Centers of Excellence, as well as smaller-scale, more focused projects. Each ATE Center generally involves a collaboration among several educational institutions, along with partners from business, industry, and government, all of which work together to improve education and build the workforce in a particular area of technology. The approximately 40 ATE Centers provide leadership, have a broad impact, and act as resources for curricula and faculty development either within a defined geographic region or across the nation.

Complementing the broad missions of the ATE Centers, approximately 300 smaller project grants focus more narrowly on specific aspects of technician education, such as developing or improving educational materials, learning environments, courses, and curricula; providing professional development for educators; preparing future K-12 teachers with strong backgrounds in technology; or giving students the business and entrepreneurial skills needed to succeed in the modern workplace.

“AACC is proud to serve as a long-standing partner of the National Science Foundation's ATE program, which provides invaluable support to our nation's community colleges enabling them to expand institutional capacity, develop effective collaborations with industry, and strengthen innovative STEM technician education programs across the country.”

Walter G. Bumphus

President & CEO, American Association of Community Colleges



For more information visit
www.atecenters.org



MATEC NetWorks National Resource Center (MATEC NetWorks) | Phoenix, Az

360 works to develop a qualified workforce for advanced manufacturing through program improvement, faculty development, online and blended education, and career pathway opportunities. | www.matecnetworks.org

Nanotechnology Applications and Career Knowledge Network (NACK Networ) | University Park, PA

AMTEC leads the nation in industry-driven quality mechatronics education. Its competency-based modules prepare students to meet advanced manufacturers' expectations in core subject areas. | www.nano4me.org

Center for Nanotechnology Education (Nano-Link) | Rosemount, MN

Through its online learning platform CA2VES facilitates accelerated distribution and implementation of digital learning tools to increase the qualified advanced manufacturing talent pipeline. | www.nano-link.org

Northeast Advanced Technological Education Center (NEATEC) | Troy, NY

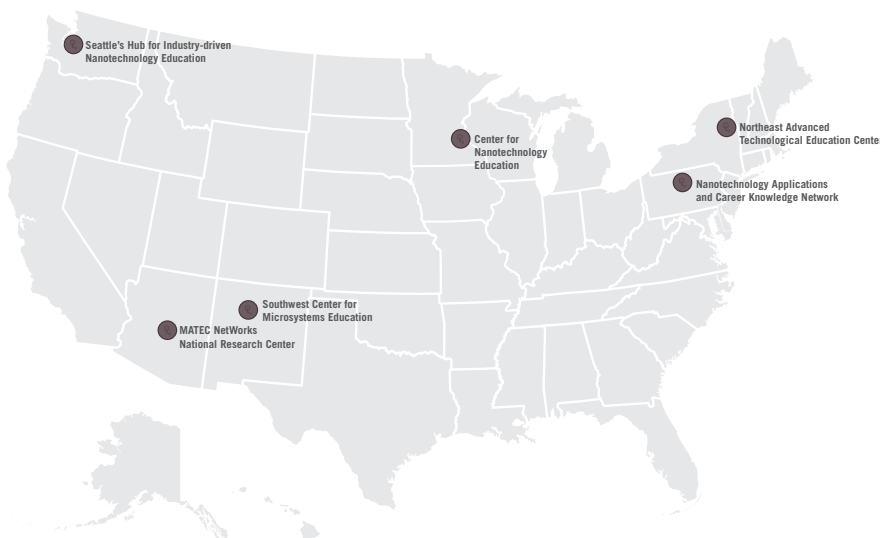
CARCAM's partnerships unite educators and employers to develop highly skilled technicians. CARCAM certificates and degrees position graduates for careers in advanced manufacturing. | www.neatec.org

Southwest Center for Microsystems Education (SCME) | Albuquerque, NM

To support Florida manufacturers, FLATE's leadership fosters expansion of Florida's Engineering Technology AS degree program by reaching out to students, growing enrollments and industry certifications. | www.scme-nm.org

Seattle's Hub for Industry-driven Nanotechnology Education (SHINE) | Seattle, WA

The primary impact of the RCNGM has been to make students, educators, and other persons involved in career choices aware of the opportunities available in advanced manufacturing. | www.seattlenano.org



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KEY ACTIVITIES

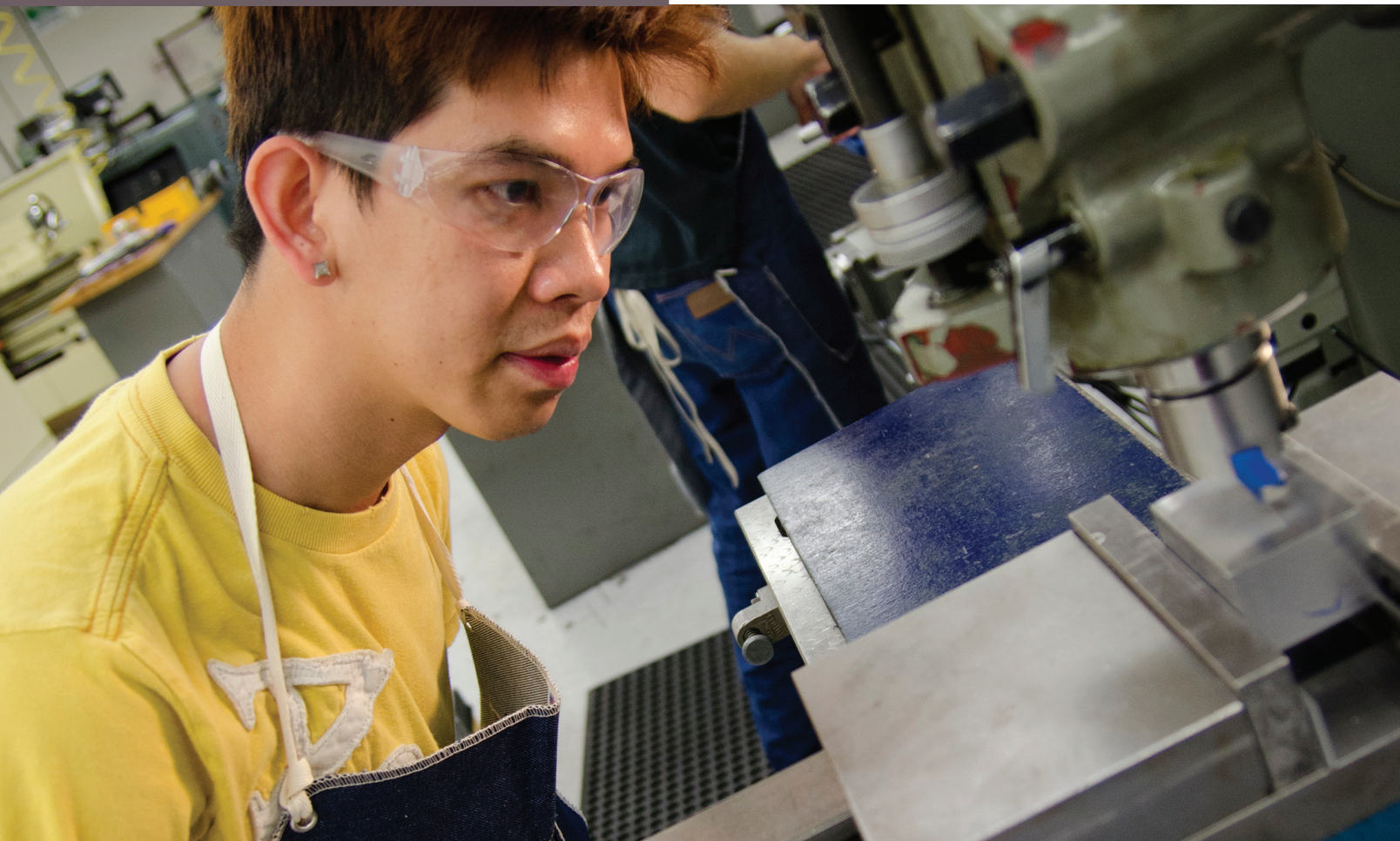
- Creates a sustaining model for ATE resource centers.
- Collaborates with institutions nationwide to offer faculty professional development.
- Partners with industry to offer STEM outreach programs.

A student prepares for an aerospace manufacturing career at the Maricopa Skill Center.

MATEC NetWorks Sustains Its Work

MATEC Networks has achieved sustainability of its resource center activities through institutionalization at the Maricopa Community Colleges and through financial support from the sale of its products and services.

The majority of MATEC NetWorks' webinars and national conferences are now done in collaboration with ATE centers such as EvaluATE and ATE Central, ATE projects such as Mentor-Connect, and nonprofit organizations such as the American Association of Community Colleges. In this way the center's core strengths are leveraged to impact large numbers of educators and industry members across the country. In 2015 the center produced or co-produced 36 webinars for 3,133 registered participants. It co-produced the High Impact Technology Exchange Conference (HI-TEC), a four-day national event with more than 600 participants.





“The HI-TEC conference provided great opportunities to interact with faculty and administrators from colleges across the country and to gain insight into innovative classroom and laboratory methods that are being utilized in technology programs.”

*Robert Decker, Engineering Technologies Program Director
Mohawk Valley Community College*

Assessment of STEM Outreach Program Finds Promising Outcomes

The center has collaborated since 2004 with the SEMI Foundation to develop and produce High Tech U, a STEM career awareness program for high school students. The program is offered at industry sites and exposes students to real-world learning activities that are relevant to their STEM studies.

In 2014 the center surveyed former participants to gauge High Tech U's impact. For this retrospective study, 1,410 students who completed the program between 2006 and 2010 were identified. Of the 252 students who responded to the phone survey, 56% were male, 44% were female. Amazingly 90% of the 252 are currently enrolled or have finished their higher education. Of the 252 survey respondents, 68% (171) persisted in STEM education. When compared to data from the National Center for Education Statistics, which shows that about 14% of college students complete a STEM major, the High Tech U alumni, who participated in the survey, completed their education in STEM at a rate nearly four times higher than this national norm.

Many of the students reported that High Tech U's introduction to high-tech workplaces reinforced their motivation to pursue STEM majors and careers.

A technician at Nichols Precision checks a critical dimension.



Significant Majority of High Tech U Students Pursue STEM Careers

High Tech U students complete their education in STEM at a rate about four times higher than the national norm.

252 SURVEY RESPONDERS

68% (171)

REPORTED A CAREER PATH IN STEM

OF THE 110 WHO REPORTED EMPLOYMENT

76% (88)

ARE EMPLOYED IN STEM CAREERS

NATIONALLY, 14% OF COLLEGE STUDENTS COMPLETE STEM MAJORS.



NACK Network Assists Nanotech Program Development

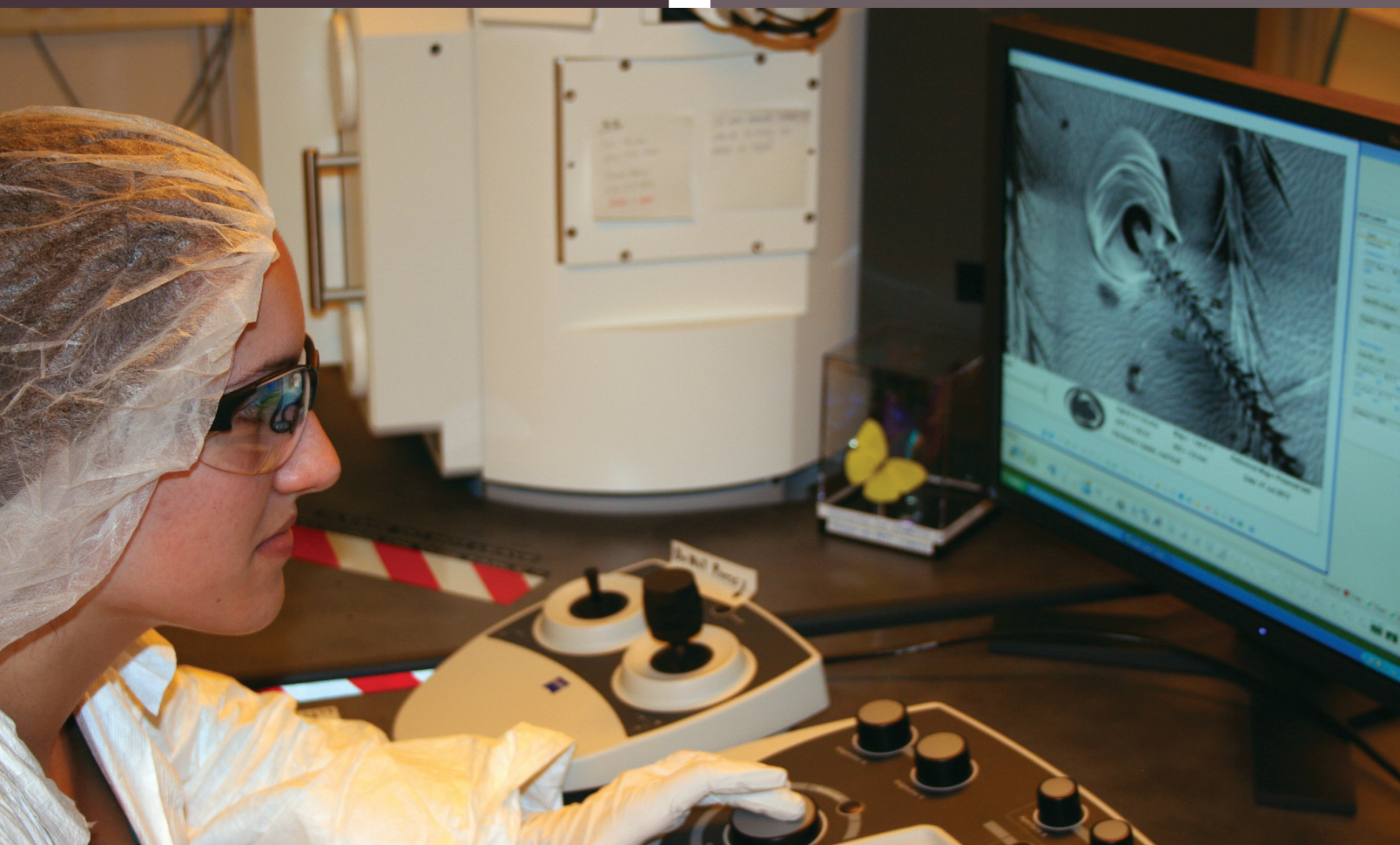
NACK Network has assisted more than 300 postsecondary institutions in developing nanotechnology programs through guidance in planning and design, instruction at educator workshops, and distribution of adaptable curriculum materials.

More than 1,200 students have completed nanotechnology workforce education programs nationwide, many of whom are contributing their nanotechnology knowledge to companies across the US. According to 2013 and 2014 industry surveys by NACK, more than 200 companies nationwide are employing graduates from NACK partner institutions in microtechnology and nanotechnology-related positions. All of the surveyed companies plan to hire technicians with nano-scale fabrication skills by 2018.

Students gain valuable hands-on industry endorsed skills through NACK Network programs.

KEY ACTIVITIES

- Serves industry by enabling nanotechnology workforce development education at community and technical colleges across the US.
- Advances development of international nanotechnology skill standards.
- Propagates a network of remote equipment access providers.
- Cultivates diversified modes of dissemination of nanotechnology course materials.





ASTM Recognition Next for NACK's Core Skills

A strong nanotechnology-based industry must have a workforce skilled in synthesis, fabrication, and characterization at the nanoscale. NACK is currently engaged with ASTM International to institutionalize NACK's industry-approved core skills into ASTM standards. Nanotechnology workforce education standards have been approved and published. They are at ASTM's website www.astm.org.

NACK Offers Nanofabrication Tools Professional Development

NACK piloted the Remotely Accessible Instruments for Nanotechnology (RAIN) network to provide secondary schools and community colleges with web access to state-of-the-art, nano characterization and nanofabrication tools. A survey of 30 educators participating in the pilot remote access (RA) sessions showed that 90% would recommend RA to their colleagues; and 87% of the 600 students participating in this survey found remote access more engaging than traditional textbooks.

NACK also offers professional development workshops and webinars for educators to help them develop a deeper understanding of nanotechnology and what is necessary to teach it in a meaningful way. To date, 1,360 educators have attended these workshops. More than 5,600 individuals have registered for NACK's webinars, accessed archived webinars at nano4me.org, or watched them on YouTube.

“Students are trained in environments and with equipment that is specifically used in nanotechnology; indeed, they are able to operate and repair equipment that most four-year and advanced degree STEM graduates would have had little or no exposure to in their educational experience.”

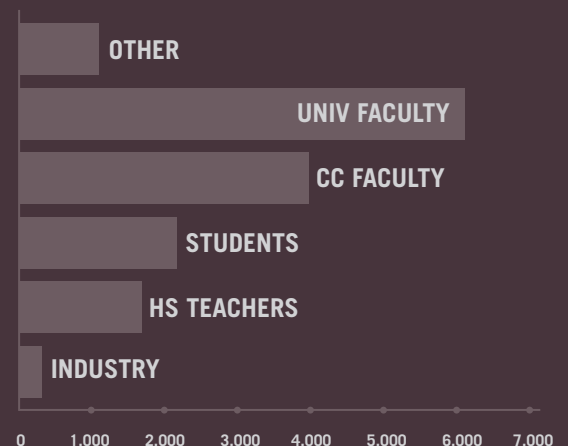
Les Ivie, President and CEO
F Cubed, LLC

A NACK program graduate analyzes chromatography samples at Restek Corporation.



Key Audiences Access NACK Network Education Materials

University and community college faculty downloaded 11,000 NACK materials from January 2012 to June 2015.





KEY ACTIVITIES

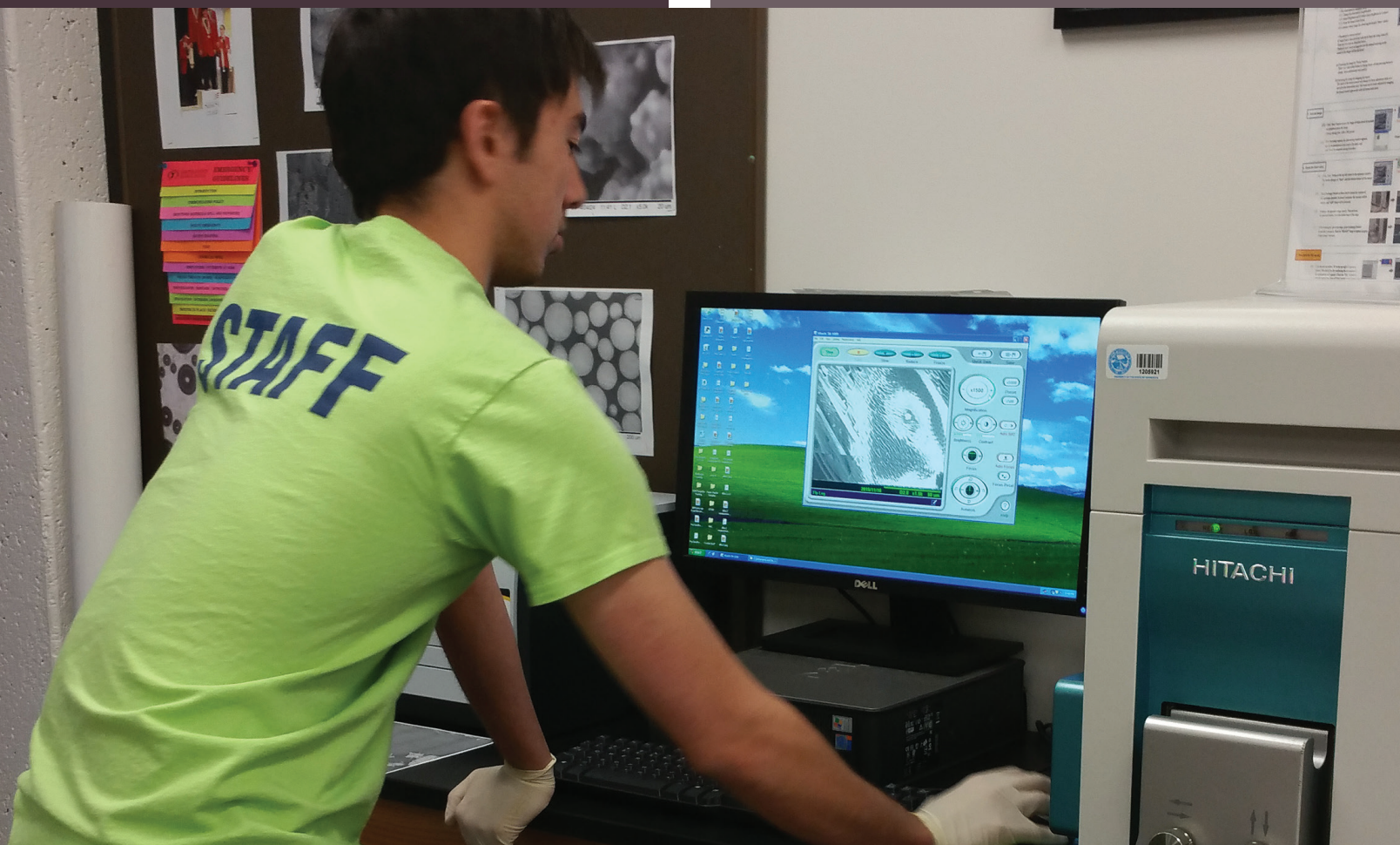
- Develops technicians for emerging technology careers.
- Partners with industry to coordinate student outcomes that meet industry requirements.
- Helps educators infuse nanoscience concepts into traditional classes as well as technical programs.
- Offers professional development opportunities for educators.

Nano-Link Builds Nano & STEM Career Pipelines

To create a pipeline of students interested in nanotechnology and science in general, Nano-Link reaches out to high school educators. Its 60 workshops and seminars have been attended by 1,200 educators. More than 450 of these teachers report reaching 65,000 students by using Nano-Link materials, activities, and experiments. The teachers have used these Nano-Link resources in physics, chemistry, biology, career education, math, and English classes.

Of the 831 high school students surveyed since 2014, 73% agreed or strongly agreed that use of Nano-Link educational content increased their interest in learning about nanotechnology, and 72% agreed or strongly agreed they had increased interest in learning about science-related careers.

A student learns to use a scanning electron microscope.





Nano-Link Builds Science Knowledge to Address Future Nano Workforce Needs

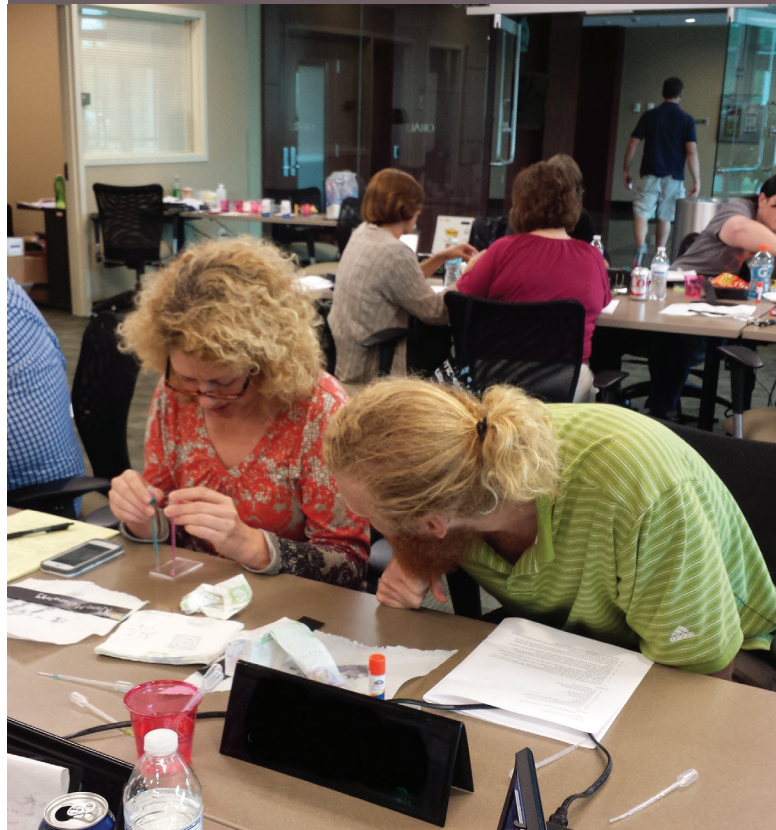
Nano-Link is an alliance made up of 14 high schools, two-year colleges, and universities. It focuses on faculty, students, and the public to increase awareness of nanotechnology and the multitude of career options available.

Acknowledging the multi-disciplinary aspect of nanotechnology, the alliance also develops and defines the competencies required for a career in nanotechnology. As a result, Nano-Link partner colleges prepare students to meet the needs of employers in diverse industries such as energy, material science, biotechnology, food industry, agriculture, electronics, and medical device manufacturing.

Program graduates are employed at more than 35 companies nationwide. They serve as research assistants, lab managers, instrument operators, test technicians, customer service representatives, quality control technicians and manufacturing technicians. Some work independently, performing multiple jobs at companies that range in size from very small to large. Others are on research teams working with scientists and engineers.

Nano-Link facilitates student success and lifelong learning: 60% of 120 graduates between June 2006 and June 2014 continued their education after attaining a two-year degree. Many of these individuals have attended courses while working full time.

Nano-Link workshops provide educators with replicable hands-on experiences and modularized content.



Nano-Link's Embedded Approach to Educational Content

Nano-Link uses implementation of topic-specific modules and college-level labs to instigate institutions' development of nanotechnology certificate, diploma, and degree programs.

Guidance, Tutorials, Syllabi, Slides,
Tests, Quizzes

Courses
Lectures & Labs
Major Categories
Semester Long
College

Lab Experiments
Experiment/enhanced activity
Deeper concepts - 2 to 4 hours
College

Module
Activity Based
Topic Specific
1 hour
Multiple Grade Levels

“The nanoscience program has allowed me to gain experience and knowledge in an advanced technical field far sooner in my academic journey and career path than any four-year degree. I now have the advantage over most graduates.”

*Samantha Zahratka, Associate Engineer
AVEKA, Inc.*



NEATEC Facilitates Experiential Learning

NEATEC works with high schools and two-year colleges to enhance the students' skills in nanotechnology, semiconductor processes, and photovoltaics. It also facilitates industry internships.

From September 2014 to August 2015,

- 27 high schools used the NEATEC Learning Modules to instruct 500 students;
- 45 community college students attended NEATEC workshops;
- 130 students participated in co-ops and job shadowing with General Electric;
- 20 students participated in 20-week, clean room-focused internships with the State University of New York (SUNY) Polytechnic Institute and GLOBALFOUNDRIES; and
- six students participated in 16-week paid internships with the National Institute of Standards and Technology (NIST).

KEY ACTIVITIES

- Provides workshops for two-year college and high school educators and students.
- Develops NEATEC Learning Modules in nanotechnology for high school science and technology courses.
- Partners with industry to create experiential learning opportunities for students.
- Offers colloquia.

A high school instructor who received NEATEC's professional development teaches nanotechnology concepts.



“Being selected for the NIST Internship was a life changing experience. The facility and staff allowed me to gain a great deal of knowledge and skills which led me to where I am today—a semiconductor tool engineer.”

*Mike Kennedy, Semiconductor Tool Engineer
Applied Materials, Inc.*

NEATEC Teaches Technicians

NEATEC has developed a strong relationship with semiconductor industries in New York and Western New England. Since 2014, 600 technicians employed by GLOBALFOUNDRIES, a full-service semiconductor manufacturer, have attended NEATEC training programs. These programs covered mechatronics, workmanship skills, pneumatic technology, and radio frequency technology. From January 2014 to December 2015 NEATEC's two contracts with GLOBALFOUNDRIES resulted in 60 full weeks of technician training.

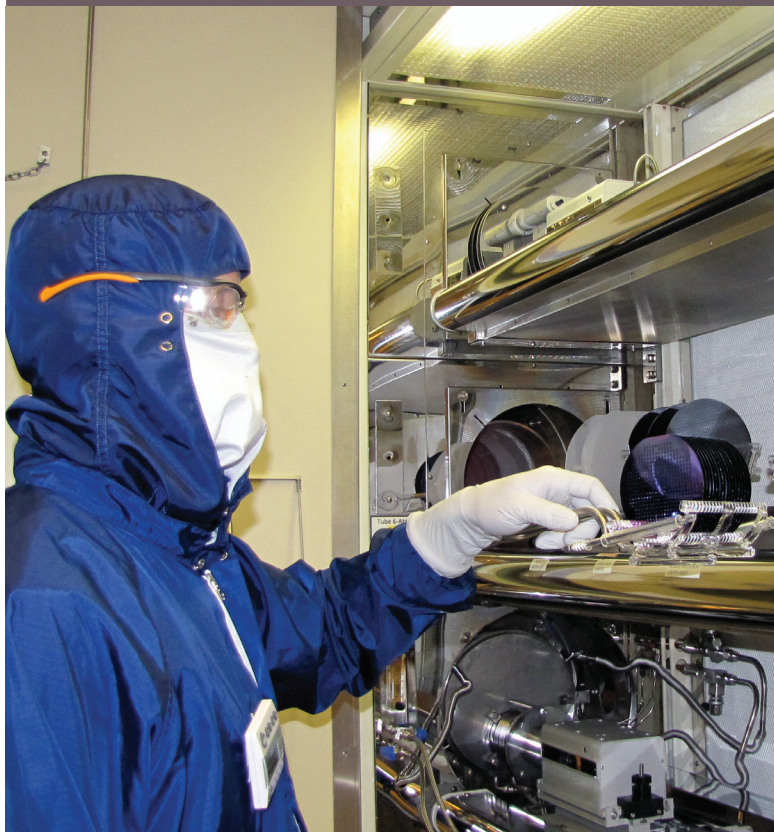
NEATEC's Workforce Development Begins in High Schools

NEATEC offers professional development short courses to high school teachers to prepare them to use its learning modules. More than 50 teachers from 25 schools attended these courses in 2014-2015 and received hands-on kits to teach nanotechnology. The teachers learned how to use atomic force microscopes and various electronics in science and technology classrooms.

NEATEC also created an introductory nanotechnology course that is offered by the SUNY Polytechnic Institute's College in High School program. Students who complete the course earn college credits.

To broaden public awareness of nanotechnology and semiconductor career opportunities, NEATEC offers colloquia and participates in job and science fairs.

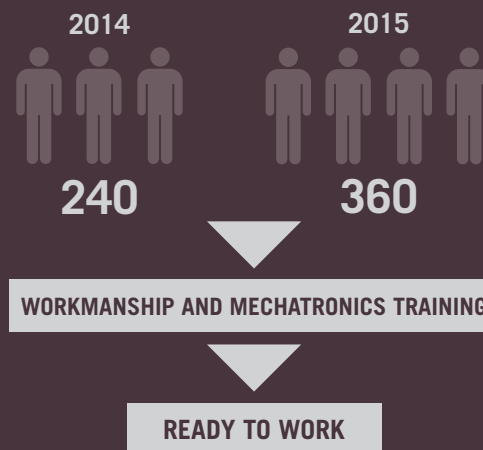
A Hudson Valley Community College graduate prepares silicon wafers for oxidation at GE Global Research.

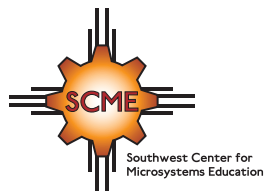


Industry Turns to NEATEC for Training

NEATEC teaches GLOBALFOUNDRIES' new technicians workmanship and mechatronics, a blend of mechanical, electrical, and computer technologies.

NEW EMPLOYEES TRAINED AT GLOBAL FOUNDRIES





SCME Adds Microsystems Concepts to STEM Instruction

Biannual surveys of SCME professional development recipients show that SCME hands-on kits and other educational materials are impacting high school, community college, and university students. These surveys found that students have used SCME materials for more than 310,000 hours since 2012.

Approximately 300 community college and four-year college students completed a certificate or associate degree in a technology program that included microsystems educational components. Half of these students continued their education, while the other half found employment. Approximately 10% were early leavers, individuals who left before completing their degree because they found a job.

Engineering students team up with technicians, a requisite in the high-tech workplace.

KEY ACTIVITIES

- Offers professional development via a hands-on, clean room workshop network, web-enhanced distance learning, and workshop series.
- Disseminates microsystems and nanotechnology educational lessons via YouTube channel, classroom MEMS activity kits, and conference workshops.
- Assists technical programs' inclusion of advanced micromanufacturing.





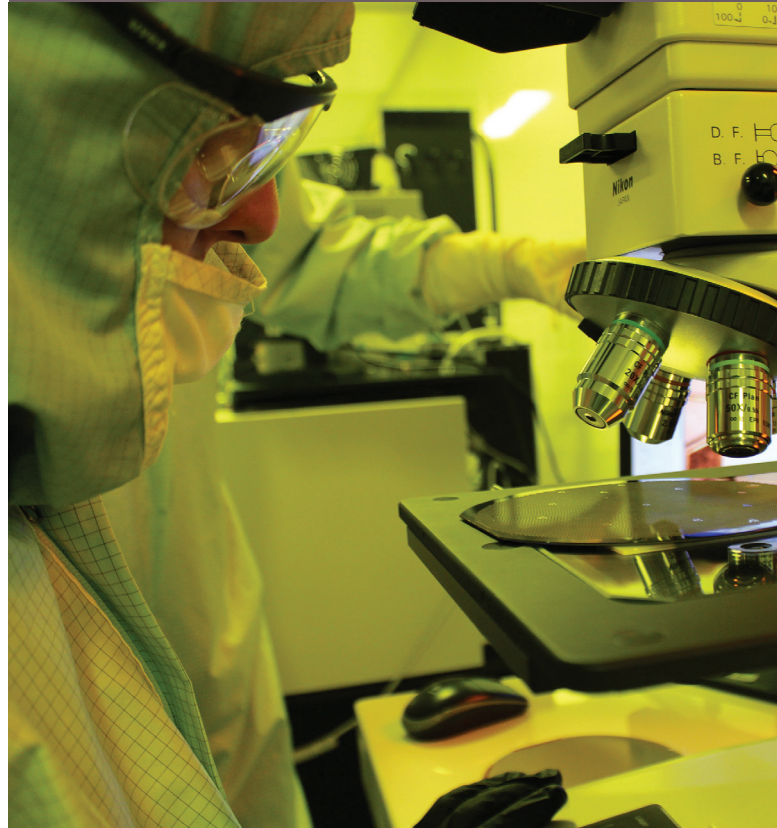
Micro-Pressure Sensors Make Useful Vehicles for Applied Learning

To prepare students for microsystems industry needs, SCME's educational materials and professional development activities focus on micro-pressure sensors. The center has developed more than 50 learning modules that include dozens of hands-on activities that teach about micro-pressure sensor design, fabrication, and applications.

SCME's micro-pressure sensor workshops and supporting curriculum have been successfully transferred to five other educational institutions. By offering these multi-day workshops in clean rooms in various locations, SCME makes advanced micromanufacturing education more available to students, educators, and employers. These workshops cover chemical safety, surface and bulk micromachining processes, sensor operation, electronics, microdevice characterization, crystallography, and microelectromechanical systems (MEMS) applications.

SCME provides its entire curriculum including presentations, animations, instructor and student guides, hands-on classroom activities, and a dozen related, hands-on kits so that professional development participants can take their clean room experience into regular classrooms. More than 100 educators have participated in the clean room workshops; another 400 participants have attended 40 other workshops during the current grant.

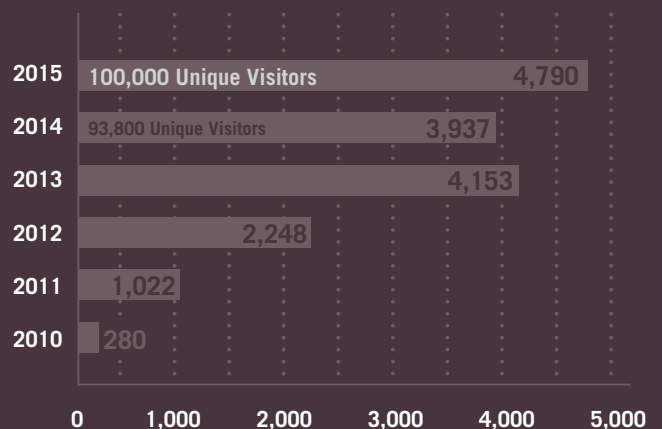
A technician inspects a MEMS wafer containing thousands of individual devices.



Use of SCME Website Spreads

With more unique visitors to SCME's website, the subset of visitors who download microsystems education documents has increased too.

The average download/month by year is



“The SCME is THE place to find qualified micro and nanotechnologists. Aspiring next generation micro and nanotechnologists need look no further than the SCME for up to date training.”

Todd Christenson, Founder and Chief Technology Officer
HT MicroAnalytical, Inc.



SHINE Promotes Nanotechnology in Pacific Northwest

SHINE promotes nanotechnology education throughout the Pacific Northwest region. Since 2012, SHINE has reached more than 5,000 students and educators with hands-on nanotechnology demonstrations at outreach events and science fairs. SHINE helped with the development and delivery of introductory nanotechnology courses at three partner high schools, impacting 309 students from 2012 to 2015.

SHINE has also excelled in delivering high quality professional development opportunities for educators. In 2015, SHINE launched its SHINE Fellows Institute, a scalable professional development program. The program supports educators as they develop curriculum and facilitate training workshops for other educators in their geographic areas.

A student looks at a microelectromechanical systems (MEMS) device.

KEY ACTIVITIES

- Educates nanotechnology students to meet industry needs through hands-on instruction and high-quality instrumentation.
- Creates internship opportunities for students to work directly with industry.
- Offers high-quality professional development opportunities to high school and community college educators.



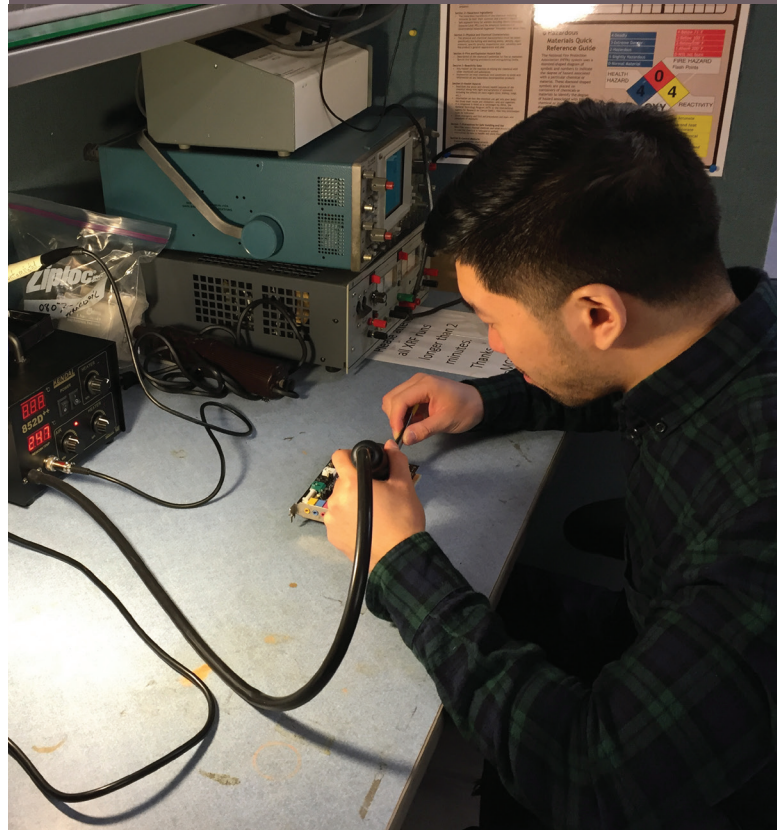


Nanotechnology Lab Serves Students & Industry

SHINE's Nanotechnology Lab at North Seattle College, provides students and industry with access to state-of-the-art equipment, such as an atomic force microscope, a confocal microscope, a profilometer, and a scanning electron microscope. Small companies and start-ups use the Nanotechnology Lab to access expensive equipment for their fabrication and characterization needs. As a result, student interns who work in the lab gain valuable experience identifying and analyzing materials that are used in commercial and industrial products. From 2014 to 2015, eight student interns were mentored by industry representatives, and received an additional 100 hours of hands-on experience using the equipment to collect data for the companies using the lab.

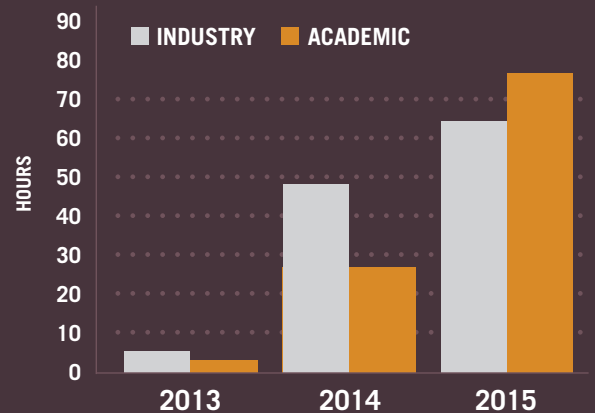
SHINE has been a leader in developing its lab facilities to support education and industry beyond its immediate geographic area. As an active member of the Remotely Accessible Instruments for Nanotechnology (RAIN) Network, SHINE allows students and educators to control nano and micro instruments in the Nanotechnology Lab from their own classrooms. From 2013 to 2015 SHINE hosted 20 remote access sessions for 32 educators and 363 students from across the country.

A nanotechnician disassembles a circuit board to analyze its heavy metal content using x-ray fluorescence spectroscopy.



Nanotechnology Lab Use Increases

SHINE maintains strong partnerships with educators and local companies that use its Nanotechnology Lab at North Seattle College.



“North Seattle College’s nanotechnology program gave me an edge when I was looking for a career. I received hands-on training that strengthened both my technical and soft skills. Thanks SHINE for helping me transition into a career with endless opportunities.”

*Jeanine Pebbles, Senior Engineering Technician
Lawrence Livermore National Laboratory*