The Value of Accreditation

How ABET Helps STEM Programs Adapt to Industry's Evolving Needs

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SUMMARY: Research has shown that more engagement between academia and industry is needed to equip students in Science, Technology, Engineering and Math (STEM) programs with the skills today's employers require. Sitting at the nexus of industry and academia, ABET bridges this gap to ensure that STEM graduates are prepared with the knowledge, skills and aptitudes to meet workforce demand. With several feedback channels from industry, ABET continues to support STEM programs in adapting program content and delivery as markets and professions evolve.

This issue brief explores the value of ABET accreditation from the perspective of industry stakeholders and underscores the important role of industry experts in the accreditation process, through participation in the ABET Industry Advisory Council (IAC), representation of professional societies and involvement as Program Evaluators.

ABET At a Glance

ABET is a federation of 36 professional societies that govern policy, establish strategy, develop criteria and guide accreditation activities on behalf of their respective professions. These societies represent more than 1.5 million professionals located in nearly every country of the world. The societies are also the primary source of more than 2,000 expert volunteers who conduct the important work of accreditation in their respective disciplines. These volunteers provide the necessary assurance that a program is being evaluated by an expert with that discipline's specialized knowledge.

ABET was founded in 1932 as the Engineers' Council for Professional Development (ECPD), an engineering professional body dedicated to the education, accreditation, regulation and professional development of engineering professionals and students in the United States. A decade later, the council expanded to evaluate engineering technology degree programs. Around the same time that Boeing and other industry representatives called for a reimagining of engineering education in the United States, ABET began branching out from engineering to other STEM disciplines such as computer science.

Today, the organization accredits more than 4,000 college and university programs in applied and natural science, computing, engineering and engineering technology at over 800 universities in 32 countries.

ABET also has significant global engagement as a signatory to multilateral and bilateral international agreements such as the Washington Accord for engineering. ABET has signed several other mutual recognition agreements (MRAs) that recognize the substantial equivalency of participating organizations' accreditation processes and their graduates' preparedness to begin professional practice at the entry level. ABET's global engagement and responsiveness to international partners is critical to ensuring that STEM graduates are prepared to succeed in the global economy.

Historical Overview: A Post-War Shift to Scientific Research

STEM education in the United States entered a new era in the aftermath of World War II. Many of the innovations, such as nuclear technology, came out of physics labs rather than engineering departments. This led to a profound shake up in engineering education during the post-war period. The global Cold War and resulting arms race drove research funding from the federal government to support a shift to more theoretically based engineering.

With such a strong focus on scientific research, universities paid less attention to the demands of industry. By the mid-1980s, industry representatives put out a call to radically overhaul engineering programs because they weren't producing graduates who were prepared to work in the private sector.

A recent article in *The Chronicle of Higher Education* tracked how Boeing principal engineer John McMasters brought industry and academia together in his quest to rewrite engineering education in the late 80s. At the time, Boeing was hiring graduates who were more prepared for research than for careers in engineering. McMasters was concerned that this skills gap would hurt U.S. industry's competitiveness in an increasingly globalized market. One Boeing leader said that it took five years of on-the-job training to bring new hires up to speed.[1]

A New Focus on Outcomes

McMasters set his sights on ABET as the preeminent accreditor of engineering programs. At the time, the organization's accreditation standards were seen by industry as rigid, prescriptive and antithetical to innovation, and program assessment focused on specific courses and credit hours students were taking.

In response to industry demand, ABET overhauled its engineering criteria over the course of the 1990s, resulting in the adoption of a new outcomes-based framework known as Engineering Criteria 2000 (EC2000) in 1997. EC2000 changed the focus of accreditation from what universities were teaching to what students were learning — a shift from inputs to outputs. The new framework still required students to have foundational knowledge in science and math, but also included a focus on soft skills, such as critical thinking, communication and teamwork.

"The beauty of EC2000 is that by using outcomes we're not going to tell [institutions] how to weave them into the curriculum. Universities have to show us how they address these outcomes," explained Dayne Aldridge, ABET's Adjunct Accreditation Director for Engineering, who was involved in the transition process throughout the 1990s. "It's worked much better than any of us ever imagined it would. Today, soft skills are built into the curriculum in different ways and there is no explicit requirement that says [students] have to take courses in X, Y or Z."

While much progress has been made since the adoption of EC2000, there is still a need for continued collaboration between academia and industry as employer needs continue to evolve.

Program Criteria Adapts to Evolving Market Demands

Since EC2000, ABET streamlined changes to and allowed flexibility in program criteria based on input from industry via the member societies. "ABET itself has worked hard to enable innovation and shorten the cycle as to how the criteria gets changed, how we approach accreditation, and to enable programs to really differentiate themselves. ABET honors that and simply looks for a satisfaction of the criteria that is defined for all programs," said Ron Hinn, Executive Vice President at PetroSkills and current Chair of ABET's Industry Advisory Council. "The majority of graduates come out of programs that have specific discipline criteria that's been defined by their professional society."

Program criteria can evolve in response to disciplinary needs. Daina Briedis, Assistant Dean of the College of Engineering at Michigan State University and Adjunct Director of Professional Development for ABET, said the professional society (AIChE) for chemical engineering played a major role in promoting safety in chemical engineering programs.

"The ABET member societies have had dramatic influence on program criteria. So in our case, we have unfortunately seen explosions in petroleum manufacturing, we have explosions in chemical manufacturing and that in turn came back and [translated to] the program criteria for our discipline that required the students to have extensive preparation related to the safety and hazards associated with chemical processes," she said.

1 https://www.chronicle.com/interactives/20190926-Boeing

Steven Lingafelt (top-right) serves as co-Team Chair on an ABET accreditation visit.

Being able to influence program criteria — and, ultimately, students' educational experiences and readiness to enter the workforce — was exactly why Bret Clausen, former Global Director of Health and Safety Talent and Technical Services for CH2M, wanted to get involved with ABET accreditation. A former ABET board member, he has been a hiring manager for most of his career, hiring both entry-level and experienced professionals in industrial hygiene and safety. "The more I was doing it, the more I was getting frustrated because there was such a variability in the fundamental quality of graduates," Clausen said. "Just because they came out of a reputable program doesn't mean they had that same baseline of capability. I wanted to have the opportunity to work with the professional organizations and with ABET to make sure we were keeping an eye to the future."

The Role of the Industry Advisory Council

The Industry Advisory Council, or IAC, is ABET's primary conduit for capturing the industry voice in the accreditation process. Comprised of nearly 20 industry representatives, the IAC provides the perspectives of major employers on present and future needs related to student skills and experience and important accreditation policy issues. In addition to providing counsel to ABET in those areas, the IAC helps identify opportunities to recruit qualified individuals from industry to serve as ABET Program Evaluators and helps develop and implement strategies aimed at articulating the meaning and value of ABET accreditation to technical employers, particularly as it relates to hiring preferences for recent college graduates.

Members of the IAC also provide regular feedback and recommendations to other parts of the organization, such as the Accreditation Council,

currently chaired by Clausen. "Leaders from a broad spectrum of industries [come] together to discuss what the trends are in their various industrial sectors, what the needs are [and] where they're seeing shortcomings in new hires," said Clausen. "Having folks that are actively working in industry, who are on the cutting edge of what's happening and what's developing in a variety of industries...is extremely valuable insight."

The IAC represents industries ranging from information technology and computer science to shipbuilding and petroleum engineering. When Janice Zdankus, Vice President of the Enterprise Group at Hewlett Packard Enterprise and IAC member, was invited to join the IAC, she welcomed the opportunity to provide an industry perspective on the accreditation process — a prospect that has the potential to help STEM programs adapt to evolving workforce needs.

"I have seen curriculum evolve based upon how jobs are changing. For example, back in the 1990s, when software engineering emerged as a major need, we encouraged top university programs to add software engineering courses to the requirements for the major," she said. "Now, for example, in the computing space, data science is an emerging area. We've given a lot of feedback to partner institutions, saying: 'we need students who have an understanding of what that is, both from an interdisciplinary application and from a deeper computer science and engineering programs perspective.'"

Other industry representatives have gotten involved the IAC because of the opportunity to influence STEM curriculum and help build a talent pipeline. "The quality of education matters. This was an opportunity to give my input, from an industry perspective, back to the universities," said Anand Raman, Vice President of Technology and Operations at Climax Molybdenum.

Multiple Channels of Industry Engagement and Leadership

In addition to the IAC and the professional societies, ABET engages with industry through several other channels. Industry experts make up a significant portion of the pool for Program Evaluators and Team Chairs, the ABET volunteers who lead program accreditation visits. Central to ABET's Continuous Quality Improvement (CQI) process is a requirement that programs solicit feedback from the program's various constituencies, which include local employers through Industry Advisory Boards (IAB). Industry leaders are also members of ABET governance, having seats on the Board of Directors and Board of Delegates.

One of Michigan State University's industrial advisory boards.

Alice Greife, Dean of the College of Health, Science and Technology at the University of Central Missouri, teaches graduate courses in toxicology and epidemiology in an ABET-accredited master of science program in industrial hygiene. At her institution, feedback from the industrial advisory boards led to more coursework in basic programming in computer science and a new cybersecurity degree program. "In the industrial hygiene program, we were told by our advisory board that our students didn't have enough exposure to physical agents and so we created more laboratory experiences working with physical agents," Greife explained.

Briedis sees parallels between the role of the IAC for the ABET organization as a whole and those of local IABs for individual programs. "Each of the programs here at Michigan State University has an industrial advisory board. So they're a combination of employers and alumni that interact with us and are familiar with our curriculum. They suggest changes to the curriculum to include topics that maybe aren't the standard in chemical engineering that make our students unique and desirable to certain parts of the chemical engineering industry," she said.

Briedis added that her institution's relationship with its IABs has been bolstered by engagement with ABET. "The relationship we have with our industrial advisory board has been really healthy. They are aware of ABET, they know what the student outcomes are, they know what we're doing, and we know what they are doing. That connectedness to industry has been really valuable to us [at Michigan State]," she said.

A Mutually Beneficial Partnership

Not only does regular feedback from industry help inform the STEM curriculum, ABET also shares insights and updates to industry representatives on what's happening in STEM programs and the role of accreditation in producing quality graduates. However, there remains a great opportunity to increase awareness among industry representatives of the accreditation process and how their respective industries can benefit from it.

Anand Raman of Climax Molybdenum wasn't aware of ABET before becoming involved in the IAC. "Even as a graduate, I really hadn't heard of ABET," he said. "I took the quality of graduates pretty much for granted."

Climax Molybdenum often hires from the same universities that have strong mining engineering programs, all of which "happen to be ABET-accredited," Raman said. He added that his HR department was unaware of ABET and the value the accreditation process brings to industry. Now, the company's recruiting department seeks out accredited programs.

The involvement of industry representatives such as Raman can help increase awareness of the ways in which the accreditation process works in the quality assurance of STEM programs.

Other industry representatives say that ABET has provided an approach they have been able to incorporate into evaluation processes at their own organizations. "ABET has provided me additional skills, knowledge and techniques for...implementation of assessment and evaluation mechanisms for addressing complex enterprise business problems and technical problems," said Steven Lingafelt, Senior Manager for Internal Network Security at IBM, IEEE Fellow and an ABET Team Chair.

He has also gained personally and professionally from his extensive experience as a Program Evaluator and Team Chair. In particular, he has expanded his professional network through his

engagement with ABET and gained exposure to the most up-to-date thinking and engineering methods and research, which he has in turn applied toward solving his own organizations' business challenges.

"Professionally, networking is foundational for cross-industry collaboration toward solving our business problems. Personally, it improves my understanding of the world around me and I become friends with like-minded engineers, yielding many hours of pleasant conversations across a broad range of engineering and scientific topics that only an engineer would love," Lingafelt explained.

Creating a Talent Pipeline

Employers are more confident in their decisions when hiring students who graduate from ABET-accredited programs, because accreditation provides quality assurance through independent, third-party review. Newport News Shipbuilding in Virginia, for instance, requires all its new engineers to graduate from an ABET-accredited program. Current IAC member Suzanne M. Beckstoffer, retired Director of Engineering, said of her former company's strong reliance on quality and ABET accreditation, "If you're building a nuclear-powered submarine and you mess up the engineering, then people will die. You have to be able to rely on your engineers."
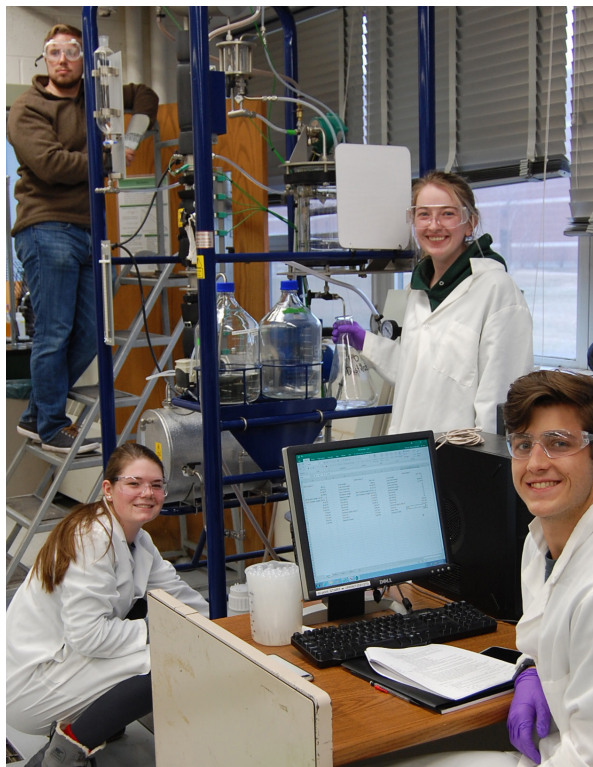
Michigan State University engineering students.

ABET helps establish a recruitment pipeline of graduates with the skills necessary to meet market demands. Charles Menke, Machine Development Manager at Caterpillar and past IAC Chair, said the fact that nearly all engineering programs in the United States are ABET-accredited is a huge benefit for a company like Caterpillar. It allows it to recruit from a wide range of colleges and universities. "Caterpillar works to ensure standards for engineering curriculums are maintained as they help us recruit talented engineers from different universities," Menke said. "For engineering, it gives companies that are hiring a large pipeline of qualified candidates. Whatever need we have, knowing that a program is ABET-accredited gives us the confidence to recruit from that school."

Graduates from ABET-accredited programs also tend to have stronger fundamentals in classic engineering skills, said Jon D. Ness, President and Director at RFA and an IAC member. "We really know where they're starting from. It's a foundational set of skills, and it's helpful to know what the foundation is before you start building."

Some hiring managers turn to ABET-accredited programs because they know they will have certain skills based on student outcomes. "In engineering there is a focus on design, and how engineers are trained to design systems, processes and products. Hiring managers turn to ABET-accredited programs because they know graduates from these programs will have the proper knowledge and background to succeed. As an employer, if an engineer has an ABET-accredited background, I am confident they will bring these important skills to our team," said Jeffrey Abell, ABET Industry Advisory Council Chair and Director of Manufacturing Systems Research at General Motors.

ABET helps ensure that STEM graduates are prepared to work in a global workforce. Students graduating from ABET-accredited engineering programs, for instance, need to have an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments. In addition, they must be able to consider the impact of engineering solutions in global, economic, environmental and societal contexts — which are critical skills for today's professionals. "ABET helps maintain the quality of STEM education that attracts students from all over the world by holding programs and institutions accountable to industry stakeholders, who will ultimately be hiring graduates from those programs," Ness said.

ABET's role in defining STEM disciplines

Working through its member societies, ABET has been instrumental in helping fields such as occupational health and safety and cybersecurity establish their academic disciplines and define the competencies for their respective professions.

Hamid Fonooni, Director of Ergonomics Program at University of California - Davis, said the academic field of occupational safety and health started in 1971 when the federal government created the Occupational Safety and Health Administration (OSHA) to ensure workplace safety. Early education in the field was focused on training OSHA compliance officers. In the late 1980s, a group of safety educators began working within ABET, through the American Society of Safety Engineers (which changed its name to the American Society of Safety Professionals in 2018), to determine the program criteria for safety programs. As the field of OSH thrived in many different directions, in 2016-17, the program criteria for OSH was updated according to the OSH body of knowledge and two rounds of workshops attended by OSH subject matter experts (SMEs) representing academia, industry, and government. "We decided to work together to basically define the competencies expected of graduates to become the professional practitioners," said Fonooni, who currently serves as the Applied and Natural Sciences Area Director for the ABET Board of Directors.

Engineers at NASA's Goddard Space Flight Center inspect a component for the James Webb Space Telescope. (NASA Goddard/Chris Gunn)

Another area where ABET has played a role in creating program-specific criteria is in the field of cybersecurity, a process that was five years in the making. In July 2014, a group of volunteers made up of computing professionals representing academic institutions and professional societies became interested in developing accreditation criteria for programs in the "cyber sciences." The result was an initiative that became known as the Cyber Education Project (CEP). "There was a recognition at the highest levels of government that we needed additional support for cybersecurity education," said Lingafelt, who was involved with the development of criteria for computing programs.

According to Lingafelt, the charge to accredit cybersecurity programs was in part industry driven due to a recognition of its implications for national security. An industry stakeholder feedback group was set up, and volunteers attended conferences and other industry events to get as much industry input as possible.

In January 2016, the Institute of Electrical and Electronics Engineers (IEEE) established a committee to create ABET program criteria for cybersecurity engineering programs. In March 2016, CSAB, the lead society within ABET for accreditation of degree programs in computer science, information systems, software engineering, information technology and cybersecurity, established a committee to create ABET program criteria for cybersecurity computing programs.

ABET approved its program-specific criteria for cybersecurity in 2018, accrediting programs at the U.S. Air Force Academy, U.S. Naval Academy, Towson University and Southeast Missouri State University. "By creating these program-specific criteria, ABET is helping to establish cybersecurity as an academic discipline, and helping to address the critical skills gap we're seeing in this area," said John Schnase, Senior Computer Scientist at NASA Goddard Space Flight Center and ABET Computing Commission Chair.

Lingafelt added that it was important for ABET to push for new accreditation criteria at a time when there were only a few cybersecurity programs in the United States. "It was and still is a growing discipline. If we did it correctly, it was the beginning of consistent programs across the United States. If we waited, then there would be many different programs. It'd be much more difficult to harmonize later," Lingafelt said. "The industry is poised to grow really broadly because you have cybersecurity issues inside semiconductors all the way up to very large systems like the electric grid."

Recognizing the impact of cybersecurity issues on nearly every aspect of our lives, ABET's 2019 Annual Symposium focused on cybersecurity challenges and the need to have a workforce prepared to counter the rapidly evolving threat. It

brought together academic leaders with industry and government experts to discuss how ABET can help prepare the next generation of technical professionals with the necessary knowledge, skills and educational experiences.

Challenges and opportunities in evolving fields

Since 1932, ABET has been committed to continuous improvement to assure confidence in quality STEM programs. Input from industry experts, as well as academia and government, is crucial, as rapidly changing technology impacts both classrooms and workplaces.

Computer science, in particular, faces a labor shortage. There were less than 50,000 computer science graduates in 2017 but more than half a million open computing positions; that number could grow to 1 million by 2020, according to Code.org. Employers face a challenge in finding enough graduates to fill positions.

Craig Berry, Chief Information Officer at Siemens Digital Industry Software, sometimes has to hire graduates outside of the traditional computer science programs. "Many in my industry have resorted to hiring on potential, not credential," he said. "Computer science majors, however, are most likely to become the gladiators of a computing organization — spanning all technical layers and commanding architecture, management and/or cyber defense roles."

While ABET won't be able to solve the supply issue, it will need to get creative in how traditional accreditation is applied to computing and emerging fields such as data science, industry representatives say. The IAC, for instance, has been discussing the need for more engagement with community colleges and quality assurance of micro-credentials.

Amine Chigani, an Enterprise Technologist at Amazon Web Services (AWS) and IAC member, said that computing is penetrating so many parts of society and is evolving so quickly that we as a society haven't caught up. "We haven't [yet]... put forward the same level of ethical expectations common in traditional engineering disciplines for the engineer who builds software systems…systems that are everywhere in our lives from health and transportation to defense and commerce," he added.

The changing landscape is also having spillover effects for ABET's more traditional engineering domains. As Janice Zdankus of Hewlett Packard Enterprise put it: "Computing is becoming a set

Craig Berry speaks at the 2019 ABET Symposium.

of skills that will permeate all disciplines. And in all likelihood, there will be a need for changing accreditation criteria for other disciplines to ensure that they have appropriate computing skill literacy and application built in. I think it's going to be an interesting and very impactful change."

ABET and industry: A powerful partnership

Drawing on the expertise of representatives of both academia and industry, ABET is uniquely positioned to ensure that STEM programs can adapt to evolving industry demands; that students are equipped with the knowledge, skills and aptitudes required by a global economy; and that companies operating in the STEM sectors can have confidence in the programs their employees graduate from. ABET's Industry Advisory Council provides an important platform for industry voice on accreditation and industry experts fulfill Program Evaluator and leadership positions throughout the organization and its professional member societies. In the last three decades, industry has helped drive changes in accreditation ranging from the shift to an outcomes-based framework that includes soft skills to new standards for disciplines such as occupational health and safety and cybersecurity. Against this backdrop, ABET is strongly positioned to maintain its global leadership in STEM education as it takes on the challenge of accreditation in the rapidly evolving fields of computing and data science. As the past Chair of the IAC Ron Hinn notes, "the ABET accreditation process provides an effective path for industry to engage STEM programs, positively influencing a broad range of graduate qualities needed to meet today's business challenges."

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