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Review of Professional Engineering Societies' Websites for Indicators of Engagement in Engineering Education

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1. Introduction

In 1966 the recently established National Academy of Engineering (NAE) convened a symposium to determine what role it should play in engineering education. Participants also discussed what professional engineering societies are doing about engineering education (NAE 1966). Fifty years later, the NAE is again asking the extent and nature of engineering societies' contributions to improving the quality and effectiveness of engineering education in the United States.

The emergence of professional engineering societies in the United States was a result of the technological revolution that began in the late 1800s. The massive expansion of rail and telegraph lines after 1870 allowed unprecedented movement of people and ideas. As Edwin Layton (2003) noted, the societies "became a means for developing professional spirit among engineers; and, as the sometimes-adverse effects of rapid technological change became manifest, they also became a means for expressing their members' sense of social responsibility."

Engineering societies demonstrate this sense of social responsibility, of *acting for the benefit of civilization at large*, by providing continuing educational opportunities to their members, setting and maintaining professional standards, helping to clarify the knowledge and skill base needed by those practicing in the field, and serving as a bridge between employers and schools of engineering (Linder 1966). Many of these characteristics, according to the proceedings of the 1966 NAE symposium, were mentioned as items of importance in the charters of the engineering societies. The proceedings also described meetings and publications as serving the "primary process in which people in academic life have related to the reality of engineering in industry and government" (NAE 1966, p. 54).

Today, the communication of professional societies is no longer limited to publications and face-to-face meetings. They can now contribute to the engineering education community (i.e., undergraduate and graduate students, faculty, administrators, and industry representatives with a vested interest in education) via their own websites and various social media platforms. Their influence flows from their

continuing and highly visible functions: to help define and set standards for their professional fields, publish professional journals, and promote high standards of quality through awards and other forms of recognition. Recognizing the important role of standards in all engineering fields, societies provide resources to help introduce and teach undergraduate and graduate students—and educators—about technical standards.

To improve and make more accessible the educational opportunities available to those in or wishing to gain entry into the profession, many societies offer student memberships (at a significantly discounted rate) and/or support organized student chapters on college and university campuses. Through such chapters, societies can introduce students to the benefits of professional organizations, such as regular meetings that encourage and enhance learning through the exchange of ideas, both with other students and with established professionals, and financial support for their education.

In an effort to link new mass communication methods with societies' commitment to social responsibility, this background paper addresses the direct and indirect engagement between societies and students based on evidence available on their public webpages. It highlights activities that are widespread among societies and those that are less so. However, it is important to note that many societies have content that is accessible to members only. The following analysis relies on data and information that could be accessed without member credentials. In addition, there was no attempt to verify the information with any society officials. Although the spectrum of engineering education begins with K–12, this paper will focuses on engineering education at the two- and four-year undergraduate and graduate levels.

This paper is organized as follows. Section 2 presents the methodology: section 2.1 describes the approach used to assess society websites, section 2.2 describes how the search results were classified, and section 2.3 defines terminology used in the paper. Section 3 reports the overall results of the website review, describing indirect and direct engagement with students and the role of affinity societies in the engagement of students. Section 4 presents conclusions.

2. Methodology

2.1 Approaches to Website Review

This study reviewed the websites of 122 engineering societies (see appendix) in the United States to identify activities that could be associated with engaging students in the engineering education community. The following keywords were used for home screen tabs and site searches: education, students, scholarships, and publications.

The initial review revealed that foundations were used as a funding mechanism for many of the societies' scholarships and awards. As a result, all society websites were reassessed to determine whether the society had a foundation, using the word *foundation* as the search term.

2.2 Classification of Search Results

The review of engineering society webpages revealed activities that were similar in nature (*Outcomes of search terms*) and therefore classified in two broad categories of engagement (*Direct* or *Indirect*) and renamed (*New categorical name*). Table 1 shows the classification process.

TABLE 1. Classification model.

Search term	Outcomes of search terms	Type of engagement	New categorical name
Education	K–12 outreach	*Removed; outside scope of this paper*	N/A
	Curriculum (input)	Indirect	Technical publications/standards
	Conferences/symposia	Direct	Professional development
	Professional development	Direct	Professional development
Students	Membership	Direct	Student membership
	Student chapter	Direct	Student chapter
Scholarships	2-year college students	Direct	Financial support
	Undergraduate	Direct	Financial support
	Graduate	Direct	Financial support
	Doctoral	Direct	Financial support
Publications	Technical standards	Indirect	Technical publications/standards
	Body of knowledge	Indirect	Technical publications/standards
	Textbooks	Indirect	Technical publications/standards
	Technical journals	Indirect	Technical publications/standards
	Educational briefings/reports	Indirect	Educational research articles/briefings
Foundation	Foundation	N/A[a]	Foundation

N/A = Not applicable.

[a] Society webpages were assessed only to determine whether or not they had a foundation. Foundations were not further classified into engagement type.

2.3 Definition of Terms and Categories

The following terms were used to ensure consistency in classification:

Indirect educational engagement: This includes publications, technical journals, educational research articles and/or briefings, standards, and a prescribed body of knowledge. These are classified as "indirect" because there is no guarantee that students will either review these materials or be introduced to the standards or recommendations for curriculum during their education.

Direct student engagement: This includes (1) opportunities for students to join a professional society through membership either at the national level or in a student chapter at an institution of higher education and (2) student financial support through scholarships and awards.

The following terms were used to ensure consistency in this paper:

Educational research articles/briefings: Articles or reports on the state of higher education, innovative teaching methods, or engineering education in a society's field(s).

Financial support: Scholarships, fellowships, or awards sponsored by societies or their foundations to support the educational and professional development of student members.

Foundation: Charitable arm of a society, dedicated to financially supporting student education and professional development. This category is separate from *financial support* because not all societies that support students financially do so through a foundation. Websites were reviewed only to determine whether or not they had a foundation.

Professional development: Webinars, workshops, conferences, and other types of facilitated learning opportunities.

Student chapters: Formally organized subunits of a national society. Reside based at one or more colleges or universities, and ideally involve students and faculty members from different departments whose fields are relevant to the society. The purpose of a chapter is to generate interest in the society's area of expertise by providing students with various educational and professional development opportunities. Memberships within student chapters are often offered at reduced rates.

Student membership: Available to students who do not have a student chapter on their campus. Some societies offer both student chapters and, on campuses without a chapter, student membership in the national society (such societies were counted in both categories). These memberships, often offered at reduced rates, provide students with the knowledge and tools necessary to develop a professional identity and to start developing a professional network.

Technical publications/standards: Technical journals, textbooks, or definition of field-specific body of knowledge.[1] This category also includes societies that are ABET members because of the accrediting body's impact on curriculum.[2]

3. Results and Discussion

To assess the different roles of engineering societies in supporting engineering education, information from society websites were initially classified in five categories of search terms: education, students, scholarships, publications, and foundation. The reclassification process (table 1) resulted in six new, more specific categories of direct and indirect engagement, along with the original category of foundations, as shown in table 2.

Direct engagement through professional development was the most common of all forms of engagement (92 societies; 81 percent). Financial support (72 societies; 59 percent) and student membership (71 societies; 58 percent) were also relatively common. Contributing to technical publications/standards was the most common form of indirect engagement (77 societies; 63 percent). Educational research was less common (47 societies; 39 percent). Of special interest, student chapters were not a widespread form of engagement (46 societies; 38 percent). Only 34 societies (28 percent) use a foundation to support their educational activities.

TABLE 1. Number of professional engineering societies with activities in each category.

Indirect educational engagement (total: 99 of 122)		Direct engagement with students (total: 114 of 122)				Foundation
Technical publications/standards	Educational research articles/briefs	Student chapters	Student membership	Financial support	Professional development	
77	47	46	71	72	92	34

[1] *Body of knowledge* is the accepted, agreed-upon, aggregated set of knowledge that an individual is expected to have mastered to be considered or certified as a practitioner in a particular area.
[2] Societies with membership in ABET are denoted by * in appendix A.

3.1 Indirect Student Engagement

The mission of the professional societies is primarily educational and informational. Recognizing the important role of standards in engineering, societies provide resources to help introduce and teach undergraduate and graduate students, as well as educators, about technical standards. Because the ABET Engineering Accreditation Commission criteria for curriculum require faculty to ensure that their programs incorporate appropriate engineering standards (ABET 2015), societies that are ABET members were included in this category.

Society websites were assessed to determine their indirect influence on education based on published standards, industry-specific body of knowledge, or publication of society-sponsored textbooks, magazines, technical journals, or newsletters. Publications were featured on the websites of 63 percent (77) of the societies. Overall, more than three quarters (81 percent; 99) of the societies contribute indirectly to student engagement in engineering education through technical publications/standards and educational research articles/briefs.

3.2 Direct Interaction between Students and Societies

Societies' capacity for direct interaction with students was assessed based on three factors: the existence of student chapters, student memberships, and/or the provision of financial support to student members for education or travel for professional development. Based on these criteria, a large majority (93 percent; 114) of the societies have some type of direct interaction with students.

Only 46 societies have a student chapter on various campuses throughout the United States, but 71 offer student memberships.[3] Student chapters and memberships serve as a training ground for America's future engineering workforce. Long-term membership in a professional society also paves the way for lifelong learning, a professional skill listed in ABET student outcomes (ABET 2015). Members of a student chapter or of the national organization can take advantage of a society's activities and services such as scholarship/financial aid, meetings and events, and professional development opportunities.

Three-quarters of the societies (75 percent; 92) offer some type of professional development for members, including students. These opportunities include webinars, face-to-face training, mentoring channels, and conferences/symposia on technical and/or educational topics. Opportunities to enhance professional skills cover topics such as communication skills (oral and written), appreciation for the global/societal context, working on teams, professional and ethical responsibility, and contemporary issues relevant to the organization.

Many studies have examined the influence of nonacademic factors, alone and combined with academic factors, on student retention and performance (e.g., Reichert and Absher 1997; Brainard and Carlin 1998; May and Chubin 2003). These studies have reported that financial support is a critical factor especially in the retention of women and people of color in engineering programs. More than half of the societies (59 percent; 72) contribute financially to two- and four-year undergraduate and graduate students by offering competitive scholarships, fellowships, or awards (i.e., contests, theses,

[3] As explained above, societies that offer both student chapters and memberships were double counted.

dissertations, or travel). A little more than one-quarter (28 percent; 34) of the 122 societies have a foundation that helps support the society's direct and/or indirect impacts on student engagement.

3.3 The Role of Affinity Societies in the Direct and Indirect Engagement of Students in Engineering Education

Affinity societies provide forums for individuals to gather and share ideas outside of their particular technical area of expertise while serving as advocates for the members of their organization to the engineering education community (Rider 2014). Although affinity societies do not represent specific engineering fields, this review found that they play a significant role in the direct engagement of students in engineering education. Of the 124 societies assessed, 14 are classified as affinity societies.

TABLE 3. Number of professional engineering affinity societies with activities in each category

Indirect educational engagement (total: 11 of 14)		Direct engagement with students (total: 14 of 14)				Foundation
Technical publications/standards	Educational research articles/briefs	Student chapters	Student membership	Financial support	Professional development	
2	10	7	6	10	13	0

All of the affinity societies provide some type of professional development opportunity for student members. There were seven affinity societies with student chapters and six with student membership. None has a foundation, but ten of them provide some type of financial support to students. Ten affinity societies produce educational research articles/ briefs; two produce technical publications.

4. Conclusions

The primary goal of this background paper is to provide a perspective on the engagement of engineering professional societies with the engineering education community. This perspective focuses solely on the information readily available on each society's public webpages; any pages that required member credentials for viewing were not assessed.

This review found that engineering societies, in line with their core purpose, work to impact engineering education both indirectly and directly. In an effort to prepare the future engineering workforce, 93 percent (114) of the 122 societies reviewed directly engage students: they offer student memberships, have student chapters on campus, or provide some type of financial support to student members. Over a quarter of the societies (28 percent; 34) have foundations that provide funding for students. For example, the Society for Manufacturing Engineering (SME) has an Education Foundation that was created to "inspire, prepare, and support young people in their pursuit of advanced manufacturing career pathways." It provides cocurricular activities and scholarships, and the site reports the amount spent on students in manufacturing. The foundation also posts its annual reports online.

Unfortunately, there was very little explicit evidence on the society webpages of how these activities directly impact student retention in engineering or of the effectiveness of society engagement. There was also no evidence of how society publications (magazines, technical journals, or newsletters) contribute to students' preparedness to enter the workforce. However, it is possible that this

information exists in annual or internal reports that may not be posted or publicly accessible on society webpages.

The analysis of societies' websites shows a great deal of commonality in activities across societies. It also reveals activities that are less common. Both findings point to areas where it may be useful for societies to share information.

It may also be useful to investigate how strategic relationships between technical and affinity societies can help meet engineering student, faculty, and workforce needs. This is not a new concept for affinity societies—the website review found joint membership opportunities among the Society for Women Engineers (SWE), the American Indian Science & Engineering Society (AISES), the National Society of Black Engineers (NSBE), and the Society of Hispanic Professional Engineers (SHPE). This allows members of one organization to register and pay for membership (at a discounted rate) in one of the other three societies. Likewise, the Women in Engineering ProActive Network (WEPAN) and the American Society of Mechanical Engineers (ASME) work together on an NSF-funded project to empower faculty teams in mechanical engineering to advance inclusion and diversity in their departments.

Finally, when looking at the impact of societies and their ability to focus on engaging engineering students, it may also be important to consider overall the capacity of societies and their ability to dedicate staff to these specific efforts.

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APPENDIX: List of Professional Engineering Societies Reviewed

AACE International (Association for the Advancement of Cost Engineering)
ABET (formerly the Accreditation Board for Engineering and Technology)
Acoustical Society of America
American Institute of Mining, Metallurgical, and Petroleum Engineers (AIME)
Air and Waste Management Association
American Academy of Environmental Engineers and Scientists**
American Association of Engineering Societies
American Ceramic Society**
American Chemical Society
American Concrete Institute
American Council of Engineering Companies
American Ecological Engineering Society
American Indian Science and Engineering Society
American Industrial Hygiene Association**
American Institute for Medical & Biological Engineering
American Institute of Aeronautics and Astronautics**
American Institute of Architects
American Institute of Chemical Engineers**
American National Standards Institute
American Nuclear Society**
American Physical Society
American Public Works Association
American Society for Engineering Education**
American Society for Engineering Management
American Society for Healthcare Engineering
American Society for Nondestructive Testing
American Society for Quality
American Society of Agricultural and Biological Engineers**
American Society of Certified Engineering Technicians
American Society of Civil Engineers*
American Society of Gas Engineers
American Society of Heating, Refrigerating and Air Conditioning Engineers**
American Society of Materials, International
American Society of Mechanical Engineers**
American Society of Naval Engineers
American Society of Safety Engineers**
American Society of Test Engineers
American Water Resources Association
American Water Works Association
American Welding Society
AOAC International

Association for Computing Machinery
Association for Facilities Engineering
Association for Iron and Steel Technology
Association for the Advancement of Medical Instrumentation**
Association for Women in Computing
Association of Conservation Engineers
Association of Energy Engineers
Association of Environmental & Engineering Geologists
ASTM International
Audio Engineering Society
Biomedical Engineering Society**
Board of Certified Safety Professionals
Chinese Institute of Engineers USA
Construction Management Association of America**
Construction Specifications Institute
Computing Science Accreditation Board (CSAB)**
Electrochemical Society
Engineers Without Borders – USA
Environmental Engineering Geophysical Society
Fabricators and Manufacturers Association, International
Federation of Materials Societies
Human Factors and Ergonomics Society
Institute of Electrical and Electronics Engineers (IEEE) –USA**
Illuminating Engineering Society of North America
Industrial Research Institute
Institute for Operations Research and the Management Sciences
Institute of Biological Engineering
Institute of Electrical and Electronics Engineers
Institute of Industrial Engineers**
Institute of Noise Control Engineering of the USA
Institute of Transportation Engineers
International Council on Systems Engineering**
International Federation for Medical and Biological Engineering
International Society for Pharmaceutical Engineering, Inc.
International Society of Automation**
International Society of Explosives Engineers
International Solar Energy Society
Marine Technology Society
Materials Research Society**
Minerals, Metals & Materials Society**
National Academy of Building Inspection Engineers
National Academy of Forensic Engineers
National Action Council for Minorities in Engineering**
National Association of Corrosion Engineers

National Association of Multicultural Engineering Program Advocates, Inc.
National Council of Examiners of Engineering and Surveying**
National Council of Structural Engineers Associations
National Fire Protection Association
National GEM Consortium
National Institute of Ceramic Engineers
National Society of Black Engineers
National Society of Professional Engineers**
National Society of Professional Surveyors**
Oceanic Engineering Society
Optical Society of America
Rehabilitation Engineering and Assistive Technology Society of North America
SAE International**
Society for Biological Engineers
Society for Mining, Metallurgy and Exploration**
Society for the Advancement of Material and Process Engineering
Society of Allied Weight Engineers
Society of American Military Engineers
Society of Cable Telecommunication Engineers
Society of Fire Protection Engineers**
Society of Flight Test Engineers
Society of Hispanic Professional Engineers
Society of Manufacturing Engineers**
Society of Mexican-American Engineers and Scientists
Society of Motion Picture and Television Engineers
Society of Naval Architects and Marine Engineers**
Society of Petroleum Engineers**
Society of Plastics Engineers
Society of Reliability Engineers
Society of Women Engineers**
Southeastern Consortium for Minorities in Engineering
SPIE - The International Society for Optical Engineering**
Standards Engineering Society
Tau Beta Pi
Technical Association of the Pulp and Paper Industry
Vietnamese Association for Computing, Engineering Technology, and Science
Women in Engineering Programs and Advocates Network**

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