2006-2045: ASCE STUDENT CHAPTERS: A CONTRIBUTOR TO ACHIEVING PROGRAM GOALS

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ASCE Student Chapters: A Contributor to Achieving Program Goals

Abstract

An analysis is presented of the American Society of Civil Engineers (ASCE) Policy 465 outcomes, their origins, and the ways an ASCE Student Chapter could contribute to their attainment. The authors draw on their experience serving on ASCE's Committee on Student Activities, working with student chapters and clubs, and serving on the ASCE's Second Edition of the Body of Knowledge Committee. Using their experience from reviewing student chapter and club annual reports from many schools over several years, from attending and observing numerous Regional Student Conferences, from running Workshops for Student Chapter Leaders, from participating in Practitioner and Faculty Advisor Training Workshops, and finally from serving as advisor for the USMA student chapter, the authors assess the contribution of student groups to attainment of Policy 465 outcomes.

Through community service projects, field trips, guest speakers, organizing and running local, regional and in some cases national events, and through the leadership opportunities offered in the ASCE student groups, civil engineering undergraduates can, and do, demonstrate that they are developing the skills and gaining experience in many of the areas outlined in the 15 outcomes of the BOK. When the student group has faculty and practitioner advisor participation, and takes on significant service projects and/or the running of events involving large numbers of participants, the learning and experience are at their best.

The educational opportunities presented by an active and well run ASCE student group cannot be matched in traditional classroom settings. In examining recent initiatives of the National Academy of Engineering (NAE) regarding the future of engineering education, it is clear that many typical ASCE student group activities can contribute to meeting the recommendations of the NAE immediately, without significant changes to a program's curriculum. Finally, ASCE student group activities can also be used to support civil engineering program accreditation, under both current and proposed criteria.

Introduction

Civil engineering programs, and the policies and guidelines for their assessment, continue to evolve. The latest activities in these areas are reflected in the American Society of Civil Engineer's (ASCE) publication Civil Engineering Body of Knowledge for the 21st Century[1], the National Academy of Engineering (NAE) publication Educating the Engineer of 2020 – Adapting Engineering Education to the New Century[2], and the ABET, Inc. "PROPOSED Criteria for Accrediting Engineering Programs"[3] . In fact, Bruce Seely writes in the NAE report that "Engineering education has been the subject of more studies and reviews, formal and informal, than any other domain of professional education." [2]

ASCE student group activities are a historically underutilized resource to civil engineering programs who are working to keep up with these changes. These student group activities are a place where many of the things that the above pundits are looking for have been, and continue to

be, occurring. Others have come to the same conclusions. Shah[4], and DeNatale and Ghafoori[5] published related work in the early 1990s, and Estes, et al[6] have recently addressed the topic.

The benefits of the ASCE student groups' contribution to education should not be discounted either. A well-run vibrant student organization is set up to enhance a student's overall educational experience. Based on the review of 2600 empirical studies of college's effects on students, "One of the most inescapable and unequivocal conclusions…is that the impact of college is largely determined by the involvement in both academic and nonacademic activities."[7] These groups also provide another opportunity for student faculty interaction, especially out of class, which numerous studies have shown to have a positive effect on all academic outcomes.[8] And of course these student groups provide numerous opportunities for frequent student interactions which are associated with "a pervasive pattern of positive benefits."[9]

What we add to the previous studies and discussions is the perspective of some six years of service on the ASCE Committee on Student Activities, as well as a review of typical student group activities with respect to the most recent discussions of civil engineering programs and curricula noted above.

ASCE Student Groups

The general organization of ASCE student groups is outlined in the "BYLAWS of the American Society of Civil Engineers".[10] As noted in the bylaws, students may form chapters, clubs or international groups depending upon their situation. Common to all are the requirements for direct involvement of an ASCE Society Section or Branch and an ASCE member who serves as an advisor. The majority of ASCE student groups fall in the category of "Student Chapter" and typically have one or two practitioner advisors in addition to the faculty advisor. The character of ASCE student groups vary widely across the U.S., as do the regional "Student Conferences" in which they can participate. Active chapters and clubs include most or all of the civil engineering majors in a program and these students participate in the vast majority of activities listed below. At the other end of the spectrum there are some student groups that only coordinate a few activities and involve only a limited membership. Regional Conferences can also range from very large weekend-long venues having upwards of twenty competitions, involving outside speakers, career fairs and attracting well over a thousand students to more modest day long events having two or three competitions and involving approximately a hundred students.

The major activities of ASCE student groups are listed below. These were taken from the published format for the required annual report, and represent what ASCE considers to be the essential activities of a successful student group. The specific examples listed are taken from activities the authors have seen student groups engaged in from year to year.

1. Hold professional meetings: Meetings are held periodically throughout the year that focus on a business or technical presentation, usually given by an outside speaker. Examples of the wide variety of presentations at a meetings include: real world case studies, project management discussions, briefings on CE projects, technological advances in the discipline, cutting edge research, lessons learned through a career in CE,

introductions to advanced CE software, business practices, the role of a new CE graduate in a firm, preparing for job interviews, resume writing and opportunities in the CE field.

2. Hold professional conduct meetings: A special meeting category exists to promote meetings that focus on ethics and issues concerning professional licensure. Often real cases are discussed, issues engineers face in the real world on a continual basis, as well as requirements and expectations on the road to becoming a PE.

3. Give outside presentations: Student chapter members make engineering presentations to audiences outside of the college or university. These have included presentations at technical conferences, project briefs to local planning boards, class room presentations to K-12, and presentations about the organization itself to potential sponsors.

4. Plan and take field trips: Typical field trips take students on site to see civil engineering related work, projects, businesses or historical sites.

5. Plan and hold social functions: This may well be the most popular activity; but often serves as a catch or spring board for a student's greater involvement, and provides great opportunities for out of class student faculty interaction. These events can be tied to specific milestones in the academic year such as start of the term, end of the term, FE exam, or tied to a holiday, an organization's special project or just an opportunity to get students together.

6. Host Branch/Section meetings: Allows students to interact with local professionals on their home turf and integrates them into professional societies. This also serves as a way for the local ASCE Sections and Branches to see what students are doing and to meet with them.

7. Attend Branch/Section meetings: Provides an introduction to professional society activities.

8. Organization business meetings: Gives students the opportunity to become involved with running an organization, running a meeting and working with a large group.

9. Attend Regional Conference: Provides students an opportunity to compete and interact with students from different universities; also introduces them to the idea of a professional conference.

10. Host Regional Conference: This task is usually rotated amongst schools in a region and provides the host school with an exceptional leadership and project management opportunity in a year long effort. Students must work with budgets, fundraising, scheduling, arranging for food and lodging, recruiting judges, and administrative and logistical support.

11. Host National Competition: Similar to hosting a regional conference, although at a much higher level of outside visibility. In addition to the tasks involved in hosting a regional

completion students must work with a national sponsor and ASCE National Headquarters.

12. Student competitions: Not all civil engineering student competitions have direct national ASCE involvement, but most ASCE Student Groups are an integral part of the organization and operation of student teams participating in the steel bridge, concrete canoe, timber bridge and other similar contests. These competitions provide project management experience in designing and building to a given set of specifications taking into account economy, efficiency, constructability, and require a high level of team work to be successful.

13. Publish a newsletter or website: Another opportunity to work on communications skills.

14. Attend a National ASCE Event: Usually involves limited numbers of students but provides an opportunity to tie into the larger professional society.

15. Attend the Workshop for Student Chapter Leaders: Usually limited to an organization's officers but provides a weekend long workshop focusing on leading a better organization, and provides for interaction with ASCE leadership form local to national levels.

16. Organize and conduct service projects: These can vary greatly in scope from group to group, but also within a group as many groups do multiple projects. The projects range from highway clean up, working with Habitat for Humanity, running food drives, K-12 outreach, judging science fairs, tutoring at risk students in math and the sciences, to designing and building bridges play grounds, and simple structures for communities. The larger projects usually involve extensive planning, fundraising, getting approval from various municipal boards and agencies, team work, leadership and many person hours of work. Even the smaller projects though give individual members leadership opportunities and provide students with a chance to give back to the greater community.

17. Submit an annual report: Provides practice in communications skills in a document that is a combination of a technical report and a year book for the organization. The annual reports are submitted to the ASCE Committee on Student Activities where they are evaluated and judged for awards, with each group receiving direct feedback on both their report and their group's activities over the past year.

There are many moves afoot in the engineering world as we look towards the future. For civil engineers three in particular are worth noting and looking at in detail: the ASCE BOK, NAE 2020 and ABET proposed criteria. A more in depth examination of each initiative follows.

The ASCE BOK

The BOK is ASCE's initiative to provide a forward looking enumeration of the knowledge, skills, and attitudes necessary to enter the practice of civil engineering at the professional level in the future.[1] This has been done through 15 outcomes that are necessary for entry at the professional level, achieved through a combination of formal education and experience. Each of

these outcomes has been tied to a level of achievement using Bloom's Taxonomy[11]. Below in Table 1 is a list of the outcomes and the level of achievement expected as a result of the formal education process[12] [13].

Outcome		Formal Education **To satisfy the academic prerequisites for the professional practice of civil engineering, an individual must be able to:**
1	**Technical core**	**Solve** problems in mathematics through differential equations, calculus-based physics, chemistry, and one additional area of science.
2	**Experiment**	**Design** a civil engineering experiment to meet a need; **conduct** the experiment; and **analyze** and **interpret** the resulting data
3	**Design**	**Design** a complex system or process to meet desired needs, within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
4	**Multi-disciplinary**	**Function** effectively as a member of a multi-disciplinary team
5	**Engineering problems**	**Solve** well-defined engineering problems in four technical areas appropriate to civil engineering
6	**Prof./Ethical**	**Analyze** a complex situation involving multiple conflicting professional and ethical interests, to determine an appropriate course of action
7	**Communication**	**Organize** and **deliver** effective verbal, written, and graphical communications
8	**Engineering Impact**	**Determine** the global, economic, environmental, and societal impacts of a specific, relatively constrained engineering solution
9	**Life-long learning**	**Demonstrate** the ability to learn on their own, without the aid of formal instruction
10	**Contemporary issues**	**Incorporate** specific contemporary issues into the identification, formulation, and solution of a specific engineering problem
11	**Engineering tools**	**Apply** relevant techniques, skills, and modern engineering tools to solve a simple problem
12	**Specialized area**	**Evaluate** the design of a complex system or process, or **evaluate** the validity of newly created knowledge within a specialized area of civil engineering
13	**Proj. mgmt., const., and asset mgmt.**	**Explain** key concepts and problem-solving processes used in management
14	**Business and public admin.**	**Explain** key concepts and problem-solving processes used in business, public policy, and public administration
15	**Leadership**	**Explain** the role of the leader, leadership principles, and attitudes conducive to effective professional practice of civil engineering

Table 1: Levels of Achievement from Formal Education for each BOK outcome.

ASCE student organization activities primary support outcomes 6, 7, 9, 10, 14 and 15. A further discussion of the correlation follows later in the paper in conjunction with Table 2.

The Engineer of 2020

Following are the recommendations from the NAE Committee on the Engineer of 2020, Phase II[2], many of which are supported by ASCE student group activities:

1. The baccalaureate degree should be recognized as the "pre-engineering" degree or Bachelor of Arts in engineering degree, depending on the course content and reflecting the career aspirations of the student.

2. ABET should allow accreditation of engineering programs of the same name at the baccalaureate and graduate levels in the same department to recognize that education through a "professional" master's degree produces an AME, an accredited "master" engineer.

3. Engineering schools could more vigorously exploit the flexibility inherent in the outcomes-based accreditation approach to experiment with novel models for baccalaureate education. ABET should ensure that evaluators look for innovation and experimentation in the curriculum and not just hold institutions to a strict interpretation of the guidelines as they see them.

4. Whatever other creative approaches are taken in the four-year engineering curriculum, the essence of engineering-the iterative process of designing, predicting performance, building, and testing-should be taught from the earliest stages of the curriculum, including the first year.

5. The engineering education establishment, for example, the Engineering Deans Council, should endorse research in engineering education as a valued and rewarded activity for engineering faculty as a means to enhance and personalize the connection to undergraduate students, to understand how they learn, and to appreciate the pedagogical approaches that excite them.

6. Colleges and universities should develop new standards for faculty qualifications, appointments, and expectations, for example, to require experience as a practicing engineer, and should create or adapt development programs to support the professional growth of engineering faculty.

7. As well as delivering content, engineering schools must teach engineering students how to learn, and must play a continuing role along with professional organizations in facilitating lifelong learning, perhaps through offering "executive" technical degrees similar to executive MBAs.

8. Engineering schools introduce interdisciplinary learning in the undergraduate environment, rather than having it as an exclusive feature of the graduate program.

9. Engineering educators should explore the development of case studies of engineering successes and failures and the use of a case-studies approach in undergraduate and graduate curricula.

10. Four-year engineering schools must accept it as their responsibility to work with their local community colleges to ensure effective articulation, as seamless as possible, with their two-year programs.

11. U.S. engineering schools must develop programs to encourage/reward domestic engineering students to aspire to the M.S. and/or Ph.D. degree.

12. Engineering schools should lend their energies to a national effort to improve math, science, and engineering education at the K-12 level.

13. The engineering education establishment should participate in a coordinated national effort to promote public understanding of engineering and technology literacy of the public.

14. NSF should collect and/or fund collection, perhaps through ASEE or the Engineering Workforce Commission, of comprehensive data by engineering department/school on program philosophy and student outcomes such as, but not exclusively, student retention rates by gender and ethnicity, common reasons why students leave, where they go, percent of entering freshman that graduate, time to degree, and information on jobs and admission to graduate school

ASCE student organization activities primary support recommendations 4, 8, 9, 10, 12 and 13. The correlation is again further discussed in conjunction with Table 2 below.

ABET PROPOSED Criteria for Accrediting Engineering Programs

ABET continues to strive to improve the accreditation process as reflected in the existence of both a criteria for 2006-2007, as well as a proposed criteria for 2007-2008. We have listed below only those criteria that are related to our discussion – complete information is readily available on the ABET website.

It should be noted that the first 11 outcomes in the ASCE BOK are "the 11 ABET outcomes, which are included verbatim in the 15 BOK outcomes…"[3] These 11 ABET outcomes are items (a)-(k) under Criterion 3 below - they are the same in both versions of the ABET criteria. The differences between the 11 ABET outcomes and their corresponding ASCE BOK brethren in Table 1 reflects the efforts being made to tie the outcomes to Bloom's Taxonomy.

Criterion 4 in 2006-2007 is presented as Criterion 5 in the proposed 2007-2008 version. Although the name has also changed, as noted below, the content is the same.

Criterion 3: Program Outcomes and Assessments (in 2006-2007)/ Outcomes (in 2007-2008)

(a) an ability to apply knowledge of mathematics, science, and engineering

(b) an ability to design and conduct experiments, as well as to analyze and interpret data

(c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability

(d) an ability to function on multidisciplinary teams

(e) an ability to identify, formulate, and solve engineering problems

(f) an understanding of professional and ethical responsibility

(g) an ability to communicate effectively

(h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context

(i) a recognition of the need for, and an ability to engage in life-long learning

(j) a knowledge of contemporary issues

Criterion 4: Professional Component (2006-07)/Criterion 5: Curriculum (2007-08)

"The professional component must include:

(a) one year of a combination of college level mathematics and basic sciences (some with experimental experience) appropriate to the discipline

(b) one and one-half years of engineering topics, consisting of engineering sciences and engineering design appropriate to the student's field of study. The engineering sciences have their roots in mathematics and basic sciences but carry knowledge further toward creative application. These studies provide a bridge between mathematics and basic sciences on the one hand and engineering practice on the other. Engineering design is the process of devising a system, component, or process to meet desired needs. It is a decision-making process (often iterative), in which the basic sciences, mathematics, and the engineering sciences are applied to convert resources optimally to meet these stated needs.

(c) a general education component that complements the technical content of the curriculum and is consistent with the program and institution objectives.

Students must be prepared for engineering practice through a curriculum culminating in a major design experience based on the knowledge and skills acquired in earlier course

work and incorporating appropriate engineering standards and multiple realistic constraints."[3]

The Correlations

Considering the close relationship between the ABET and ASCE/BOK outcomes, the following correlations focus primarily on the link between student group activities and ASCE/BOK and NAE outcomes and recommendations. In a few cases, the ABET criteria will be directly addressed. The intent is to show how much an active ASCE student group can contribute to the goals of a civil engineering program, by recognizing what they are already doing, and how these groups can be used as a test bed or spring board for new initiatives.

Student Activity	**Contribution to CE Program (potential)**	
	ASCE BOK	NAE Recommendations
Hold Professional Meetings	6 (**Prof./Ethical**), 8 (**Engineering Impact**), 10 (**Contemporary issues**), 13 (**Proj. mgmt., const., and asset mgmt.**)	4 (**essence of engineering**), 8 (**interdisciplinary learning**), 9 (**case studies**),10 (**work with community colleges**)
Hold Professional Conduct meeting	6	
Give Outside Presentations	6, 8, 13	10, 12 (**K-12 Outreach**), 13(**promote engineering**)
Plan and take Field Trips	7 (**Communication**)	4, 8, 9,10
Plan and hold Social Function	13	
Hosting Branch/Section Meetings	7, 13, 14 (**Business and public admin.**)	4, 8, 9,10
Attending Branch/Section meeting	10	4, 8, 9,10
Organization Business meetings	13, 14, 15 (**Leadership**)	
Attending Regional Conference		
Hosting Regional Conference	4 (**Multi-disciplinary**), 7, 13, 14, 15	
Hosting National Competition	4, 7, 13, 14, 15	
Compete in Student Steel Bridge Competition	3, 13, 15	
Compete in Concrete Canoe Competition	2 (**Experiment**), 3, 4, 7, 13, 15	
Publish a Newsletter or website	7	
Attend a National ASCE Event	10	4, 8, 9,10
Attend the Workshop for Student Chapter Leaders	15	
Organize and conduct service projects	6, 8	4, 8, 9,10, 12, 13
Submit an Annual Report	7	

Table 2 Correlation of Student Activities to BOK Outcomes and NAE Recommendations

Summary of Example Contributions of ASCE Student Activities

Putting students in front of engaging speakers talking about interesting projects is clearly a way to convey to students the "essence of engineering" as well as exposing them to the growing interdisciplinary nature of engineering projects and solutions. Interesting case studies can also be introduced to students through student meetings, and then further explored in individual courses where appropriate. Inviting local community colleges to these events presents an opportunity to promote and sustain cooperation with these significant potential sources of engineers.

Community service projects offer all of the opportunities noted above, but can also be a vehicle to improve math, science and engineering education in the K-12 levels. Service projects will often promote public understanding of engineering and technology as the public sees the fruits of the students' labor. These service projects also typically provide a "hands on, learn by doing" experience with project management, team work and leadership.

Hosting a Regional Conference or a National ASCE Student Competition is a great long term project where students will exercise significant leadership, project management, and communications skills while having to work in a variety of different disciplines, as part of a team, to accomplish all the work necessary to host these events. Each has significant budgeting and financing requirements and requires significant administrative and logistical work as well. Possibly no other undergraduate undertaking requires as diverse a set of skills to make these high visibility events successful.

Conclusions and Recommendations

ASCE student organizations can play a significant role in a program's accomplishment of the BOK. Vibrant and thriving student organizations involve large numbers, if not all of a program's students and offer a variety of experiences that go beyond what can be accomplished in the classroom. It is time to recognize this asset and fully utilize it for the development of the civil engineers of tomorrow. There is the argument that a voluntary extracurricular activity could not reliably be counted on to satisfy the objectives for ABET, ASCE BOK or any given criteria. The authors are not suggesting that an ASCE student organization could do this alone. However, students take electives to help fulfill a program's objectives and all students do not take the same electives. In much the same way that electives contribute to a program, student groups can be a key supporting element of an undergraduate CE program of study.

Currently there are very successful programs that recognize the value of their student organizations to such an extent that they make participation at certain events mandatory. While this idea strikes many as impossible, it is probably worthy of consideration when the potential contribution of these groups is recognized. Could a certain number of guest speaker presentations be made mandatory? Could students be required to perform a certain number of hours of service project work each year?

Other programs provide such an engaging and exciting list of events that the vast majority of students do participate voluntarily! Could your students receive the support to make their

program this engaging and vibrant? The authors pose these questions, based on their observations of what is being done in colleges and universities with ASCE student groups today, and not based on a dreamed of future vision.

Recommendation 3 of the NAE committee should be heavily considered in every program. At our own institution, we conduct a fairly common civil engineering capstone experience, where all of the seniors work on the same project. Being members of a combined civil and mechanical engineering department, we also have seen for years the successful mechanical engineering capstone experience where the seniors are broken into groups to work on different projects. Both of these activities satisfy the ABET Professional Component (criteria 4) in 2006-2007 and criteria 5 in 2007-2008. Many of the projects that are taken on as individual study in our civil engineering program could be viable "capstone" experiences as well. The ASCE student chapter can contribute here as well for projects that are of a community service nature by assisting with project management and labor.

Many ideas representing the intent of Recommendation 3 of the NAE could be "prototyped" through ASCE student group activities, with little or no risk to the CE program, while at the same time probably promoting interest of underclassman and retention of upperclassmen in civil engineering programs. ASCE student group activities could also be a venue for research into engineering education as discussed in NAE Recommendation 5.

At a national level the ASCE Committee on Student Activities could support further efforts to utilize student group activities by reworking the required Annual Report format to encourage BOK related activities. The current report format is reflected in the list of student group activities presented above – it would be a relatively simple matter to add or remove categories. It might be even more effective for a CE program to set their own requirements for their student group's report(s) such that the program has an annual source of assessment data to draw upon that is catered to their individual program. This link to the BOK and other criteria would only help the annual report be a more purposeful and apparent part of any civil engineering program. It could also help to cement the relationship between its student organization and its educational and professional mission of developing future civil engineers.

Many perceive the biggest short coming of undergraduate engineering education to be its apparent lack of wide-spread appeal, and its inability to retain many who start out in CE programs. We firmly believe that ASCE student group activities represent a major asset in tackling these ongoing problems. Further, we strongly suspect that students who are fully engaged as undergraduates, who are exposed to the full flavor of engineering, and who have opportunities for hands-on activities, all of which can be accomplished/enhanced through ASCE student group activities, will be more interested in pursuing advanced engineering degrees.

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