Engineering Internships – Individual and Program Assessment

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Abstract

One of the highlights of engineering education is the opportunity to participate in an internship. Although not a graduation requirement in most curricula, the internship provides experience and opportunities to engage a professional organization to supplement the academic experience. The Citadel recently developed a mechanical engineering program and sought opportunities to promote academic activities beyond the basic engineering requirements. Internships allow students to enhance their learning and problem solving experience in a real world environment and perhaps give them a start on their senior design project. The summer internship program allows them to conduct research and solve engineering problems with scientists and engineers in some of the nation's finest facilities. Internships are purely voluntary, but nearly half of the mechanical engineering majors forfeit some of their free time at least one summer to participate in these programs. These internships are usually all summer (12 weeks) but some are shorter in duration due to other institutional requirements that can only be accomplished during the summer. This, however, is sufficient time to allow the students to be exposed to, work on, and sometimes solve an engineering problem. The John Hopkins Applied Physics Lab (APL) and Army Research Laboratory (ARL) along with a host of local and regional organizations sponsor most of the internships. This paper describes the internship program and discusses how it attracts engineering majors and assists in job placement. Additionally, feedback from the project sponsors can be used to measure student progress and assess the curriculum.

Keywords

Intern, Student Professionalism, Experiential Learning, Program Assessment

Background

The School of Engineering has had a proud record of significant contributions at The Citadel since its inception in 1842. Approximately 35-40% of the graduates enter military service with the remaining entering industry or graduate school. The Civil and Environmental Engineering Department was established in 1912 and became accredited in 1936. The Electrical and Computer Engineering Department was established in 1941 and became accredited in 1976. The Mechanical Engineering Program was added in 2014 with the first mechanical engineering courses offered in the fall. The School of Engineering applied for accreditation of the new Mechanical Engineering program with the first mechanical engineering student graduates in 2016.

One of the challenges in the teaching profession is to inspire students to learn. Numerous examples to motivate students are discussed by Barbara Davis. These range from incorporating different teaching methods to de-emphasizing grades, giving feedback, and influencing student preparation[1]. Chickering and Gamson argue that time on task and active learning leads to better

understanding[2]. Internships are the link between classroom theory and concepts and real time industry applications. Internships have long been regarded as an important element in preparing undergraduate students for the job market[3]. Although most students at this institution do not currently receive academic credit for participation in an engineering internship, they gain considerable knowledge of collaborative problem solving and learn a variety of new skills.

Some of the goals of the engineering majors are for the students to understand the complexities of engineering and design and how to solve an engineering problem with application of engineering fundamentals and principles. Detailed and extended engineer problems with competing constraints are usually not experienced until the students encounter their capstone project, typically in their senior year. With the institution primarily a teaching and not a research organization, the internal support required for faculty to manage extensive engineering research opportunities cannot be met. The existing infrastructure (test and fabrication equipment, computer resources, and technicians) would require much upgrade to accommodate project needs. As a result, students and faculty must look outside the institution to promote active learning and motivation for engineering.

Since the start of the Mechanical Engineering major at The Citadel, students are encouraged to find their own internship. However, several organizations and industries have expressed a strong interest in working with The Citadel students for research projects and internships. The Applied Physics Laboratory and Army Research Laboratory were some of the larger organizations that wanted multiple student interns, but many more local companies sought individuals; many students expressed equal enthusiasm. A selection process helps screen the students to ensure they are the best match possible for particular internships. All students are required to take an extensive number of math and science courses, and faculty members try to match a student's desire to participate in an engineering internship with their level of success in the coursework.

This paper describes the student experiences with various internships. Students responded to surveys to assess three major areas: 1) their growth in professional skills; 2) their ability to connect information from the academic environment to the internship; 3) and the appropriateness of the Mechanical Engineering Program Educational Objectives for their success after graduation.

Method

Assessment of the internship program was partly based on student perception of the value of knowledge and skills gained. Additionally, as a new program seeking accreditation, students are constituents, and it was important to seek student assessment of the program educational objectives.

Data in this study was collected through a survey administered to many of the juniors and sophomores. The survey discussed in this paper was administered well after the semester had begun when they had time to experience the content of their fall courses. The questions mainly gaged the students' professional skills gained at the internship.

Survey questions were in the format of the Likert Scale, in which students select on a scale of: one for strongly disagree, to five for strongly agree, whether that statement fits their perception.

We believed in this way we could get a more accurate range on the students' thoughts versus a true or false or yes or no format. We also believed we could account for the opinions and thoughts of those who had not considered some of the statements we asked them to rate.

Data

The first category of the survey asked the students to rate a professional skill or trait. The students were rating on the basis of whether they had either developed or practiced the skills from experiences they gained while working on the job at their internship. The first category consisted of ten skills or traits which included the following.

1. Organization
2. Time Management
3. Communication
4. Work Quality, attention to detail, and improved work standards
5. Team work and group leadership
6. Confidence
7. Social and networking abilities
8. Personal appearance and conduct standards
9. Problem solving
10. Self-assessment of own strengths and weaknesses regarding professional and technical skills from interning.

Results from this survey can be seen in Figure 1.

Figure 1: Survey Results for Professional Skills and Traits Developed and Practiced During Interning

Focusing on the student's perspective of relevance that their academic studies had with their work while interning, two groups of questions were included in this second category of the survey. The first category contained three questions that targeted the opinion of the students for

how often they were able to relate topics between interning and academic classes. The second category measured more generally of their level of benefit that their internship experience had provided them. These six questions are as follows, and a graph of the results is provided below in Figure 2.

1. I have applied prior knowledge learned from my studies to a concept or problem that I have experienced during interning.
2. I have applied prior knowledge learned from interning to a concept or problem that I have experienced during my studies.
3. I am often able to relate academic content to my work while interning.
4. Interning has provided me with an interest, excitement, and motivation for my academic studies.
5. My internship experience has helped me in deciding a possible career path.
6. I believe an engineering related internship is a valuable opportunity.

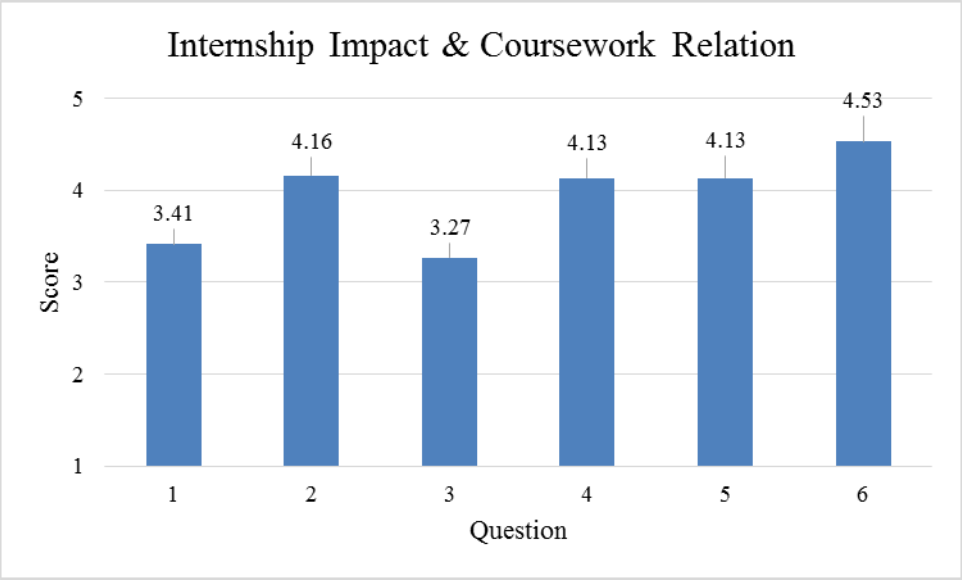

Figure 2: Survey Results for Students Connecting Coursework to Internship Work and the Positive Impact of Interning

Program Educational Objectives are required and described by ABET, "Program educational objectives are broad statements that describe what graduates are expected to attain within a few years after graduation. Program educational objectives are based on the needs of the program's constituencies[4]." Students are listed as one of the program constituents, and those who experienced an internship over the last year were asked, "As students, many of you have had internships, employment, are currently seeking employment, and have specific career goals. Please determine the appropriateness of the MECH PEOs." The Mechanical Engineering Program Educational Objectives (PEOs) prepare graduates to attain:

1. Success in the practice of mechanical engineering, by ethically and judiciously applying knowledge of science, mathematics and engineering methods to solve problems facing a technologically complex society.

2. Positions to apply and operate current engineering and analysis tools and equipment to conduct and/or lead engineering analysis, design and research.
3. Self-Development to value and pursue lifelong learning, not only to keep current in the mechanical engineering field, but also to sustain awareness of engineering-related issues facing contemporary society through formal and informal opportunities.
4. Graduate education and/or professional registration as desired or required.
5. Roles as principled leaders with strong communications and team-building skills to lead people, manage resources, solve complex problems, communicate information, and influence decisions.

Results of this survey can be seen in Figure 3 below.

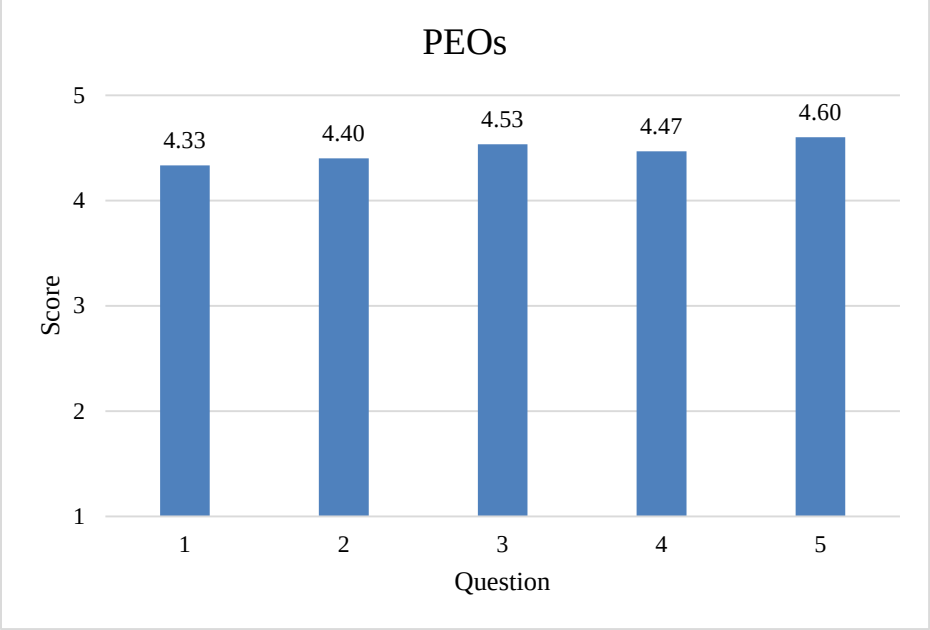

Figure 3: Survey Results for the Appropriateness of the Mechanical Engineering Program Educational Objectives

Overall, this survey shows the students feel they are being prepared for the skills necessary for success three to five years beyond graduation. The PEOs are appropriate. Further discussion of specific questions that contribute to this conclusion are outlined below.

Discussion

Although all questions for the PEOs were rated high (above 4.33), some deserve mention. PEOs #3 and #5 show that students who participated in the internships realized the value of the professional skills (communication, teamwork, time management, etc.) and this was reflected in the separate survey that assessed the professional skills. Additionally, these students realized they would not learn everything about engineering to be successful, and they would have to become self-learners and continue to be engaged in their profession. PEO #1 inquired about their knowledge of math, science, and engineering. As sophomores and juniors responding to

the survey in the fall semester, they did not have the technical background to understand some of the technical challenges in the internship.

Both positive and negative feedback are crucial to the process of growing and improving any new program and internships are no different. However, when there is positive feedback, it allows the program coordinator to perceive that this program is a necessity for some students to thrive and learn beyond a classroom setting. Also, if students are willing to recommend internships to their classmates, the program will continue to grow and develop on its own, allowing more students to obtain experiential learning opportunities.

After reviewing the results of the student survey, category two, regarding student's relating coursework to internship work, stands out most for its significantly low score of 3.27 and 3.41 for questions 3 and 4, respectfully. Although this may initially seem to be of concern, it is easily explained by the factors of when the internships took place and when the survey was conducted. The Citadel's Mechanical Engineering Program outlines the order of its curriculum as expected, with humanities, math, and general sciences filling most of the first year and part of the second. Concluding the second academic year of classes, students have only experienced these classes and fundamental engineering courses including circuits, statics, dynamics, and mechanics of materials. With the survey completed by juniors and sophomores who interned over the previous summer, they are only able to pull from this small exposure to engineering courses. This explains why students seem to rate low the ability in applying academic studies to their real world experience while interning. On the other hand, by question 2 having the second highest score of the category, it is show that students are relating content from their internship to the topics of their first semester junior level classes, which includes thermo-fluid systems, manufacturing, measurements and instrumentation, engineering software, and material science. Considering these factors, it is easily concluded that students are making the important relationship between academics and their necessity in the engineering field. This illustration of the importance of learning the academic material is considered one of the most valuable aspects of experiencing and engineering related internship during a student's undergraduate education.

Questions 4 and 5's relatively high scores of 4.33 draw attention to additional important benefits of interning that are recognized by the students. It is shown that students are gaining a motivation for their academics as they see a direct use of content in their internships. Moreover, students are better understanding the daily work of specific engineering careers, which contributes to a more knowledgeable and informed opinion as they consider possible career paths.

The results from the survey's first category of professional skills development were all rated high (above 4.0), in turn there were some skills that stood out for being lower than the others. However, the skills that rated low were not rated low in respect of not developing the skill but rather in the respect that the skill was developed very little due to the military culture and environment that makes up daily life at The Citadel as a cadet. The first skill that was rated low involved personal appearance and conduct standards. This is explained by understanding that The Citadel is a Senior Military College (SMC) which holds students to a high standard of personal appearance as well as strict rules and regulations that set a standard for how students conduct themselves. Time management and organization, the next lowest scores obtained low ratings for the fact that students at The Citadel, from the time they arrive on campus until they leave, must balance academics, military obligations, physical fitness, as well as clubs or sports

and must constantly organize each and every day to be proficient in each category. Team work and group leadership also scored low out of the other skills, but can be explained by considering the daily duties as a student at The Citadel who is typically in charge of some administrative duty or a group of cadets in which he/she is responsible for their performance and well-being.

From the data, the skills that rated high are expected for a technical internship. The most notable of the high rated skills was the development of problem solving skills which plays a large role in the engineering community. Students also were able to develop or practice communication skills which allows them to build confidence while on the job, which will in turn allow the student become a well-rounded individual and future engineer upon graduation. Finally, the skill that was developed while interning that will play a role for the student upon graduating is the ability to understand and improve work quality and work standards as well as notice the small details that come along with the job title as engineer. Overall each student was able to learn and figure out their own strengths and weaknesses that regard to professional and technical skills which is beneficial for the student so that they know what they need to improve on before they graduate and enter the work force.

Future Work

The implementation of this survey provided a baseline of data and information about how to continue developing the internship program. A needed area of improvement is preparing students better in their coursework before engaging in the internship. As the student population matures, there will be more seniors involved in internships, so this observation may disappear, but is worth tracking for trends. Industry and organization support of the internships is critical to its success. Each year we have received more interest from different organizations who wish to partner with us. Fostering these relationships and seeking new ones will be continuous work.

Conclusion

Incorporating more time for engineering education is difficult with a full curriculum, but the internships offer some solution. There are many beneficiaries of the internships. Any successful internship program is dependent on the competence and motivation of the student, the school, and the sponsoring organization. The sponsors receive an enthusiastic student to do work, conduct tests, and be part of an engineering team. Even though the project sponsor spends time mentoring the student initially, the student provides the organization some degree of expertise and most sponsors are surprised at the zeal and commitment to the project they receive from the student. The students work on real world projects. Some of them are small, and some are larger, involving complex test equipment that the academic institution may not have. Students have the opportunity to see real-world applications of the engineering concepts they learn in class. The students gain insight and experience they can use in the classroom and beyond.

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