

## **Push and Pull: Integrating Industry Across the Student Experience**

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## **Push and Pull: Integrating Industry Across the Student Experience**

### **Abstract**

This work-in-progress paper focuses on efforts related to the Student Experiential Education (SEE) Initiative in the Department of Mechanical Engineering at the University of Colorado Boulder. The SEE Initiative was founded in Spring 2018 and is currently in its first year of implementation. The initiative aims to more effectively integrate professional insights and industry-related connections throughout students' experience in the department.

The SEE Initiative approaches the goal of increased industry/academia integration from two angles. The first approach focuses on finding opportunities to *pull* industry into education. This approach includes hosting alumni panels in core classes, using alumni/industry volunteers for required student informational interviews, planning networking events hosted on-campus, and integrating industry-focused modules and sample problems across the curriculum. These components were selected to bring industry/professional connections into the curriculum in places where students sometimes struggle to connect academic concepts to outside practice, especially early in their academic career and in foundational core courses.

The second approach of the SEE Initiative is to *push* students out into industry/professional environments. The primary goal of this component is to increase the percentage of the department's students who complete an internship from the current rate of 44% for students graduating in AY 17-18. By bringing students into ongoing contact with industry professionals through the *pull* component of the initiative, the goal is to build a department culture where internships are viewed as a typical component of an undergraduate Mechanical Engineering program and an important step in a student's professional development. To that end, the department has employed a new cohort of Student Apprentices to be peer mentors and role models -- providing advice and encouragement to students considering internships, and demonstrating the value of their own internship experiences.

Initial observations and data will be shared from the SEE Initiative's first year of implementation, along with future directions and lessons learned that may be of value for those interested in implementing similar efforts at their institutions.

### **Introduction**

The Student Experiential Education (SEE) Initiative was founded in Spring 2018. It was established with the goal of more effectively integrating industry, alumni, and real-world engineering practice across undergraduate students' experience in the Department of Mechanical Engineering at the University of Colorado Boulder. In order to achieve that goal, the SEE Initiative uses two corresponding approaches. The first is to *pull* industry into students' academic

experience. The second is to *push* students out into industry. These complementary approaches strive to equip and empower students to pursue professional development opportunities within and outside of the university environment.

## **Background & Rationale**

The goals of the SEE Initiative are supported by both outside research and internal assessment. The *2014 Gallup-Purdue Index Report* included a number of relevant findings. The primary goal of the Gallup-Purdue study was to identify factors that led to an increase in post-graduate workplace engagement. Graduates who completed a career-relevant internship during college were found to be twice as likely to be engaged in the workplace as their peers. The study also found that students who had a job or internship that allowed them to apply their academic coursework in a real-world setting were 1.5x as likely to report that they were thriving in all five of Gallup's well-being categories (purpose, social, community, financial, physical). The statistics were even more powerful when it came to alumni engagement, with graduates reporting that they were 8.7x more likely to feel attached to their alma mater if they felt that their university had prepared them well for a career and for life after college [1].

The *Academic Pathways (APPLE) Study* provides additional support for the value of internships and other career-related experience as a component of an engineering undergraduate education. That study found that work-related experiences (i.e.: internships, co-ops, etc.) were the top response when seniors were asked how they gained their knowledge about the engineering profession. The researchers also found a positive correlation between engineering-related employment experiences and students' self-reported gains in engineering knowledge [2]. Outside the realm of engineering education, internships are included on the Association of American Colleges & Universities' (AACU) list of High Impact Educational Practices [3]. A study commissioned by the AACU found that 73% of employers and 67% of recent college graduates felt that colleges and universities should place more emphasis on "the ability to apply knowledge and skills to real-world settings through internships or other hands-on experiences" [4].

Within the Department of Mechanical Engineering at the University of Colorado Boulder, 44% of the graduating class for AY 17-18 had completed an internship prior to graduation. Breaking that total down by gender, 53% of female and 42% of male students completed an internship [5]. While that is a substantial percentage, it also means that over half of the graduating class finished their degree without this pivotal experience. Of the students who reported completing an internship, 86% reported that their first internship was useful, very useful, or extremely useful. An additional 11% indicated that their first internship was somewhat useful, with only 3% indicating that it was not at all useful. That data indicates that students within the department who do complete an internship find the experience valuable [5]. A previous study conducted by a graduate researcher in the department lends weight to that perception; it found a positive correlation between graduates' completion of an internship and their self-assessment of how prepared they felt to begin an engineering career [6].

Students graduating from the Department of Mechanical Engineering during AY 17-18 also noted a relative lack of interest in their courses during their first (3.06/5.00) and second

(3.28/5.00) year in the program, with an increase during the third (4.18/5.00) and fourth (4.52/5.00) year. While there were likely a number of factors that contributed to those results, there was a notable trend in the associated qualitative feedback of students expressing a preference for courses where they could see a clear connection between the course material and the real-world of engineering practice. For example, one student commented that “I was generally interested in the subject upon arrival; however, I found many of the early required courses boring and I could not see the real world application of the subjects. As a result of this, I did not expend much effort in my early years. In the final years the classes became a lot more interesting and more applicable and my effort expended increased.” [5].

The findings from both department-specific assessment and larger, multi-institutional studies present a clear motivation for preparing and motivating students to find internships [1], [2], [3], [4], [5], [6]. They also support the goal of more clearly demonstrating the connections between students’ undergraduate experience and their future roles as practicing engineers [1], [4], [5]. By making those connections more direct and integrating them across the curriculum, there is significant potential to improve students’ experience as undergraduates and better prepare them to thrive in their future careers.

## Goals & Objectives

The SEE Initiative has five specific goals, which are addressed through a combination of curricular and co-curricular efforts. Table 1 below outlines the program goals, objectives, performance criteria, and evaluation methods. It was developed in order to provide a coordinated structure for assessment of a program that is distributed across multiple events, years, and groups of students. The goals and objectives for the program contribute to the overarching vision of increasing integration between academia and industry, in order to help students see where their degree is headed and encourage them to pursue internship opportunities.

Table 1: SEE Initiative Goals & Objectives

| Objectives   | Performance Criteria                               | Evaluation Methods   |
|--|--|--|
| <b>Goal 1: Increase the percentage of students who complete an internship prior to graduation.</b>                           |  |  |
| Objective 1: Increased internship rate.  | Numeric measure of internship rates at graduation. | Senior Survey  |
| Objective 2: Improved culture of internships.  | Student recognition of the value of internships.   | Summer Plans Survey<br>MCEN2000 Pre/Post Survey                            |
| <b>Goal 2: Increase students’ knowledge and confidence with regards to their ability to navigate the job search process.</b> |  |  |
| Objective 1: Confidence in ability to navigate job search process.   | Self-assessment of confidence in abilities.        | MCEN2000 Pre/Post Survey   |
| Objective 2: Understanding of necessary steps and skills for conducting job search.  | Quality job search materials.                      | MCEN 2000 Resume, Mock Interview, and Career Goal Setting Meeting Feedback |
| <b>Goal 3: Students will successfully articulate their career goals and initial steps for working towards those goals.</b>   |  |  |
| Objective 1: Articulate career goals.  | Clear articulation of goals and action items.      | MCEN2000 Goal Setting Meeting Feedback                                     |

|  |   |  |
|--|---|--|
| Objective 2: Articulate initial steps in working towards career goals.   |   |  |
| Goal 4: Students will form an initial understanding of what it means to be an engineer in practice.  |   |  |
| Objective 1: Understanding of the variety of industries and roles that make up the world of engineering practice.<br><br>Objective 2: Understanding of the day-to-day roles and responsibilities associated with being an engineer in practice | Self-assessment of understanding/knowledge. | Post-Event Surveys                                 |
| Goal 5: Students will identify and continue to build their professional networks.  |   |  |
| Objective 1: Identify existing professional networks and means for building them.<br><br>Objective 2: Utilize, maintain, and build professional networks.  | Self-assessment of confidence in abilities. | MCEN2000 Pre/Post Survey<br><br>Post-Event Surveys |

## Program Overview

On a structural level, the SEE Initiative includes both curricular elements and a co-curricular professional development requirement. The curricular elements include both *MCEN2000: Mechanical Engineering as a Profession* and the development of industry-based problems for use in additional core classes. MCEN2000 is a one-credit course taught every fall semester by a full-time faculty member. It is a prerequisite for the department's Senior Design course and requires a passing grade of C or higher. The co-curricular requirement is referred to as *Design Your Career* and includes specific requirements for each year in students' undergraduate education. *Design Your Career* receives primary support from a full-time Professional Development Advisor in the Department of Mechanical Engineering, with additional support provided by a variety of campus entities including Engineering Career Services. Key components of both MCEN2000 and *Design Your Career* are detailed below in Table 2.

Table 2: MCEN2000 & Design Your Career Program Components

| Component                   | Description   | Class Level | Program            |
|-----------------------------|---|-------------|--------------------|
| Student Group Participation | Participation in at least one event or meeting hosted by an engineering-related student group.  | First-Year  | Design Your Career |
| Explore ME Dinner           | Career exploration and networking events featuring alumni, upper-division students who have previously completed internships, and representatives of student organizations. | First-Year  | Design Your Career |
| Careers in ME Symposium     | Conference style symposium featuring short presentations by department alumni and other practicing engineers. Presentations focus on the day-to-day of engineering          | Second-Year | MCEN2000           |

|                             |  |                         |                    |
|-----------------------------|--|-------------------------|--------------------|
|                             | practice and on career-related advice for current students.  |                         |                    |
| Mock Interview              | Practice interview with a program alum or practicing engineer.   | Second-Year             | MCEN2000           |
| Informational Interview     | Conversation with a practicing professional (engineer or non-engineer) in a field that is of interest to the student.  | Second-Year             | MCEN2000           |
| Career Goal Setting Meeting | Individual meeting with a faculty member or career advisor focused on identifying career goals and setting practical steps for achieving those goals.  | Second-Year             | MCEN2000           |
| Industry Tour               | Tour of a local engineering company or national lab.   | Second-Year             | Design Your Career |
| Research/Industry Talks     | Lectures, workshops, and networking events that allow students to learn about the work being done by engineers at different companies and in different functional areas. May have a recruiting or informational focus. | Second-Year, Third-Year | Design Your Career |
| Summer Plans Survey         | Quick survey asking students to report back on their plans for the summer and how those plans relate to their career goals.  | Second-Year, Third-Year | Design Your Career |
| ME Alumni Connect Day       | Full day event that brings alumni back to campus to participate in classroom panels, a networking lunch, and other events.   | Third-Year              | Design Your Career |
| FE Exam                     | Graduating seniors are required to complete the FE Exam. This is a long-standing requirement in the department.  | Fourth-Year             | Design Your Career |

An important component of the SEE Initiative is the hiring of a new cohort of Student Apprentices. The Student Apprentices serve as ambassadors both to and from the program, moving between industry and academia. The first cohort of Student Apprentices consists of 9 students, with 7 of those students having completed an internship in industry and 2 having completed a research or public policy fellowship. They served as TAs for MCEN2000 during Fall 2018 and transitioned into curriculum and program development roles for Spring 2019. They also provided a critical student voice throughout the implementation process, helping to provide insight into areas where students might struggle or feel that they weren't being sufficiently challenged.

Figure 1 below shows how all of the components of the SEE Initiative combine to form a cohesive effort to push the department forward in terms of students' career and professional development. When interpreting Figure 1, it should be noted that the Senior Design program intersects with the SEE Initiative but is not part of the new initiative. Because the Senior Design course is already a prominent and well-established part of students' senior year, the SEE Initiative focuses primarily on students' experiences in the department prior to their senior year. The Senior Design course provides an opportunity for students to work closely with industry through sponsored design projects. It is structured to emulate an industry-based engineering team

environment and has been very well reviewed by students, faculty and industry sponsors with the course consistently rated above its targets (4.0 on a five point rating scale) in important outcomes such as teamwork, communication, project management, and design skills.

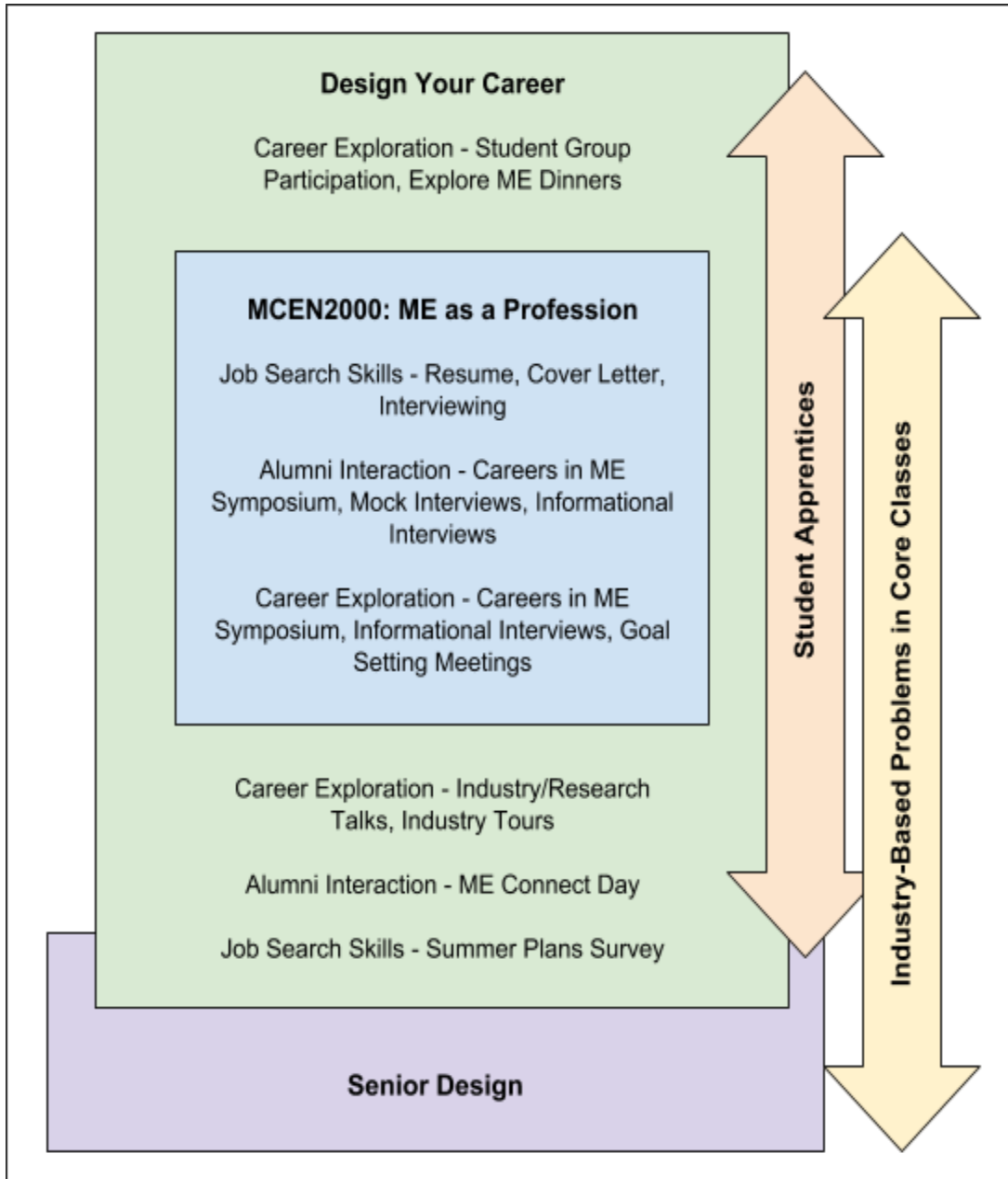


Figure 1: SEE Initiative Components

In terms of the *pull* vs *push* components of the SEE Initiative, most of the concrete elements included in the initiative speak primarily to the *pull* component. They are focused on bringing industry representatives into the classroom or into other aspects of students' academic experience, either directly through guest speakers and panelists or indirectly through the development of relevant modules/problem sets that reference professional practice. The *push*

component is more challenging to visualize because it focuses on a change in the department culture and relies primarily on students pursuing opportunities for themselves. The current hypothesis is that the *pull* components of the SEE Initiative, with their emphasis on integrating industry-based components across students' experience in the department, will be a catalyst for that cultural change. The career preparation components of MCEN2000 and the networking opportunities included in *Design Your Career* aim to equip students with the skills they need to effectively and confidently pursue internship opportunities and other self-directed *push* activities.

One programmatic *push* component of the SEE Initiative is the addition of industry tours for Spring 2019, which will send students into the field to observe industry environments. Despite efforts to empower and prepare students for an internship search, there is still a significant issue within the department with students feeling like an internship is beyond their reach. By pushing students into an industry environment, the program aims to demystify the professional environment, provide insight into the activities students may take on as interns or practicing engineers, and help students start to think more proactively about the idea of finding their fit and identifying opportunities to contribute on a professional level.

### **Initial Evaluation Results**

Data collection related to the SEE Initiative is currently ongoing, with many of the most important data points being delayed by 2-4 years post-implementation. For example, there will not be data available to indicate whether the incoming class of 2018 has higher internship rates than their predecessors until 2022. That said, initial data related to the initiative is promising and points to clear gains. A summary of current data related to each program goal is included below.

*Goal 1: Increase the percentage of students who complete an internship prior to graduation.*

While data is still pending regarding internship rates for current students, there were some interesting results with regards to the internship culture in the department. Pre and post-surveys administered as part of MCEN2000 included questions about whether students believed internships were valuable and whether they were planning to apply for an internship for the following summer. The sample size for that survey was 180 after feedback was removed from students who did not complete both components. When asked "To what extent do you believe that an internship is a valuable part of your undergraduate education?", the mean response for the pre-survey was 4.62/5.00 and the mean response for the post-survey was 4.63/5.00. That indicates that students attribute a high value to internships. It also indicates that MCEN2000 was not a significant positive or negative factor in their valuing of internships.

The post-survey for MCEN2000 also included questions about both where students were currently in their internship search process and the average number of applications that they believed a mechanical engineering student would need to submit to find their first internship. Figure 2 below shows where students reported being in their internship search process at the time when they completed the survey, keeping in mind that MCEN2000 is a fall term class and that the post-survey was administered in mid-December. While the large percentage of students who



had started applying for internships was encouraging, there is an obvious need to encourage students to start their internship searches earlier. Out of the 178 total students who replied to that survey question, 8.4% had already secured an internship, 47.8% were in the process of applying, 29.8% were planning to apply, 12.4% were not planning to apply, and 1.7% were graduating seniors in the process of applying for post-graduate positions.

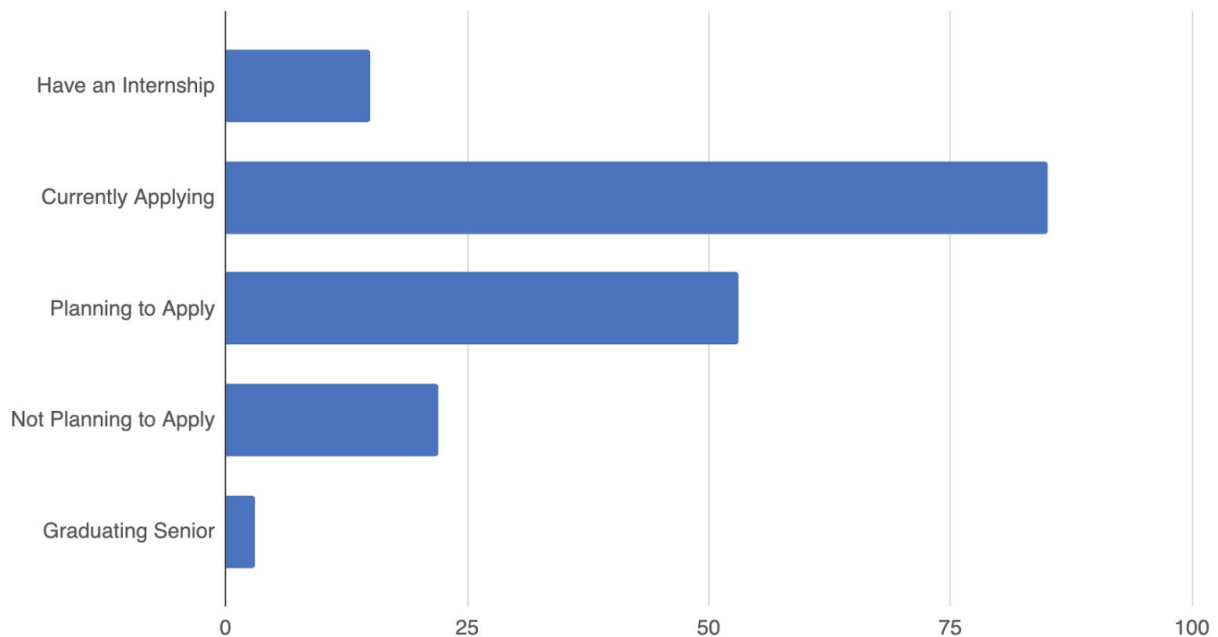


Figure 2: Students' Internship Search Status at the End of MCEN2000

Students' median response when asked about the average number of applications needed to secure an internship was 10 applications, which means that half of the students in the sample believed that the average number of applications needed to secure an internship was less than 10. The mean response to the same question was 13.14 with a standard deviation of 14.42. Those estimates seemed low, given industry partners' anecdotal reports of reviewing 100+ applications per open position. That apparent discrepancy led to a future goal of collecting data related to the actual number of internship applications that ME students submit prior to finding their first position. If it is found that the average number of applications needed to secure an internship is many multiples of 10, that would be helpful information for students to have. It could both help them set realistic expectations for their internship search and help prevent students from interpreting initial rejections as a sign that an internship is unattainable.

*Goal 2: Increase students' knowledge and confidence with regards to their ability to navigate the job search process. (and) Goal 5: Students will identify and continue to build their professional networks.*

Questions regarding students' confidence level with regards to various job search tools and networking components were included in the MCEN2000 pre and post-surveys. Figure 3 below

shows students' reported confidence levels at the beginning and end of the class for each category. The range of possible responses was out of 5 total, with options including "extremely confident", "very confident", "moderately confident", "slightly confident", and "not confident at all". While it would have been ideal to see scores closer to 4 in the post-survey, it is encouraging that there was a statistically significant increase for all 6 competencies ( $p < 0.01$ ). The implementation team also realized after administering the survey that there is a large conceptual gap between "very confident" and "moderately confident", which will be addressed with revised question options during the next iteration of the course survey.

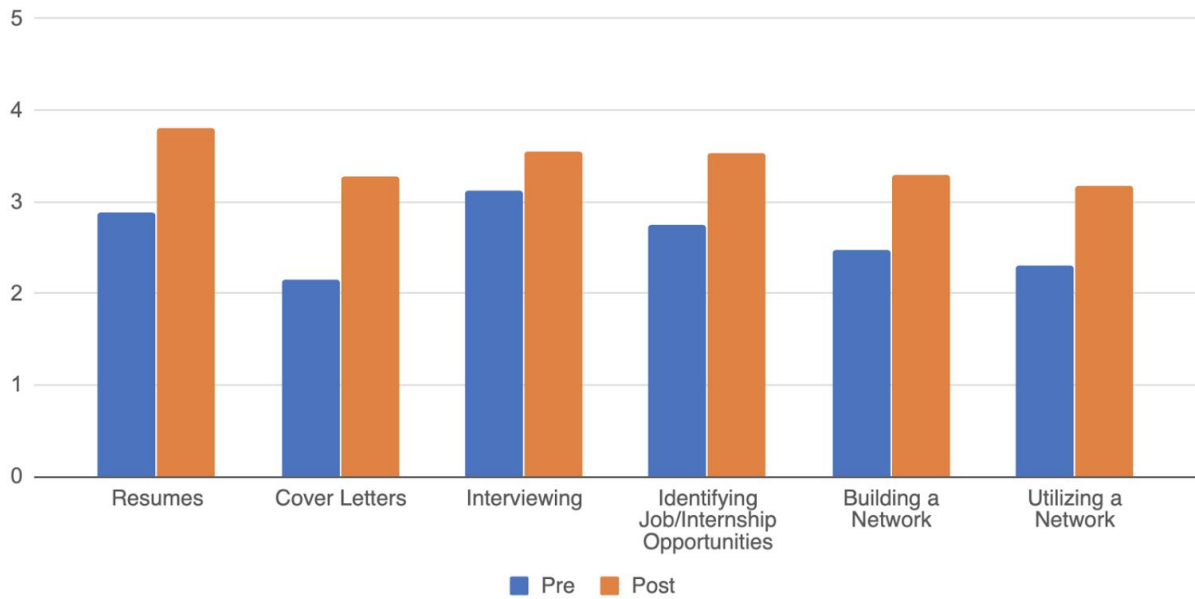


Figure 3: Pre vs. Post-MCEN2000 Confidence Levels

A post-event survey was also administered following the networking lunch component of ME Alumni Connect Day. That survey focused on students' confidence related to the networking process and the likelihood that they would reach out to alumni or other practicing engineers in the future for career advice. The results to both of those questions were very positive, with 94.7% of students reporting that the networking lunch had a positive impact on their confidence and 94.7% reporting that it had increased the likelihood that they would reach out to alumni or other practicing engineers in the future. However, the response rate for the survey was very low. Out of an estimated 100+ students who participated in the lunch, only 19 completed the survey.

*Goal 3: Students will successfully articulate their career goals and initial steps for working towards those goals.*

A total of 257 students enrolled in MCEN2000 met with a career advisor for a goal setting meeting during Fall 2018. At the end of each meeting, the career advisor answered the question, "Has the student clearly articulated their career goals and the next steps towards meeting those

goals”? Career advisors were asked to rate the students on that question on a range from 1 (low) to 5 (high), with responses being used purely for program assessment purposes (i.e.: not for grading). The median response was 4 and the mean response was 4.28, with a standard deviation of 0.78. That indicates that the majority of students were able to clearly articulate their career goals and initial steps for working towards them.

*Goal 4: Students will form an initial understanding of what it means to be an engineer in practice.*

Students enrolled in MCEN2000 were asked to complete a feedback form at the conclusion of the Careers in ME Symposium, in order to receive credit for participating in the event. The last question on the feedback form was, “To what extent has this event contributed to your understanding of what it means to be an engineer in practice?” The median response to that question was 4 out of 5. The mean response was 4.27 with a standard deviation of 0.75. That indicates that the Careers in ME Symposium was highly successful with regards to the goal of helping students learn about what it means to be an engineer in practice. That said, there was not a baseline measurement for that metric and the Careers in ME Symposium is also only one component of a much larger effort. That means that data related to this goal is encouraging in terms of gains, but not conclusive in terms of students’ overall understanding.

Similar questions were asked as part of the assessment for the classroom panels conducted during ME Alumni Connect Day. Those questions were framed in terms of the panels’ overall impact on students’ understanding of what it means to be an engineer in practice and their understanding of how the course material related to engineering practice, with a response scale ranging from -2 (strong negative impact) to +2 (strong positive impact). Out of 263 total respondents, 95.8% indicated that the panels had a positive impact on their understanding of what it means to be an engineer in practice. The responses were similar for the question about the impact of the panels on students’ understanding of how the material in the course relates to engineering practice, with 92.4% of students reporting a positive impact.

## **Lessons Learned & Next Steps**

It was apparent early in the development process that there would be challenges associated with implementing *Design Your Career* as a co-curricular requirement. The goal is to productively assist students in their career development, but even the most productive activities can feel like busy work when students are short on time and are not able to fully engage with them. It is difficult to prioritize the important when confronted with the urgent, which can lead students to choose activities based on last-minute availability rather than long-term value. Efforts are ongoing to more fully integrate the *Design Your Career* activities into the student culture, with current projects including physical displays and the development of online resources to support students in strategically planning their own progression through the program.

Additional next steps for the SEE Initiative during Spring 2019 include the addition of industry tours and Explore ME Dinners, as well as beginning to develop industry-based problems for use in core courses. There are also plans to continue refining the ethics and workplace transition

components of the initiative, with ideas for future offerings including an expanded ethics case study unit in MCEN2000 and a workshop for graduating seniors focused on benefit plans and salary negotiation. Assessment is ongoing and will continue to be refined, with plans to present an update at a future conference.

## **Acknowledgement**

Special thanks to the 100+ alumni and industry volunteers who participated in year one of the SEE Initiative. Their dedication and interest in creating a better experience for the next generation of students is central to this effort and it would in no way be possible without their help and support. Thank you also to the University of Colorado Boulder Department of Mechanical Engineering, the Mechanical Engineering Strategic Advisory Board, the University of Colorado Boulder Chapter of the American Society for Mechanical Engineers, and Phillips 66 for their support of this initiative.

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