

Equipping Undergraduate Engineering Students for Professional Success: An Exploration of Multiple Approaches to Career Development

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Abstract

Fostering an understanding of the breadth of available professional pathways is a crucial component of preparing engineering students for post-graduation. This can be accomplished through a variety of programmatic offerings, including specific opportunities that promote collaboration between academia and industry, which is critical for supporting the majority of engineering undergraduates' career development. Through a content analysis of in-depth interviews with thirteen professional staff members including academic advisors, directors of undergraduate programs, and career service staff across eleven departments in a college of engineering at a large midwestern university, this paper discusses multiple approaches that are currently utilized to facilitate students' career development.

In addition to traditional senior design projects and company recruitment during university-sponsored career fairs, this paper highlights several nontraditional approaches that expand collaboration between the university and industry, including company visits, industry-sponsored events, specialized workshops, alumni visits and workshops, and events developed and facilitated by student organizations. These approaches create multiple, diverse opportunities for students to engage with potential employers and explore a variety of career paths.

This project identified innovative collaboration strategies for universities with large enrollments in undergraduate engineering programs and industry partners to enhance students' career readiness. It also provides a case study of prevalent and effective programmatic efforts and rationale for support of such programs and events. By combining traditional and innovative career development approaches, universities and industries can collaborate more effectively to support undergraduate engineering students' career development.

1. Introduction

There are a multitude of career pathways for individuals who study engineering and science disciplines, including for those with advanced degrees. While some students find career opportunities within academia, most others ultimately pursue positions in industry, government, law, entrepreneurship, and medicine, among others. There exists an opportunity to study how engineering undergraduate and graduate students understand and seek out the various career opportunities available to them to utilize the knowledge and skills obtained while earning their degrees.

Much is known about the impact of intentional career development programming on overall student professional readiness [1, 2, 3]. Career services offices are standard at higher education institutions, and many engineering colleges have their own, specific entities devoted to helping prepare their students for post-graduation opportunities. Services that these units often provide include, but are not limited to, networking and recruitment events, access to online career platforms, career fairs, professional skill development workshops, guest speakers, resume guidance, and career advising. Career readiness is also facilitated through curricular experiences that provide course credit for learning about various aspects of professional development [4, 5],

[6, 7]. Finally, capstone project and senior design courses exist to help students gain practical experience in applying their technical skills, and many of these courses connect students directly with industry partners [8, 9].

There are approximately 13,500 full-time undergraduate and graduate students currently enrolled in The Grainger College of Engineering at the University of Illinois Urbana-Champaign, a large midwestern university. These students are exposed to many curricular and co-curricular opportunities to broaden their understanding of professional career paths, enhance their career readiness, and engage directly with industry professionals. Formally understanding how students are exposed to these opportunities is relevant and important to informing academic advising and curriculum development so that students can be further encouraged to reflect on their professional goals and the ways in which they can make an impact throughout their career. This study can also result in recommendations that will strengthen the college of engineering's ability to expand students' entrepreneurial mindsets [10].

This project examines the activities each department is engaged in and provides in order to highlight various career opportunities available to their students. In addition, this project explores how offerings differ across departments. Ultimately, the findings from this first case study detailed in this paper will be used alongside student perception data to develop a career pathways assessment report and a framework for aligning career advising with the entrepreneurial mindset framework. This framework is summarized through the KEEN 3Cs (curiosity, connections, and creating value) and the entrepreneurial mindset is defined by KEEN as the ability to:

- Recognize and identify opportunities
- Enhance multi- and inter-disciplinary collaboration
- Focus on their impact
- Create value in any context

2. Method

Project Site and Participants

This project was conducted within The Grainger College of Engineering at the University of Illinois Urbana-Champaign. This institution is a large, public, research-oriented university in the United States that has multiple offices to support student career readiness, including multiple departmental career service offerings and a centralized career services unit housed within the entire college of engineering.

It is worth noting that this exploratory project, which aims to identify multiple approaches utilized to facilitate engineering students' career development, is one part of a multifaceted research project that is comprised of three distinct stages. Semi-structured interviews using targeted sampling were conducted in the first stage of this research with the objective of learning and examining what career development programming each department in the engineering college provides and what opportunities are available to undergraduate students. Thirteen faculty and professional staff members across eleven departments and student service offices were recruited for interviews. This paper discusses the findings of this first stage.

In the second stage, surveys will be sent to engineering students to understand their perceived career development support from their departments and the engineering college. The third and final stage will triangulate and analyze findings from interview and survey data with the entrepreneurial mindset framework. Figure 1 summarizes this multifaceted research process.

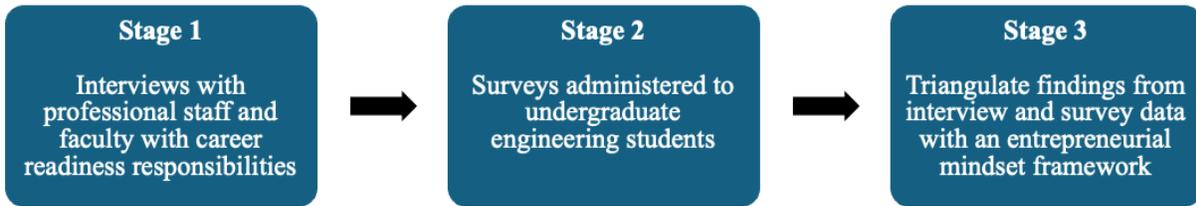


Figure 1: Multifaceted research process.

All participants work closely with undergraduate engineering students and are involved in students’ career and professional development. Specifically, their roles include academic advisors, career service professionals, academic program directors, and faculty. Table 1 provides an overview of participants. To maintain anonymity, pseudonyms were used for all participants, departments have been given a letter pseudonym, and titles have been generalized to the participants’ overall area of expertise.

Pseudonym	Department/Unit	Area of Expertise
Amy	A	Advising
Mia	B	Academic administration
Billy	C	Academic administration
Mary	D	Corporate engagement
Tom	E	Faculty
James	E	Faculty
John	F	Corporate engagement
Wendy	G	Advising and academic administration
Bella	H	Advising and academic administration
Chester	I	Advising and teaching
Patrick	I	Advising and faculty
Molly	J	Advising and corporate engagement
Jeffery	K	Corporate engagement

Table 1: Participant profiles.

To account for discrepancies between department/unit resource allocation and availability, it should be noted that A – E have total enrollments of over 1,000 undergraduate and graduate students whereas F – J have less than 1,000 total students. K is a unit that serves the entire engineering college.

Data Collection

An in-depth and semi-structured interview structure was selected as the primary instrument to collect data [11]. To capture available resources and various approaches utilized for students' career development, most of the interview questions focused on departmental-level programming and participants' perceptions of the programming's impact on student career development. To ensure the quality of the interview instrument, all interview questions were reviewed by two principal investigators and two doctoral students. A comprehensive list of interview questions can be found in the Appendix.

All thirteen interviews were conducted via Zoom between July and September 2024 and each interview lasted 30-60 minutes, depending on the depth of participant responses. With participant consent, interviews were audio-recorded for data analysis purposes. Each interview was subsequently summarized and recorded in writing by the interviewers. This program evaluation and quality improvement project was given a non-human subject research (NHSR) determination letter from the Institutional Review Board (IRB23-0253).

Data Analysis

Since this study aims to capture and understand various approaches engineering departments utilize for their undergraduate students' career development, content analysis was applied to analyze interview data [12]. According to Hsieh and Shannon [13], qualitative content analysis is a subjective interpretation through systematic coding and theme identification processes. All interview data were analyzed through two coding rounds.

To learn how the engineering college supports students' career development, two major pre-determined themes were utilized: 1) academic support directly provided by faculty and staff through curricular efforts, workshops, meetings; and 2) support provided collaboratively by companies and the university. During the first coding round, one researcher coded all interview transcripts and marked all data related to the two pre-determined themes. In the second coding round, all other data were inductively coded. After the second round, four emerging themes were initially identified. After careful examination of their characteristics and interrelation, four initial themes were merged into three primary themes that each demonstrate distinct approaches that are utilized to support students' career development.

3. Findings

The following three themes emerged from data analysis. First, departments within this engineering college utilize traditional, or well-established and routine approaches to support undergraduates' career development, including providing various academic resources and support to help students finalize their career interests and practice professional and academic skills. Second, the college and departments explore and test innovative approaches to collaborate with corporations to enhance students' career readiness. Third, empowering student organizations and professional societies to support students' career development can be beneficial.

Traditional Academic Support

The engineering college offers various traditional academic support structures for students' career development. In general, first-year students receive support from academic advisors and,

to varying extents, faculty. The engineering career center professional staff is another resource for students' career development. Moreover, students receive curriculum support, like specialized classes, updated curriculums, and practical senior design projects to explore diverse career paths and shape their career decisions. Lastly, research and financial support add another layer to support students' diverse career choices, especially those who decide to continue in advanced degree programs.

Advisor Support

Since students' major choices have an extraordinary impact on their future careers, support related to the choice of major is considered career development support. Most participants discussed their departments' academic advising structures and shared how they assist students of varying academic standing levels with their major and career choices. In general, first-year engineering students have access to at least two people to discuss majors that interest them, which leads to their future careers. One is the academic advisor, who provides general registration information and shares departmental resources. Another is the faculty advisor, who has more field knowledge and access to research and graduate schools. Considering the adaptation process for first-year students, most departments assign advisors to students. Some departments, such as B and G, require students to meet with an assigned faculty advisor every semester. Students have the option to change advisors during the process of exploring their fields of interest. For instance, Bella from department H and Mia from department B indicated their students could request a change of advisors and choose advisors more familiar with their fields of interest.

Besides departmental academic advisors and faculty advisors, engineering students have the engineering career center's professional staff as an additional resource for career development. The engineering career center closely collaborates with departments to provide workshops to improve students' professional skills and host events to share internship and full-time job opportunities. Students can sign up for engineering career center's workshops to learn how to build a resume, search for internships and jobs, or prepare for interviews. Department E participants emphasized that they always encourage students to attend the engineering career center's workshops to prepare for their careers. Meanwhile, the engineering career fair, as the biggest college-level career fair, has been widely advertised across engineering departments. James mentioned, "We encourage all of our students to go to every career fair that they can. The more exposure, the more comfortable they get; just talking to recruiter is always good."

Meanwhile, most participants emphasized that they highly recommend that students attend the engineering career fair as early as possible. For instance, Bella shared:

In [the engineering college's introductory course required for all first-year students], all of our students are required to at least talk about going to the career fair in the fall. Our engineering learning assistant [i.e., the section instructor] will often collect the students that are available and go with them, saying you at least need to witness this. You do not have to talk to any recruiter if you do not wish to. But you need to experience it so you have some idea of the question that they asked.

The majority of participants agree that attending the engineering career fair is a valuable opportunity for students to secure internships and full-time positions. However, some participants also express the need to educate recruiters and improve to meet diverse student populations. Some recruiters are only looking for specific majors rather than students' skill sets, which causes qualified students to lose the chance to apply for jobs. Wendy shared that her department changed its degree name from a short title to a longer, more descriptive title in 2008 to represent three concentrations. The department decided to change the degree name to highlight three concentrations because students experienced difficulties finding jobs with just the short title, despite their concentrations being directly related to specific job opportunities. Wendy stated:

They [recruiters] put on the registration form with the major of interest that they are targeting. And sometime that can be a little bit frustrating for our students because they do not see their major listed.

What's more, the diverse needs of the student population require different support and accommodations for career development. Bella, Mia, and Mary pointed out that many positions are not open to international students due to visa restrictions. Mary shared, "companies [in a particular field of study] do not hire foreign national students." Similarly, Mia said, "I think the number one complaint I have gotten is about international students. I think they have a harder time finding jobs or knowing where to apply." As a result, Mia's department hired an international student advisor to help them go through job searching and hiring processes. Additionally, some participants mentioned that engineering career fairs should provide more accommodations for diverse needs. Bella gave an example of a student overwhelmed with sounds or sights at the career fair. To provide more specific and customized support for students' careers, some departments like J, E, and I host smaller, department-run career fairs.

Curricular Support

Most departments offer curricular opportunities for first-year students to familiarize themselves with various platforms such as Handshake and LinkedIn, learn how to build a resume, and network and use different resources to explore career paths. For instance, departments E, C, H, I, and J, as well as unit K, offer introductory career development and leadership courses for first-year students.

For seniors, most departments have senior design or capstone courses that provide practical opportunities for students to implement their technical and non-technical skills under the guidance of the company's engineers or faculty on real-world projects. Additionally, in department I students can receive credit for internship experience with written reflections and oral presentations. Students in department B can take professional development seminars to increase their career readiness and talk directly with alumni. Tom from department E teaches the senior class and shared:

Part of my senior class is called professional practice, which focuses on career development and thinking about next steps. We discuss graduate school and frequently talk with students about job choices and pathways, given their many options."

In addition to standard professional development courses and senior design projects, most engineering departments adjust and update their curricula regularly to create diverse opportunities for students to explore a variety of career paths. John from department F shared:

Our research that we do here really guides our curriculum a lot. We are constantly updating our curriculum based on the research that we do. So oftentimes our students are the first ones who are learning these different concepts about materials. You know, before a paper is formally published.

The updated curriculum assists students in learning the trends and the latest achievements in the field and making decisions about their career paths. Patrick from department I shared that his department always invites engineers from various companies to give talks related to the course content.

Research and Financial Support

It is worth noting that not all students decide to enter full-time positions directly after graduation, so support related to research and providing proper funding is necessary, especially for those who plan to attend graduate schools as their career path. During the interview, five participants emphasized that their departments offered financial and research support to diversify students' career paths and explore their career interests.

Mary, John, Partick, and Mia pointed out that their departments have broad research opportunities for undergraduate students and advocate for students' participation in research. For instance, Patrick claimed, "I am a big advocate [for undergraduate research]. For undergrad research, I usually have eight to ten students per semester do some kind of project with me." John from department F shared that his department is very focused on research. Therefore, faculty typically encourage students to do research and send students who have done research in their labs to other research-oriented universities to pursue their doctoral degrees. Similarly, Mary's department has broad research opportunities for students. Moreover, students can receive credits by doing independent study. For department B, Mia said their statistics show that about 40% of students in her department have done undergrad research. They organize a research fair to publicize students' research. Meanwhile, Mia's department noticed that most students voluntarily do research, so they offered two research scholarships, which allow students to get compensated for their research and encourage them to continue exploring their career interests.

Regarding financial support, three participants shared that their departments provide funding for students to attend professional conferences, where students can build connections, share academic work, and display professional skills. Patrick and John expressed that their department funds many students to attend professional conferences, where they can directly meet and talk with recruiters. Although Bella's department has less budget, they still offer a small amount of funding for students to attend conferences.

Innovative Collaboration Between the Engineering College and Corporations

Many departments try innovative ways to collaborate with corporations to create multiple, diverse opportunities for students to engage with potential employers and explore a variety of

career paths. These innovative collaborations include company visits, field trips, industry- or university-sponsored events, specialized workshops, and alumni-supported events.

Company Visits and Field Trips

Company visits and field trips are invaluable for students' career development as they offer real-world exposure. During the company visits, students can observe how engineers apply academic knowledge to practice and learn their insights into various career paths and required skills for professions. Meanwhile, company visits allow students to experience different company cultures and build professional networks. Thus, some departments collaborate with companies to arrange site visits. For instance, Molly from department J shared that one introductory course requires site visits and aims to enhance students' understanding of the profession. Department H also arranges local company visits, especially with those who have alumni work. Field trips, which aim to complement the class content and provide an educational experience, have been provided by departments F and I. Chester pointed out that his department has arranged many local visits and has taken students to local farms for lab activities. John also shared:

We do a lot of field trips, so there are manufacturing facilities locally, and you know, we will go as far as St. Louis or up to Chicago or as far as Indianapolis, go to different places. We have been to steel mills and Boeing, and different companies and national labs.

Company visits and field trips provide practical opportunities for students to practice theoretical knowledge, gain insights into different career paths, experience various company cultures, and learn the required skills for different professions. These experiences are essential for students to choose career paths and make future career decisions.

Industry Engagement

Many departments actively collaborate with corporations to host various events, such as network events, specialized workshops, and alumni-supported events, to offer students access to industry professions and shape their career decisions. Students can gain industry-specific information during collaborative events, build professional connections, and develop demanding skills. These prepare students for the job market and decide their desired career paths. First, workshops and networking events are the most common. Many departments work with corporations to schedule tech talks or workshops to give students a deeper understanding of the field or get familiar with the job market. Department F has a formal program that connects outside companies with the department to offer presentations or recruit students. Similarly, department I schedules regular talks with company representatives that occur approximately ten times per semester. Department D invites companies for the two-day event. On the first day, companies provide information sessions or tech talks with food and snacks, which is more attractive for students to attend. On the second day, the department works closely with companies to customize the schedule. For instance, some companies might collect resumes and do interviews; others might host networking events.

Regarding networking events, most participants discussed how their departments collaborate with companies to arrange different scales of networking events. It is worth noting that alumni

play an essential role in networking events. Departments A, B, and C each have after-hour events, which provide opportunities for students to meet and talk with companies' representatives and recruiters. Others, such as D, E, and J, host annual bigger-scale networking events. Molly shared that the biggest event in her department is an annual networking event that serves as a career exploration opportunity for students. Department E has an annual alumni association meeting in Chicago, Illinois, where students can network with alumni to learn about their work experience. Additionally, Tom stated:

We have alumni speakers who come in to give students an idea of what to expect in the first few years after graduation, such as advice for those going into consulting engineering. We also have professional alumni speak to first-year students about career development when their job horizon is still four years away. They cover topics like landing a first internship and what employers look for from students with minimal experience.

Department D also has an active alumni advisory board, which not only provides a blueprint for students to follow but also offers information sessions related to career development. Mary discussed that, in addition to an alumni weekend where students can talk and network with alumni, the alumni board also brings panel groups from industry to share their career development paths, work experience, and other topics in which students have interest.

Empowerment of Student Organizations and Professional Societies

Student organizations and department professional societies are important in students' career development. First, these organizations offer leadership opportunities for students. Students can practice their professional skills and improve their communication and organizational skills by participating in organizations' events and taking leadership roles. Mary indicated that the student organization within her department "is a diversity and inclusion group that is being led by our students. They are looking at opportunities and bringing in speakers..."

Second, student organizations and professional societies serve as a connection to bring industry professionals into the department through networking events, workshops, recruitment sessions, job fairs, and conferences. For instance, Chester, James, Billy, and Mia mentioned that their student organizations invited companies' representatives to join regular meetings or schedule brown bag lunches to give talks on topics like resume review, interview preparation, and offer negotiation. This exposure provides students insight into industry trends, challenges, and opportunities and prepares them for their future careers. Meanwhile, Billy and Bella from departments C (larger enrollment) and H (smaller enrollment) shared that student organizations within their department collaborated with companies to host job fairs. Billy articulated:

One student organization, [the name of a large computer science organization], has a conference they call [name]. And part of the conference is a big job fair, and they get a lot of companies to send representatives to come and recruit. Sometime[s] I see some of the representative[s] that come from companies to recruit are our former students.

Bella indicated that her department's student organization has also hosted conferences with companies joining and recruiting students.

Third, student organizations and professional societies are popular with student populations and can advertise events, workshops, recruitment information, and opening positions through their channels. Generally, companies send inquiries directly to departments to post internship and full-time positions. However, empowering student organizations can act as a multifaceted bridge, connecting students with companies, students with their departments, and companies with departments. For example, Molly from department J shared that her advising office is connected to seven student organizations. They regularly communicate with student leaders to share information about upcoming events and ask them to share departmental information in their newsletters. Similarly, John's department empowered their student organizations with more than half the student population to advertise potential work opportunities or professional workshops.

4. Discussion

This study shows several ways the engineering college supports students' career development. First, traditional academic support, such as academic advisor support of major choices, faculty support of research, and career service staff support of professional development, are beneficial for students' career development. Various resources and information help engineering students decide their majors and future career paths. Therefore, the engineering college should continue pairing freshmen with advisors to ensure students get guidance on their major choices. Second, the engineering college should focus on curriculum updates and adjustments, which create diverse opportunities for students to explore a variety of career paths.

Although introductory professional development courses and senior design projects offer chances for students to practice professional and technical skills, regularly updated curricula assist students in learning the latest achievements in the field, which is especially beneficial for those interested in research and graduate schools. Meanwhile, it is worth noting that offering financial and research support is important for students' career development. Most engineering departments have put much effort into supporting students in finding internships and developing professional skills. These are helpful for those who aim to work directly after graduation. However, students interested in applying to graduate schools need more financial and research support in their career development. Thus, the engineering college should consider students' diverse career paths and provide proper support.

Third, innovative collaboration between the engineering college and corporations improves students' career development. Besides career fairs and general recruitment events, company visits, field trips, specialized workshops, and alumni-supported events are highlighted as efficient ways to create diverse opportunities for students to explore potential career paths. Among these collaborations, alumni have made a significant contribution to networking events. As a result, engineering departments should increase alumni influence and build stable connections with alumni. Lastly, empowering student organizations and professional societies creates diverse opportunities for students to engage with employers and departments. Since student organizations and professional societies significantly influence the student population, departments and companies often advertise their events, workshops, and recruitment information through their channels. Therefore, empowering student organizations is another way to support students' career development.

5. Conclusion

This study discovered three primary themes from data regarding areas of emphasis in career readiness preparation from a large college of engineering. Empowering student organizations emerged as a common way students receive support. Institutions have differing ways of providing administrative and financial support to student organizations, and it is worth discussing whether this formal support of these organizations might be modified and enhanced in order to bolster the success of this source of programming. It is important to recognize that the career development support also included research and continued education support (e.g., how to apply and prepare for graduate education), which was anticipated at this research-oriented institution. Finally, it is worth noting that many of the opportunities discussed with interviewees could be categorized as traditional, frequently utilized methods of career development. These approaches have long been established as effective ways for students to enhance their career and professional development. While these methods continue to provide significant value, it is also important to explore emerging career development strategies to address the evolving needs of the workforce while encouraging students' curiosity and connections.

The primary expected outcome of this project was to categorize and understand the efforts across the engineering college used to introduce students to different career paths and opportunities. A broad range of viewpoints and programmatic offerings were identified through formally interviewing and learning from multiple stakeholders across the engineering college. In the next stage, feedback will be collected from students in order to understand and assess this alternate perspective on career readiness offerings. These student-oriented findings will be aggregated and analyzed with the interview data discussed in this paper to understand which career readiness offerings correlate to different aspects of the entrepreneurial mindset and facilitate growth of the KEEN 3Cs. These insights could then be aligned with the entrepreneurial mindset framework to help students better assess transferrable skills and potential professional pathways to create impact that aligns with their interests, skillsets, and values. Finally, these findings and framework will be discussed with key stakeholder groups (such as academic advisors) to assess the effectiveness of current programming, collectively brainstorm innovative ideas for future programming, and discuss potential blocks and challenges, all in an effort to develop a career pathways assessment report for this specific college.

Further work will also formally investigate if and how students are exposed to opportunities in innovation and entrepreneurship. These findings will aid in the engineering college's ability to help students in understanding their role as future inventors and innovators within their fields, whether that be through entrepreneurship, intrapreneurship, or other professional paths.

Other institutions, especially those that have large enrollments or many distinct units, might benefit from conducting a similar program evaluation with semi-structured interviews or focus groups. Ultimately, it is hoped that a key outcome of projects such as this is to strengthen a department or college's ability to expand students' entrepreneurial mindsets by providing students with career readiness programming that encourages them to be curious about their discipline, make connections between their academic interests, and understand how to truly create professional value.

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Appendix

Semi-structured Interview Questions

1. What is your name?
2. What is your role?
3. How long have you been in this role?
4. In which department do you work?
5. What academic programs (e.g., majors, minors, etc.) are offered in your department?
6. What is the department's advising team structure?
7. How many members does your department's advising team have?
8. Do you have an independent (i.e., department-run) career fair?
9. Do you offer any career development related workshops, events, presentations, networking opportunities, etc.?
10. How do your students secure internship and/or full-time positions?
11. Do you think the location of the job fair is conducive to promoting conversation/engagement?
12. What is the breakdown of the students that attend your career events?
13. What types of networking opportunities do you offer for students (social events, informational sessions, trips/company visits, etc.)? (OR Do you offer a social event such as a networking opportunity (different from the info session)?)
14. Do you set specific expectations of follow-up, positions available, and how connections are made for the recruiting institution?
15. How much do you encourage students to engage in job fairs early to expose them to potential paths instead of focusing on job placement?
16. Is there anything you're currently doing that might not be as impactful for your students?
17. What is the one thing that think needs to be done or done better to merit a larger student impact?