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Industry Mentorship Program Brings Increases in BME Internships, Co-Ops, and Career Placement for Undergraduate Students

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Introduction:

The notion that biomedical engineering (BME) students struggle to transition from undergrad directly to industry positions still persists [1]. This problem has been looked at from a variety of angles. There are critiques that BME programs and curriculum are too broad which may disadvantage undergraduates looking for industry positions relative to other engineering majors which have more defined backgrounds, traditional skillsets, or a specific focus [2], [3], [4]. Additionally, the fact that BME programs have varying curriculum, and each graduate comes out with different skills depending on the university may be contributing to confusion for potential industry employers [3], [5]. With varying backgrounds, employers do not always understand what skills a BME graduate is bringing in with them. Additionally, BME grads do not always have a direct path from undergrad to industry. Many BME programs have graduates that go to medical school and graduate school at relatively higher rates compared to those that go into industry[2], [6]. That is, compared to other engineering degrees, there are fewer BMEs going into industry [7].

Industry opportunities for BME are very broad, and getting to know the opportunities can be a challenge. Job responsibilities can also vary. Students come in to BME with a poorly defined or overly constrained view of the possible roles of biomedical engineers [8]. Some BME educators are making intentional efforts to include these varied job titles and responsibilities into the curriculum to help solve this challenge [9].

The need to connect undergraduate students with industry partners through internships and co-ops has been suggested to help address some of the various challenges of placing BME students in industry positions [1], [10]. Co-ops and internships can be a great way to help build connections between companies and undergraduate programs, allow students to test drive jobs for a potential career, help students build skills related to industry, and help students find their passions and skillsets that will translate to career satisfaction. The difficulty with this approach is that co-ops and internships are time-intensive for students. For companies, internships and co-ops can be high financial and labor commitments. For this reason, we aimed to implement an additional alternative resource to industry internships for students that can still support career-related efforts without the full commitment of a co-op or internship through an industry mentorship program.

Studies have shown that students who have at least one mentor during their educational careers have a stronger purpose in life [11]. In a university engineering setting however, this could prove challenging for undergraduates whose end goal is to work in industry as many faculty have only known academia, and lack industry experience. Kirschenman writes “Engineering is alone among professional careers that try to educate future professionals with people that are not

proficient in the practical side of the profession" [12]. Therefore, it is imperative that undergraduate students are connected with professionals who have the real-world, hands-on experience in the workforce that they hope to pursue in the future. Particularly in an engineering field, mentoring is a high impact practice that can assist students in reaching the next stages of their career development [11].

The goal of the BME Industry Mentorship Program was to form a year-long mentor/student relationship where the mentor would provide guidance for students searching for co-ops and internships and industry jobs after graduation.

Materials and Methods:

Program Development:

The BME Industry Mentorship Program started in 2021 at The Ohio State University, a large R1 University in the Midwest for undergraduate biomedical engineering (BME). This was in response to consistent feedback on senior exit surveys that undergraduates who were industry bound seemed to struggle finding co-ops and internships, and full-time employment upon graduation. Compared with their graduate school or medical school focused peers who have a more linear path to additional schooling and their post baccalaureate goals, the industry focused students were unfamiliar with resources available and what types of opportunities existed for them in the work force. Therefore, the goal of the BME Industry Mentorship Program is to pair undergraduates interested in working in industry after graduation with a mentor currently in the workforce. Our mentors, who are often alumni of our program, serve as a voice of experience for our current undergraduates who need guidance navigating what it's like to search for positions, interview, and gain exposure to the variety of BME jobs that are available.

The program was modeled after a similar program created in the Civil, Environmental, and Geodetic Engineering department at The Ohio State University [13]. Due to the BME Industry Mentorship Program being created in 2021, in the middle of the COVID-19 pandemic, it is run almost entirely online with contact between the students and mentors occurring on Zoom and through additional email and text communication. This allows the flexibility of recruiting mentors from across the country and world, which provides exposure to a breadth of experiences for our students that they may not have had access to if we limited involvement to our geographic region only. The vast majority of our mentors do not live in the state of Ohio so by conducting the program virtually, we can significantly increase the ease with which our mentors can interact with students. Students are paired one-to-one with a Mentor at the beginning of the academic year and initial introductions take place during a Zoom Kick-Off meeting facilitated by an academic advisor in the BME department. After that initial meeting, the student/mentor pairing will decide their own monthly schedule and communication preferences, with the expectation that the student interacts with their mentor 1-2 hours per month for the remainder of the school year. Sample topics are provided to facilitate conversation ranging from resume review, interview preparation, day-in-the-life conversations, and any other professional development topics the students want to learn from the mentors.

Students and mentors are told that there is no expectation that the mentor will recruit the student to a job at their company. The goal of the program is not a direct pipeline to an internship, but instead to learn the skills needed to facilitate the students' job search and also to learn about the breadth of opportunities available in the workforce under the BME umbrella so that students can see there may not be a linear path to certain BME jobs or career fields.

The BME Industry Mentorship Program was created and is managed by a staff member in the department. The responsibilities associated with running the program are in addition to the normal job functions of the staff member. There is not a budget for the program. Since the program is run primarily online, costs are minimal to none, aside from the time commitment and occasional food at events.

Industry Mentor Recruitment:

Mentors were primarily recruited from alumni of the undergraduate program using email and LinkedIn. Each year, the Biomedical Engineering department distributes a Senior Exit Survey to graduating students. One of the data points collected is the future path the students will pursue; either industry, graduate school, professional school, or other. Using these results starting from the first graduating class in 2011, the students who indicated they were going into industry were connected with on LinkedIn and if their current employment was applicable, they were sent informational emails to join the Industry Mentorship Program. Mentors were also recruited from the Biomedical Engineering External Advisory Council, a board comprised of distinguished engineering leaders from business, industry, medicine, and academia who advise the department on current demands and future trends. Following the first year of the program, the greatest recruitment strategies have been mentor satisfaction, leading to mentors returning to the program for multiple years and also referring their co-workers and friends to participate as mentors in the program. To date, 94% of mentors who have served in the program graduated with a degree from our institution.

Student Participant Selection:

At the start of the academic year in August, students enrolled in the Biomedical Engineering major are sent a recruitment email with a link to the application to apply to the Industry Mentorship Program. The expectation is set that students who are interested in working in industry after graduation are encouraged to apply and that the student is to take the lead in the mentor/student working relationship. The application includes questions about what the student's goals are in joining the program and what topics they wish to discuss with their mentor throughout the year if they are chosen to participate. Fortunately, due to the large pool of mentors, the program has been able to accept most of the students who have applied each year. In the rare event that there are more student applicants than there are available mentors, students not accepted into the program have been seniors with only one more term left until graduation and could not participate the entire academic year, or students who indicated on their application that their first priority was medical school, and not working in industry. Since the inception of

the program, 37% of student mentees have been juniors, 36% sophomores, and 27% were seniors when they participated in the program.

Student-Mentor pairing:

Each mentor and student in the program completes a questionnaire or application to participate. The mentors are asked their current location, job title, company of employment, what fields of BME they have worked in or have expertise in, and also to provide a brief biography of both professional and personal information. The students are asked their class rank, what areas of BME they have an interest in, their goals for the program, topics they wish to discuss, and also a brief biography of information to share with their mentors. After selection into the program, those questionnaires are then carefully reviewed to find common interests in order to pair students with appropriate mentors to work with over the course of the year. For example, a student pursuing a business minor may be paired with a mentor whose job is in the consulting or sales side of BME technologies, or a student who is deciding whether to go straight into industry or pursue a master's degree first, will be paired with a mentor who has an advanced degree to be able to talk though that decision process and the pros and cons of each avenue. The full pairing list is then provided to all participants so that students may connect with all of the mentors on LinkedIn, even if they are not working directly with that mentor as part of the official program. Participant selection and pairings are made by the departmental staff member who manages the program.

Students and mentors are paired for a full academic year (approximately September – April). If a student participates in the program a second or a third time, they will be paired with a new mentor each year in the program so that they may learn from a variety of experiences and hear a different perspective than they did the previous year. They may choose to continue to interact unofficially with their previous mentor and maintain that valuable communication and network, but they will officially be assigned a new mentor for each academic year they are accepted into the program.

Industry mentors come from a variety of companies and job positions such as Product Development Engineers, Management Consultants, Research Specialists, and Technology Strategy Managers, just to name a few. In addition, industry mentors came from a variety of fields summarized in Figure 1. Mentors also indicated multiple areas of expertise, so the number is larger than the total number of mentors in the program.

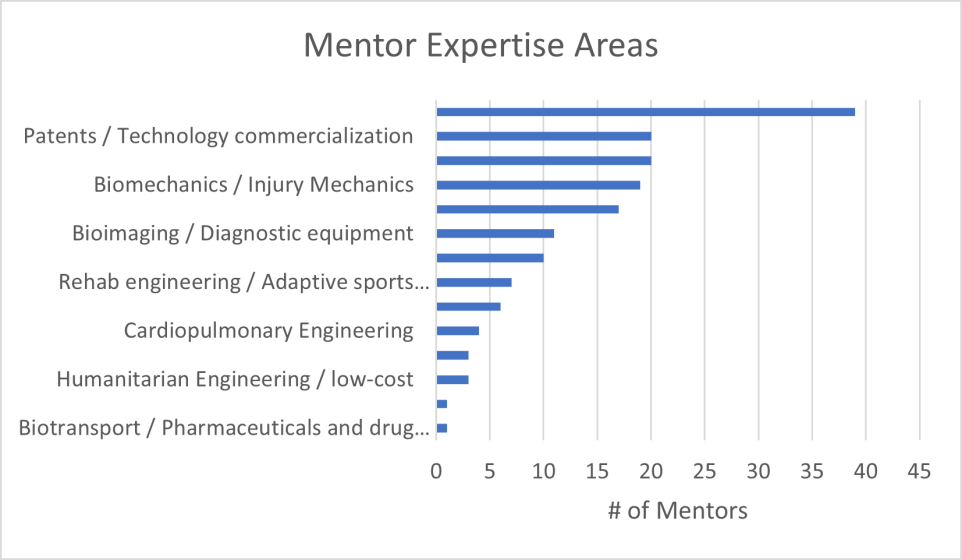

Figure 1: Industry Mentors, reported fields from application survey.

Data collection and IRB:

This study (#2024E1185) was determined exempt by the IRB at The Ohio State University.

Starting in the fall of 2021 and continuing through the fall of 2024, 90 undergraduate students participated in the program along with 47 unique industry mentors. There were 28 to 36 students in each year of the mentorship program from 2021 to 2024, with some students returning each year (Figure 2, left). There were similar numbers of mentors with 27 to 33 mentors in each year, with most mentors returning from year to year (Figure 2, left). Cohorts enter the degree program in their sophomore year; each cohort has about 110 students. So roughly 10% of each cohort of students participate in the industry mentorship program on a yearly basis (Figure 2, right).

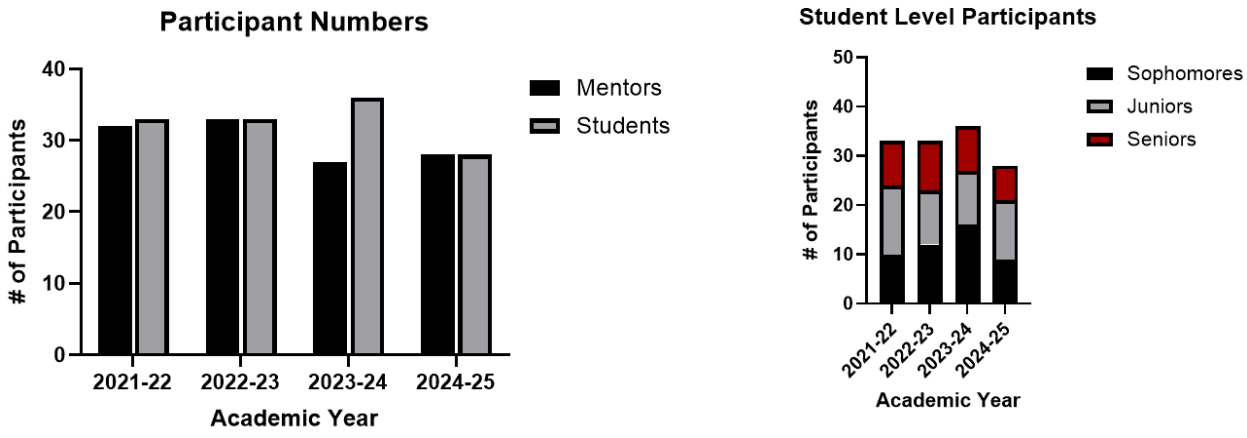

Figure 2: Participant numbers by academic year.

Data related to career placement from the engineering college career services from the years 2012 to 2019 were compared to data after the implementation of the industry mentorship program starting in 2021. Responses to a required senior exit survey from graduating students (about 2 weeks before graduation) were analyzed from years 2021 to 2024. Information about pre-graduation work experience such as internships and co-ops was obtained. Post-graduate plans such as job placement were also included in the survey results.

Specific feedback about the experiences in the mentorship program was collected through an online survey. At the conclusion of each academic year, a Qualtrics survey is sent to the current year's participating mentors and students asking about their satisfaction with the program, open ended questions about the most valuable part of the experience and soliciting constructive feedback to improve the program. It also asks what advice they would give future participants, and specifically for the mentors, if they would like to return to the program the following year and if they have any referrals for additional mentors they know through their network.

Data Analysis:

Qualitative analysis of an open-ended question "What was the most valuable part of this experience for you?" is analyzed by finding themes and frequency of those themes in order to identify some of the best aspects of this mentoring experience. There were 28 responses from students and coded themes were identified by the authors and the frequency of those themes were tabulated to identify prevalent experiences. AI was also use to validate the themes in an unbiased manner. Microsoft CoPilot was access in December 2024 with the prompt: 'Identify the main themes in these responses' (generated using https://copilot.microsoft.com/).

Results and Discussion:

Increases in participation of internships and co-ops**:**

Between 2012 and 2019, only 34% of BME students reported having any internship or co-op experience before graduation. Increases in the percentage of students in the overall undergraduate program participating in either an internship or co-op experience increased to 45%, 67%, and 72% reported by all graduating seniors in 2022, 2023, and 2024 respectively (Figure 3).

Figure 3: Placement rates in internships and co-ops before graduation for all students.

Placement in industry job positions at graduation:

Similarly, since the initiation of the program, more graduating seniors have reported having already obtained industry job positions. In the years of 2012 to 2022, roughly 32% of respondents reported an industry job. In the two most recent academic years this has increased to 44% and 41% of students reporting having obtained an industry job before graduation (Figure 4).

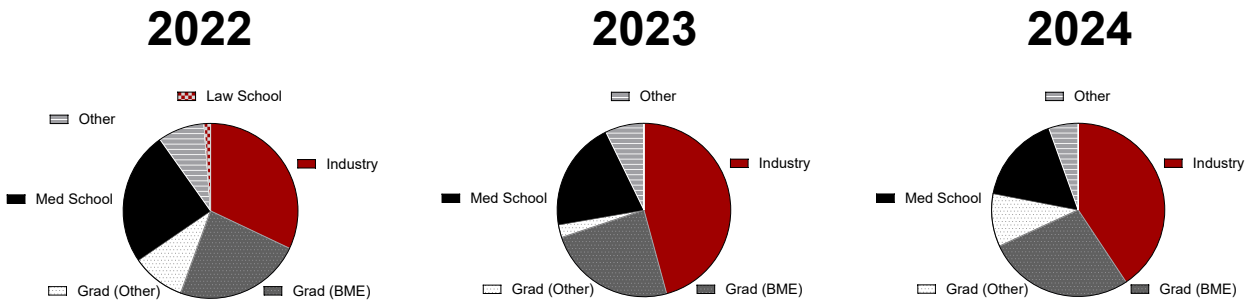

Figure 4: Near-graduation career placement rates for 2022 through 2024, after the implementation of the industry mentorship program.

Further research is needed to understand how students choose their career paths. Many BME programs are still questioning whether students intentionally opt for graduate school, medical school, or other alternatives instead of entering the industry directly, or if they pursue these alternatives because they cannot secure industry positions [2].

Qualitative Analysis from Surveys:

Students and mentors were both invited to provide feedback about the program. One open-ended question in particular was the most insightful. When students who participated in the program

were asked "What was the most valuable part of this experience for you?" many of the responses were themed around 4 main categories as identified by Microsoft Co-Pilot: 1) Career guidance and decision making, 2) industry insights and Networking, 3) Personal and Professional Development, and 4) Support and Encouragement. When coded by the authors similar patterns also consistently appeared in the responses. Codes that the authors identified were a) *Mentor's story*: insights from hearing about the mentor's career paths or experiences b) *Industry insights*: understanding different roles of industry opportunities or examples of day-to-day experience, c) *interviewing/resume/career attainment*: specific advice on finding jobs, interviewing or resume reviews, and d) *education/curriculum*: advice related to coursework, graduate school, or curricular choices. The most frequent code that showed up in student responses, appearing in 10 different responses, was related to interviewing/resume/career attainment. For example, one responses included:

> *"I think the most valuable part of this experience in the fall was the help that my mentor provided for preparing for interviews and editing my resume. The advice she gave helped me prepare for my interview for the co-op position I have this semester."*

Another frequent code was industry insights, which appeared in 10 of the 23 total unique responses. One example response said: "*She helped me understand what it is like in that role for the everyday life and I also got to shadow her once to see it in action."*

Hearing about the mentor's personal progression or story appeared in 8 responses. An example of this is:

> *"The most valuable part of this experience was hearing from someone who went straight from undergrad into industry, and who bounced around a bit before settling in their current company. That experience was very relevant for me and I really appreciated hearing about it!"*

Finally, the last major theme identified by the authors was advice on curriculum and educational goals. This appeared in 5 of the responses. For example, one student wrote: "*Getting input on classes at OSU from a recent grad as well as what options I have for after I graduate*".

When mentors were asked the same question, "What was the most valuable part of this experience for you?", two themes in particular stood out. The first theme was the vicarious reward of watching someone else succeed and grow. Another theme that stood out was linking back to their own experience as a student in the program. Several mentors mentioned being able to provide advice they wish they would have had, and wanting to give back to their alma mater. Taking into account that 94% of the mentors that participated in the program are alumni, this points to a very effective strategy in recruiting for the program through alumni connections.

<u>Challenges Faced:</u>

It should be made clear that the students are expected to lead the interactions with their mentors. The first year of our program, some students, especially the younger ones saw the mentors

similar to their faculty members. Since their only previous experience was in a classroom setting, they would show up to a meeting with the mentor and expect the mentor to teach them the knowledge they need like a professor with a lesson plan. To combat this, the application was updated to include questions about what the student wanted to get out of the year-long experience and what questions they planned to ask their mentor so that they are thinking of these topics ahead of time. The program announcement and the application also now contain a disclaimer that students are expected to lead and that this is not a passive program. We still face the challenge that students "don't know what they don't know" so they may not be aware of additional topics they may talk about with their mentor outside of resume review and interview practice. To help with this, conversation topic guides were created and halfway through the year meetings are scheduled with just the students and just the mentors to troubleshoot any issues that participants may be facing.

Another challenge is the up-front time commitment. The student applications are due, the pairings are made, and the Kick-off meeting all occur within the first few weeks of Autumn semester which is often the busiest time of the year. The program manager has a full advising load and teaches classes in addition to managing the Mentorship Program so it's important to plan for this busy time of year. However, once the pairings are established, they should be self-sufficient and require minimal time. Once created, the applications and feedback surveys can be copied and edited each year rather than having to start over.

Also, in terms of time and resources, Mentor recruitment will be an ongoing task. Mentor satisfaction will lead to mentor retention, but life events happen that may result in a mentor needing to step aside for a year or two or to resign from the program. You will want to be constantly networking and promoting the program to make sure you can replenish any lost mentors or generate new interest and experiences into the program for the students. Make sure faculty and staff are aware of the program so that if they meet somebody at an alumni event, a conference, or other event they can make appropriate referrals and help in mentor recruitment.

Conclusions & Future Work:

When creating an industry mentorship program, it is important to first start with what are the goals of the program. Each institution and engineering department will have unique student populations and cultures that will have different needs and goals to achieve through the program. This will then in turn dictate the size, scope, and purpose of a mentorship program that will best serve the undergraduate student population. It is also critical to identify the key partners to help the program succeed. Who can manage the program throughout the year? From what pool of professionals can you draw from to serve as mentors? And how can the program be financially supported?

One recommendation for starting a new program is to set small goals. The original aim of the BME Industry Mentorship Program was 5-10 dedicated mentors and paired students in its first year. Start with a number that seems manageable, both for the workload and continued success

of the program. If management of the program will be in addition to normal work responsibilities, be sure to plan around busy times of the year. For example, during summer months when students are not typically on campus, is an ideal time to focus on mentor recruitment. The creation of the program will be front-loaded in terms of time needed and then processes should become more automated after that.

Utilize your alumni network. As stated previously, 94% of the mentors in our program are alumni of our institution. Many of them state that their reason for serving as a mentor is that it is a great way to give back to their degree program and to network with other alumni. Through the outreach and the recruitment process of the mentor program a positive, unintended side effect is that we have more than doubled the membership in our department's LinkedIn group, and the program is the largest alumni outreach effort the department undertakes.

While the degree program as a whole has shown higher placements of undergraduate students directly in industry at the time of graduation, there is still a question of "what is the direct impact of the industry mentorship program?" In the future we hope to dive deeper into what role the mentors play in supporting students to acquire jobs. We would also like to better quantify the rate at which students participating in the program are landing jobs in industry and specifically in which fields.

Finally, the success of the program hinges upon the satisfaction of its participants. The best recruitment tool for new mentors is positive word of mouth from current mentors. It is important to set expectations early and hold participants accountable. Students need to know that they are the driving force of these mentor relationships and the more effort they put into the program, the more benefits they will reap from it [13].

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