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Connecting academia and industry: Piloting an industry mentor program in a first-year engineering design course

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To enhance design education and encourage retention in engineering, it is recommended to increase students' engagement with industry professionals. While industry engagement often grows throughout students' undergraduate years, typically culminating in industry-sponsored capstone projects and summer internships, there is an important opportunity to engage students earlier, such as in their first year, to motivate them and offer valuable perspectives. To fill this gap, we explored the integration of industry mentorship in a first-year project-based engineering design course. Across two course sections, four industry mentors participated in five in-class sessions throughout a 15-week semester, including two formal design reviews, culminating in their role as judges at the engineering college's design expo. Engaging 63 students, primarily from mechanical, biomedical, and aerospace engineering disciplines, this initiative sought to expose students to professional design practices to validate what they learn in the classroom as valuable and applicable to real-world engineering projects. Data collection included instructor observations and reflections throughout the semester, a focus group discussion with industry mentors, and two student surveys conducted during the middle and end of the program. Results show high student engagement and satisfaction with Industry Mentors (IMs). Students felt that IMs helped them improve their projects in the course, expanded their knowledge and application of the design process, and helped them become better engineers. IMs also expressed personal and professional benefits to mentoring first-year engineering students that can foster connections between academia and industry. We show that the piloted approach effectively engaged first-year engineering students with industry engineers via mentorship, successfully integrating industry perspectives into a first-year project-based engineering design course. Suggestions for improvements to the IM program are also provided.

Keywords: Design education, first-year engineering, undergraduate engineering, industry partnerships

1 Introduction

Retention and graduation of students are key goals of undergraduate engineering education. Design education and hands-on experiences play a critical role in supporting engineering retention because they encourage sense of community through team-based learning, expose students to real-world applications of engineering, and support creativity and sense of "fun" [1], [2]. More specifically, first-year engineering design courses can provide positive foundations that support building a student's engineering identity and sense of belonging in STEM. When students are provided hands-on learning opportunities that support their development of technical skills, their confidence builds [3]. Indeed, studies show that providing students with engineering problems to solve has positive impacts on their first-year experience and beyond [4].

In first-year engineering design courses, implementing measures to foster student motivation and a sense of belonging is crucial, as these factors are significant contributors to students transferring to other majors [5]. Research consistently shows that connecting coursework to real-world applications enhances student motivation and excitement about engineering [1], [2].

Engagement with industry (i.e., engineering activities that occur outside of a university), such as industry-sponsored projects, guest lectures, or mentorship programs, is a common strategy to highlight real-world applications. However, this engagement is typically concentrated in the later years of undergraduate education, for example during senior capstone design. This presents an opportunity to integrate and evaluate industry engagement in first-year design courses, where boosting motivation and improving retention are critical priorities.

At our university, which is a four-year public RI institution in the western region of the United States, we piloted an Industry Mentorship (IM) Program in two sections of our First-Year Engineering Project Course. This 3-credit course is a requirement for multiple engineering majors on campus, including mechanical engineering, biomedical engineering, and aerospace engineering. This course aims to provide students with an introduction to engineering through a series of hands-on projects completed in teams. Students learn a variety of skills, such as using micro-controllers, computer-aided design tools, 3-D printers, laser cutters, and woodworking tools, and apply these skills to their final term project. The IM Program sought to provide first-year engineering students with exposure to industry professionals via multiple in-class engagements and discussions throughout the semester. The objectives of the program included:

1) To introduce students to engineering practice in industry, including showcasing career examples; and
2) To provide students with additional feedback mechanisms from multiple professional perspectives.

2 Background

Engineering education has long recognized the value of industry engagement to prepare and motivate students for the realities of professional practice. The opportunity to connect classroom content to real-world applications can significantly enhance students' sense of purpose and accomplishment, motivating them to persist in their studies and pursue engineering careers [6]. Specifically, industry mentorship has been shown to provide unique benefits by exposing students to potential career paths, professional skills, workplace culture, and industry expectations [7]. For underrepresented groups in engineering, such as women and minorities, mentorship has been linked to increased confidence and interest in STEM fields [8]. Despite these benefits, the integration of industry mentorship in the early engineering courses remains underexplored.

Industry engagement is a core function of senior capstone design courses, where practitioners frequently serve as project sponsors, guest lectures, and mentors [9], [10]. Industry mentors in capstone can play roles as coaches, guiding students through iterative design processes, providing feedback, and pointing students to appropriate resources [11]. They serve as role models, demonstrating the attitudes, values, and behaviors expected of engineering professionals. These interactions can expand students' understanding of the engineering domain and offer valuable networking opportunities [12]. However, the later focus of these engagements leaves a critical gap during students' formative years, when motivation and retention are at risk.

Integrating industry mentorship into first-year engineering curricula offers a promising opportunity to address this gap. Early engagement can provide students with touchpoints that encourage informal discussions with role models outside of their instructors, potentially enabling students to see the broader relevance of their coursework and envision their future roles as engineers [13]. Educators have implemented extracurricular industry mentorship programs that have shown great benefits to students' belonging and interest in engineering [13], [14]; however, these programs may be missed by students with limited availability outside of required classes. Indeed, the specific role of industry mentorship in first-year project-based design courses has not been well studied, despite its potential to emulate benefits seen in senior capstone courses.

Beyond its advantages for students, mentorship can also be rewarding for industry professionals. Mentors often express satisfaction in "giving back" and contributing to the development of future engineers [7]. However, the broader benefits to mentors engaging with first-year students is largely unexplored. There are also many potential barriers to successful industry mentorship. Research suggests that most industry involvement in engineering education depends on individual relationships, which leave engagement at risk if individuals change roles or organizations [6]. Additionally, the process of matching mentors with students can be challenging considering the potential differences in expectations and goals [7]. Addressing these challenges is critical to sustaining meaningful industry-academia partnerships, particularly when involving first-year students.

3 Methods

We explored the ways that an in-class first-year industry mentorship pilot program impacted students and professional mentors in two sections of a large introductory engineering projects course. Our pilot included two instructors (the authors), 63 students, and four Industry Mentors (IMs). To guide our investigation, we focused on the following research questions:

1) What are the perceived impacts of a classroom-based industry mentorship program in a first-year undergraduate design course on students and mentors?
2) What ways can we improve the industry mentorship program to support student learning and motivations, while increasing department connections with local industry professionals?

3.1 Selection of Industry Mentors

To bring industry experience into the classroom, we sought IMs that 1) had professional experience working as an engineer in industry; 2) a bachelor's degree in engineering or related field; and 3) a strong interest in helping to teach the next generation of engineers in the practical application of engineering. Prior teaching experience was desirable but not required.

We recruited IMs first using purposeful and snowball sampling. First, we reached out to professional engineers with established ties to the university's mechanical engineering department, including members of the department's strategic advisory board and recent alumni who had expressed interest in becoming involved in the department. After receiving three positive responses, the resumes of interested engineers were reviewed, and phone interviews were conducted to explain the program and their required engagement, and answer any of their questions. These three engineers were then formally accepted as IMs for this study. An additional engineer became aware of the program via one of the three already selected and was later formally accepted as an IM for this study. Each IM was paid a $1000 honorarium for the participation in this pilot program and study.

The four IMs (Table 1) involved in our mentorship pilot were all alumni of our university with bachelor's in mechanical engineering, specifically. Three individuals were later career (30+ years since B.S. graduation) and one was a recent graduate (two years since B.S. graduation). All individuals were male.

Table 1: Summary of participating Industry Mentors.

	Class A		**Class B**	
	IM 1	**IM 2**	**IM 3**	**IM 4**
Current role	President/CEO	Mechanical Engineer	Senior Engineering Consultant	Senior Project Engineer
Career stage	Later-career	Early-career	Later-career	Later-career
Sector	Thermal management	Energy storage	Communications Technology	Aerospace
Degrees	MechEng BS; MBA	MechEng BS	MechEng BS; MBA	MechEng BS; Eng. Management MS

3.2 IM Pilot Program

We selected two sections ("classes" henceforth) of the same introductory engineering projects course to include IMs, both instructed by us (the authors). The classes were both organized into six teams of 5-6 students. Each class had similar demographics and were held at different times in the same classroom, which was set up with six large tables, one for each team. The classes met in the early afternoon three times per week for a total of 4.5 hours (one 50-minute session and two 110-minute sessions). Class A (32 students) met Mondays, Wednesdays, and Fridays, and Class B (31 students) met Mondays, Tuesdays, and Thursdays. We assigned two IMs to each class based on the mentor's availability and schedule preference.

Over the course of the 16-week semester, the class curriculum focused on hands-on design education. The first four weeks of the course were dedicated to in-class technical workshops (e.g., introduction to computer-aided design, microcontroller programming) and completion of an introductory design project for students to apply their new skills. During the first week, instructors assigned their classes into six teams, which they remained in for the entire duration of the semester. Starting in the fifth week of the course, students began a 10-week design process ("project" henceforth). The initial brief and scope of the project was up to the instructors, who then guided students through key stages of design and product development, including problem identification, requirements development, ideation, prototyping, component selection, manufacturing, and testing. Both instructors of Class A and B provided students with broad, flexible design prompts, encouraging the teams to work on projects that sparked their interest and excited them.

The IM program included various sessions between mentors and student teams that included meetings between a single student team and their mentor, and mentors attending design presentations of student teams (Table 2). The formats of these sessions varied but were generally in person and prioritized mentor-student interactions both in terms of duration and quality as much as possible. The IM program began with in-class engagements during the fifth week (the beginning of the 10-week design process). Throughout the remainder of the semester, IMs attended in-person 110-minute class sessions on five separate occasions and came to the semester-end Design Expo. In the first session, IMs presented to the class on their career path and engineering experience (roughly 10 minutes each), and then spent the remainder of class having informal discussions with each team. Other types of interactions with the students during in-class sessions included getting to know each other, discussing each student team's design, project goals, and timeline, and listening to and evaluating design presentations. Due to inclement weather that only impacted Class A, the two classes ended up following different schedules in the final weeks of the course.

Table 2: Schedule of meetings for Industry Mentors

Semester week	Type and duration of engagement	Description of Engagement
Week 2	Semester Kick-off (1 hour, online)	Initial IM Program kick-off call; discussed the course goals, pilot program schedule, and expectations of IM engagement
Week 5	Career Pathway Presentations and Student Team Meetings (2 hours, in-class)	Each IM presented for 10 minutes on their career, answers questions from the students (30 minutes); Each IM then met for 10-20 minutes with each of the student teams to get to know them and discuss their initial project ideas (80 mins)
Week 8	Preliminary Design Review Presentations (2 hours, in-class)	IMs watched student teams present their Preliminary Design Review presentations, asked questions, and provided feedback (written or orally) to each team
Week 9	Meeting individually with teams (2 hours, in-class)	IMs met with student teams for 20-30 minutes to discuss the team's design and progress to date, and provide feedback and advice
Week 11 (Class B) or Week 12 (Class A)	Critical Design Review Presentations (2 hours, in-class)	IMs watched student teams present their Critical Design Review presentations, asked questions, and provided feedback (written or orally) to each team
Week 12 (Class B) or Week 14 (Class A)	Meeting individually with teams (2 hours, in-class)	IMs met with student teams for 20-30 minutes to discuss the team's design and progress to date, and provide feedback and advice
Week 15	Design Expo (3 hours, in-person college-wide event)	IMs attended and judged projects presented at the University's college-wide first-year projects showcase. IMs viewed and met with the teams from their respective classes but were assigned teams from other classes to judge.
Week 16	Semester Close-out (1 hour, in-person)	The instructors facilitated a focus group with the IMs to elicit their feedback and ideas to develop this program, as well as their perceived impact of the program. One IM could not attend and provided responses to the questions via email.

3.3 Study Design and Data Collection

We collected the following data for this study:

1. Two anonymous surveys of student perceptions about their IMs: One mid-semester and one at the end of the semester;
2. Three evaluations of IMs' advice during the semester from each of six student teams in Class B;
3. Notes taken throughout the semester by the instructors of the two classes;
4. Written feedback from IMs at various times throughout the semester; and
5. Summary notes from a focus group discussion (FGD) with IMs at the end of the semester

The two surveys gathered students' perceptions of their IMs, focusing on several aspects: the usefulness and constructiveness of meetings with their IMs, the topics discussed during these meetings, and their overall perception of how their IMs influenced them and their team's product and design process. Qualitative comments were also provided by many students, which help contextualize the quantitative results of these surveys. These anonymous surveys were administered as Google Forms, were assigned to all students to complete in-class (Class A) or as homework assignments (Class B).

The evaluations of IM's advice during the semester from each of the six student teams in Class B achieved two objectives: 1) characterizing the communication of ideas from IM to student team; and 2) describing how students evaluated their IM's advice and how they ultimately intended to act (or not act) on their IM's advice. These evaluations were assigned as a homework assignment to all students in Class B and simply asked students to state the advice given to them by their IM and describe how they intend to respond to each piece of advice.

The instructors of the two classes met regularly to discuss their strategies for facilitating in-class sessions and to share insights on the program's impact. Throughout the process, we maintained notes documenting our experiences. These notes were subsequently reviewed to identify relevant themes aligned with our research questions, providing valuable context for interpreting other data collected.

We facilitated a 1.5-hour focus group discussion the IMs at the end of the semester. One IM was unable to attend and provided general feedback and responses to our prompts via email. Questions posed during the focus group focused on IMs' experience in the program, including their perceived contributions to the students' teams and challenges they faced; and what they thought about improving and potentially expanding the inclusion of IMs to more first-year engineering project classes in the future. We co-facilitated this discussion, enabling us to take detailed notes and ask relevant follow-up questions.

3.4 Data Analysis

Qualitative data in the instructors' notes, IMs' written feedback, and focus group summary notes were reviewed thoroughly by both authors. To address our first research question regarding the perceived impact of the pilot program on students and mentors, we sorted relevant data into thematic categories. Survey responses were analyzed by frequency and contextualized with related qualitative results from the instructors' notes, IMs' written feedback, and focus group summary notes. To address our second research question, we reflected on our findings and experiences piloting the IM program to identify areas of improvement and recommendations for the broader engineering education community.

3.5 Limitations

This study was based on a small-scale pilot program, which presents several limitations to the generalizability of our findings. First, we intentionally selected IMs who had pre-existing connections to our engineering department, prioritizing individuals we believed would be enthusiastic, committed participants. As a result, the mentor group lacked diversity in both gender and career stage; all four IMs were male, and three were in late stages of their careers (30+ years post-degree). Additionally, our data collection focused exclusively on the two classes that included IMs, without comparative data from similar sections of the course that did not implement the mentorship program. These limitations should be considered when interpreting the results, and future studies should explore broader and more diverse implementations of industry mentorship in the classroom.

4 Results

The perceptions of students, IMs, and instructors about the IM program are described below. Qualitative data provided the bulk of the results and are supported by quantitative data from the student surveys.

4.1 Students' Perceived Benefits of In-Class Mentors

Interactions between students and IMs provided valuable opportunities for students to engage in design-focused discussions, tailored to their project needs and the mentors' areas of expertise. Students reported that these interactions covered a range of topics relevant to engineering product development, including project management, design details, testing and analysis, ideation, prototyping, and needs-finding. The mid-semester survey revealed that most students reported engaging in discussions that aligned closely with the course's core objectives.

In Class A, most students indicated that "details of design" was the most discussed topic, while in Class B, "project management" was most discussed (Table 3). This difference is likely due to one of the IMs in Class B having a specific focus and affinity towards the importance of developing skills related to team planning and management in engineering design processes.

Table 3. Results from mid-semester survey: Which topic have you spoken with your IM about most often?

Class A (n=31)	**Class B** (n=28)
Details of design (19, 61%)	Project management (10, 36%)
Prototyping (5, 16%)	Details of design (8, 29%)
Testing (3, 10%)	Need-finding (3, 11%)
Need-finding (3, 10%)	Team dynamics (2, 7%)
Ideation (1, 3%)	Testing (2, 7%)
	Analysis (1, 3%), Prototyping (1, 3%), Ideation (1, 3%)

The end-of-semester survey revealed that students perceived a variety of benefits from their interactions with IMs. The responses highlighted the following key areas of impact for students.

1) **Technical advice:** IMs provided specialized technical advice that complemented the expertise of the course instructors. Students reported that feedback from the IMs helped them refine their design ideas, select appropriate components, and identify potential challenges before they arose. For example, IMs helped one team select an appropriate motor for a rotating device and another team identify which sensors and microcontrollers may achieve their design criteria. For instance, one student noted how an IM's critique of their selected component prevented potential difficulties and made their product development process more manageable. In both classes, "details of design" was a top discussion point during interactions.
2) **Design process and project management:** Students described how these conversations deepened their understanding of design processes and project management. One student noted, "The greatest benefit was definitely the experience they had with project management." Another emphasized the practical guidance on navigating the design process, "Industry Mentors know a lot about the design process and offer unique perspectives about how certain design choices will impact the user in ways that we couldn't have predicted/realized alone."
3) **"Outside" perspectives:** Many students commented on how having "fresh" and "outside" perspectives coming into class periodically benefitted their overall experience. Some students mentioned that the IM program motivated them to prepare improved prototypes in anticipation for their in-class engagements. Additionally, students described how IMs frequently brought up unexpected topics and details that they were not anticipating. One student wrote, "When we presented, they had questions that we really weren't expecting [...] those extra details paid off during the expo."
4) **Real-world connections:** Students' responses suggested that the mentorship program helped bridge the gap between learning and practical "real-world" application. Students valued feedback that highlighted how their projects and assignments aligned with industry expectations, helping them understand what aspects of the design process are relevant in professional settings. One student emphasized this impact by stating, "They have done many projects on larger scales, but they all involve the same design process that we used."
5) **Professional skills and career insights:** Some students commented on how the IMs helped increase the professionalism of the class by providing feedback on presentation and communication skills. Additionally, students described gaining valuable insights into engineering career pathways and options post-college. One student described, "Learning about their careers paths gave me a better understanding of what it's like having an engineering job."
6) **Motivation:** Some students reported that the presence of IMs inspired them to view their projects as more than just class assignments. One student commented, "It made our projects more than just a project for the class." Multiple students commented on the "care" IMs brought to the class, showing students that they valued their work and progress. This external validation and support from IMs motivated them to engage more deeply in course material and take a greater pride in their work.

4.2 Students' Perceived Challenges of In-Class Mentors

When prompted to answer an open-ended question about any challenges they faced during the IM program, 53 (85%) the 62 respondents indicated "none" or something similar (e.g., "N/A,", "no," "none at all"). Two of these students also noted that while the IMs occasionally challenged them to improve their designs, these experiences ultimately contributed positively to their final project. These students wrote, "No I did not [experience challenges]. It added a little extra pressure of presentation dates, but in a good way," and "No, while they did challenge us sometimes to improve upon our designs they were beneficial to our end results."

Seven students (11%) described a challenge they experienced with the IM program; two students left the question blank. One student described that the "only negative impact was reduced time to work on projects in class." Three students wrote that their IM gave them advice that directly contradicted with their instructor's advice, but did not elaborate on specific details. Two students described how IMs sometimes lacked the full background and context of their specific project, making it difficult to provide pointed advice. One student wrote, "I think that sometimes they didn't know what the project was […] which made it hard to gain feedback." In one case, a student described that they felt one IM disliked their project and was "constantly searching for ways to change it entirely."

4.3 Industry Mentor Perceptions

IMs found their roles highly valuable, both for the impact they had on students and the professional and personal benefits they experienced. The challenges experienced by IMs were generally small and were partly addressed during the semester by improving communication between students, IMs, and instructors.

4.3.1 Benefits Perceived by Industry Mentors

All four IMs saw extensive value in their mentorship roles and described feeling that they positively impacted the students they mentored. IMs identified several key areas where they felt their contributions were most impactful. These included helping students reduce the scope of their projects and clearly defining design requirements (e.g., "Teams were trying to boil the ocean initially, so I helped them narrow it down"). They also provided technical feedback on specific design choices and offered guidance on improving both slide-based and poster presentations. IMs highlighted the value of reinforcing key course content, such as the essential steps in the design process and the importance of frequent prototyping. They felt their contributions were particularly impactful in supporting the instructors' efforts while enhancing and reinforcing student learning. All IMs expressed interest in serving as IMs again in the upcoming semester or in a future semester pending scheduling conflicts with their work.

Attending design presentations and providing feedback afterwards were perceived as beneficial, but IMs certainly felt that the most beneficial time was one-on-one time with their student teams. IMs reported many detailed conversations with students about specific design choices that helped guide their relatively inexperienced student teams down the right path to a more successful product design.

Having multiple generations of IMs in Class A also seemed to provide certain benefits to both students and IMs. The IMs in Class A noted that their students benefited from asking the same questions to both IMs and getting different but complementary answers. Also, these IMs believed that seeing different stages of engineering careers were beneficial to students.

The industry perspective of IMs also gave them a different type of relationship with students compared to the instructors that proved beneficial to student learning. For example, IMs felt that they were less restricted than a professor or teaching assistant in advising students due to their specific role as mentor that had no say over student grades in the course. One IM mentioned that he easily talked with one of his teams about "not wearing shorts or hats to the next design review" but expected that a similar conversation with a professor and teaching assistant would not have been as easy. The IMs' role of mentoring students to "help them get a better grade" or help them make better engineering decisions gave them a valuable and different rapport with students than professors and teaching assistants.

IMs also reported personal benefits to mentoring student teams in this pilot. Students were curious about and invested in what IMs had to say, gratifying IMs and solidifying their value to the students. All IMs reported wanting to attend class and mentor students more frequently, and some IMs even took time to memorize their students' names. One IM enjoyed watching teams grow and learn how to work well as a team and that "they don't have to know everything" to be good engineers. All IMs, even the younger, also expressed nostalgia at reliving their engineering project courses.

IMs also reported experiencing professional benefits from their involvement. One IM noted the value of building relationships with students who will become engineers within the next 3–4 years. He perceived his involvement as allowing him to ensure that students were trained in skills relevant to his business needs while also fostering long-term relationships. Additionally, he recognized the potential to identify and connect promising students with internship opportunities at his company.

4.3.2 Challenges Experienced by Industry Mentors and Suggestions for Program Improvement

Challenges were also a part of the IM experience. They all expressed a desire for more time with students (e.g., more meeting times throughout the semester); some also offered asynchronous communication via email with their student teams to provide more feedback. IMs also expressed a learning curve of understanding what first-semester freshmen were capable of and how they learn best. IMs expressed that they had to "throttle back" what they talked with students about due to time constraints and students' abilities and knowledge of engineering. Most IMs also expressed difficulty in providing high-quality feedback quickly to students right after their preliminary and critical design presentations, primarily due to time constraints. Last, IMs expressed a desire to know in more detail what was taught to students prior to meeting with them so that they could reinforce what was taught in class.

IMs had different opinions about potential changes to the topics taught in the course. Most IMs thought that focusing on the course's current key topics of applying the design process, making design decisions, determining the details of design, and fostering good teamwork and communication skills should be the primary focuses of the course, while one IM thought that project management should be added.

To improve the IM program, IMs recommended:

- Having IMs with experience from different engineering industries (e.g., mechanical, electrical, chemical);
- Having "ask me anything" meeting times that students could drop into if desired;
- Having IMs talk about what they will learn in future classes that will support what they learned in their freshmen project course (e.g., engineering economics to justify design decisions);
- Having students write about what their product would cost to produce in their final reports if they took their product to manufacturing;
- Teaching Gantt charts and costed bills of materials; and
- Improving the onboarding process for IMs, which should include descriptions of what is taught in the course and how best to engage with students outside of the classroom.

Other types of student engagement that IMs would be interested in adding to the IM program included:

- Technical workshops to help student teams with specific analyses or details of a specific design choice;
- Workshops about engineering skills not currently offered at our university;
- Presentations of examples from industry with discussions of the design process;
- Having the university's senior student design team present their preliminary design presentations to freshmen students to show how their skills will improve throughout the university education; discussing professionalism in industry;
- Discussing integration in the design process; and
- Touring industry workplaces, labs, and manufacturing facilities with student teams.

4.4 Instructor Perceptions

The instructors perceived overwhelming benefits of facilitating the IM program. In Class A, the instructor observed a notable improvement in professionalism and communication skills during design reviews, which were attended by IMs. At the conclusion of design review class sessions, students often approached IMs to ask follow-up questions—they appeared genuinely interested in learning and hearing their opinions. The program also seemed to enhance students' pride and motivation in the course. Students felt privileged to have access to IMs, noting that other classes lacked this resource. This distinction made them feel their course offered greater value and a unique learning experience.

Students regularly commented on the positive impacts of the program, mostly in terms of learning about the design process, about making better design choices, and being exposed to broader applications of engineering. The only issue requiring instructor intervention occurred when an IM and an instructor provided differing suggestions in response to the same question from a student team. The instructor took the opportunity to discuss with the student team how to assess and make decisions when provided with conflicting information, and how to decide as a team what priorities should be important in their design process. Overall, the different perspectives provided by IMs typically complemented and helped provide a more complete and real-world engineering perspectives for students in the course.

Coordination with IMs was generally smooth and efficient, most often over email or the phone. Scheduling their availability was straightforward but required proactive communication, with emails sent well in advance of the program's start. This early planning ensured adequate course preparation and allowed IMs to attend all in-class sessions.

Overall, the IMs strongly supported the course content and provided significant pedagogical value to the instructors. They consistently reinforced the instructors' guidance, which was especially beneficial given that first-year students often resist core design principles, such as the importance of frequent prototyping and analytical decision-making. Their reinforcement helped solidify these key concepts and increased their acceptance among the students. While IMs and instructors agreed on most topics and how to teach them to students, one IM focused on project management skills, a topic that is only briefly discussed in the course to help students work well as a team, and took less time with their student teams to improve their design and design process in the course. While this was not overly problematic, one student team expressed difficulty in understanding this relatively new topic from the IM.

5 Recommendations for First-Year In-Class Mentorship Programs

Mentor Characteristics. The focus of each mentor was influenced by their current role and engineering experience. All our mentors held mechanical engineering degrees, likely influencing the design recommendations and advice they gave to students who represented multiple majors, including mechanical engineering, but also aerospace, biomedical, and integrated design. We noticed that having two mentors in each class benefitted the students, providing them multiple perspectives and enough time for one-on-one discussions. We recommend multiple mentors per design class, which may support a balance of age, expertise, and focus areas. Our pilot included four male mentors, and we did not collect information regarding their other identities. Indeed, factors such as gender, race, socio-economic background, nationality, and others can impact a mentor-mentee relationship. Future research could investigate the influence of mentor identities by expanding and diversifying the program. Increasing the diversity of mentors may better support goals for retention of gender and racial minorities in their programs.

Format of engagement. Most in-class sessions included informal, flexible conversations between mentors and student teams. The flexible nature of these engagements allowed both the students and mentors to guide the focus of conversations, which appeared successful in fostering authentic, useful conversations. However, to align discussions more closely with course goals, instructors could provide specific topics or questions to direct the conversations, while still allowing space for students and mentors to explore areas of interest.

Expectation-setting. Mentors described some difficulty in understanding what first-year engineering students were capable of, and had to reduce the complexity and quantity of the advice they wanted to give them. In the initial overview of the program, the instructors only briefly mentioned that "most of these students are coming straight from high school and have varying technical and teamwork skills." Future iterations of the program could incorporate additional expectation-setting at the beginning of the program, diving deeper into specific examples of prior projects and tasks that worked well for students, and what was too complex or sophisticated.

Effective course structure of external mentors. Incorporating in-class industry involvement in first-year, lab-based courses may be particularly effective due to the time and flexibility these courses allow. Our class met three times per week, with two of these sessions lasting 110 minutes. This extended time seems ideal for incorporating mentors, as it provides ample opportunities in a semester schedule to plan for interactions.

Organizing and planning a mentorship program. Identifying active alumni as mentors worked well, and establishing a more structured program for identifying and recruiting local industry professionals could further enhance the program. Literature suggests that mentorship programs should not rely solely on individual relationships but should aim to create more formalized processes to identify and remain engaged with a broader range of individuals [6]. Expanding these processes may also increase diversity of individuals and the industries they represent.

6 Conclusion

We planned and facilitated an in-class industry mentorship program with students enrolled in a first-year engineering design project course. Overall, the mentorship program had positive impacts, particularly in motivating students, supporting their development of engineering design skills, and increasing industry engagement within the department. The involvement of mentors enhanced the students' learning experience by providing real-world insights and reinforcing core design principles, leading to increased motivation and a stronger connection between students and the engineering field. Additionally, the program potentially bolstered the department's reputation among local firms, creating opportunities for future engagements and strengthening industry ties. Future work could expand the program, particularly with the goal to increase representation and diversity among mentors. Increased formalization of the program, such as through processes for identifying and retaining mentors, and expectation-setting during program orientation may increase the impact of industry mentorship among students and instructors. Ultimately, our experience may serve as a valuable model for enhancing student learning and fostering stronger industry-academic connections, with potential for further growth and refinement in future iterations.

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