Understanding the Gap Between Communication in the Classroom and Communication During an Industrial Internship

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Abstract

While it is known that development of expansive communication skills is critical to a successful career in engineering, teaching these skills continues to be a challenge in the classroom. Recently, ABET has updated the engineering communication outcome to include communication to a wide range of audiences. While this highlights the importance of diverse communication skills, most traditional engineering curriculum focus on technical report and presentation skills targeted at an expert audience. To develop a curriculum that meets the updated ABET requirement while providing students with the communication skills necessary to become successful practicing engineers, a better understanding of industrial communication requirements must be established. Through this work, a survey was developed for engineering students who have completed industrial internships, with a goal of understanding communication requirements in industry. Students were asked to identify both audience and means of communication used throughout their internship, as well as how effective their classroom learning, and internships were at preparing them for these forms of communication. Results showed that student interns interacted most with other engineers (of same and different discipline), as well as non-engineers with both technical and non-technical backgrounds. The most frequently used forms of communication were informal conversations, meeting discussions and both formal and informal email. Over 87% of respondents indicated that formal presentations or technical reports were used rarely (2-3 times per month) or less. Of these, 36% indicated that they never completed a formal presentation and 60% that they never wrote a technical report. Overall, students felt that that their internships were more effective at teaching communication to all audiences and through all forms of communication than their classroom learning. These results highlight the current gap that exists between classroom teaching and student experiences in industry, particularly with regard to communication with non-technical employees and through less formal means (informal discussions, phone calls, etc.). Moving forward, engineering curriculum must be developed to more clearly align with these industrial communication needs.

Introduction

Practicing engineers spend on average 64% of their time at work on communication, whether it be through formal communication assignments or informal communication amongst co-workers [1]. Communication skills are critical to a successful career in engineering but teaching these skills continues to be a challenge. In a traditional engineering curriculum, students focus on communication of results through formal lab reports and presentations that are directed at expert audiences (i.e., other students and faculty). These assignments successfully represent technical understanding but are not fully representative of skills required of a bachelor level engineer in industry. While several studies have looked at how communication is taught within the engineering curriculum, fewer have looked at communication requirements in industry, as reviewed by Donnell et al. [3]. Through this review, authors determined the key disconnects between what is taught and what is required in industry to be 1) goals of communication in the classroom vs. in industry and 2) audience of communication assignments. To better address the communication needs of graduating engineering students, the Accreditation Board for Engineering and Technology (ABET) has modified the outcomes for engineering programs to include communication to a wide range of audiences [2]. As a result, engineering programs will need to diversify communication assignments.

Some universities have aimed to reconcile the disconnect between the classroom and industry through collaboration with industry on communication-intensive courses [4,5]. While this can effectively bridge the gap, it requires significant commitment from an industrial partner to provide students with adequate feedback. Alternatively, engineering faculty have developed assignments that mirror communication that takes place in industry, but this has not been widely adopted. To understand where improvements can be made in the engineering curriculum, knowledge of both the audience and the method of communication required in industry is crucial. As a result, a survey was developed for engineering students who have completed industrial internships, with a goal of understanding communication requirements during short-term industrial positions. Students were asked to identify both audience and means of communication used throughout their internship. Additionally, they provided feedback regarding how the curriculum that they have completed thus far has helped to prepare them for these varying forms of communication. This survey is a first step in understanding the communication requirements of an industrial position and where students feel unprepared to communicate in industry.

Method of Data Collection

The survey participants were engineering students from the University of Kentucky who had completed industrial internships between Fall 2017 and Fall 2018. If more than one internship was completed, students were asked to answer questions based on their most recent position. Students who had completed an internship during this time were sent an email invitation to complete the survey. This email contained an IRB-approved cover letter explaining the purpose of the study and how data would be used for research purposes. Participation in the survey was voluntary. The Qualtrics survey was designed to take approximately ten minutes and no identifying information (including IP addresses) was collected or stored to ensure anonymity.

Students were asked to identify all audiences that they communicated with throughout their internship experience, with audience categories identified as: engineer (in discipline), engineer (out of discipline), non-engineer (with technical degree), non-engineer (without technical degree), manager (engineer), manager (non-engineer), external employee (contractor, supplier, etc.), client and general public. They were also asked to identify the types of communication that were used throughout their internship experience, with communication categories identified as: in person (informal), meeting (presentation), meeting (discussion), technical report, non-technical report, email (formal), email (informal), phone conversation, and virtual meeting. For each audience or communication form used, students were asked to identify the frequency with which these communication types occurred. Frequencies were described as very frequently (2-3 times per day), frequently (1-2 times per day), occasionally (2-3 times per week), rarely (2-3 times per month), and very rarely (once a month or less). A percent of positive respondents was calculated for each frequency by dividing the number of respondents at a frequency by the total respondents who positively identified using that form of communication. Students were asked to rate the effectiveness of both the classroom and their internship in preparing them for these varied forms of communication. Effectiveness was described as very effective, effective, somewhat effective or very ineffective.

Results and Discussion

The survey was distributed to a total of 378 undergraduate students and responses were received from 77 students spanning nine engineering majors, as summarized in Table 1.

Table 1. Summary of survey respondents by major and by timing of internship program.

Major	# of students	Semesters completed prior to internship	# of students
Biosystems Engineering	1	One	8
Chemical Engineering	18	Two	11
Civil Engineering	3	Three	6
Computer Engineering	6	Four	19
Computer Science	8	Five	12
Electrical Engineering	7	Six	14
Materials Engineering	5	Seven	5
Mechanical Engineering	27	Eight	0
Mining Engineering	2	Nine +	2

Forty five of the 77 respondents (nearly 60%) were from chemical and mechanical engineering, likely due to the size of the programs and prevalence of internship opportunities. Students completed their internships at varying times across the curriculum, with 45 completing their internship after the completion of their sophomore year (fourth semester) or during their junior year (fifth or sixth semester).

Students were asked to identify the types of people that they communicated with, as well as the frequency with which they communicated with these audiences (Figure 1).

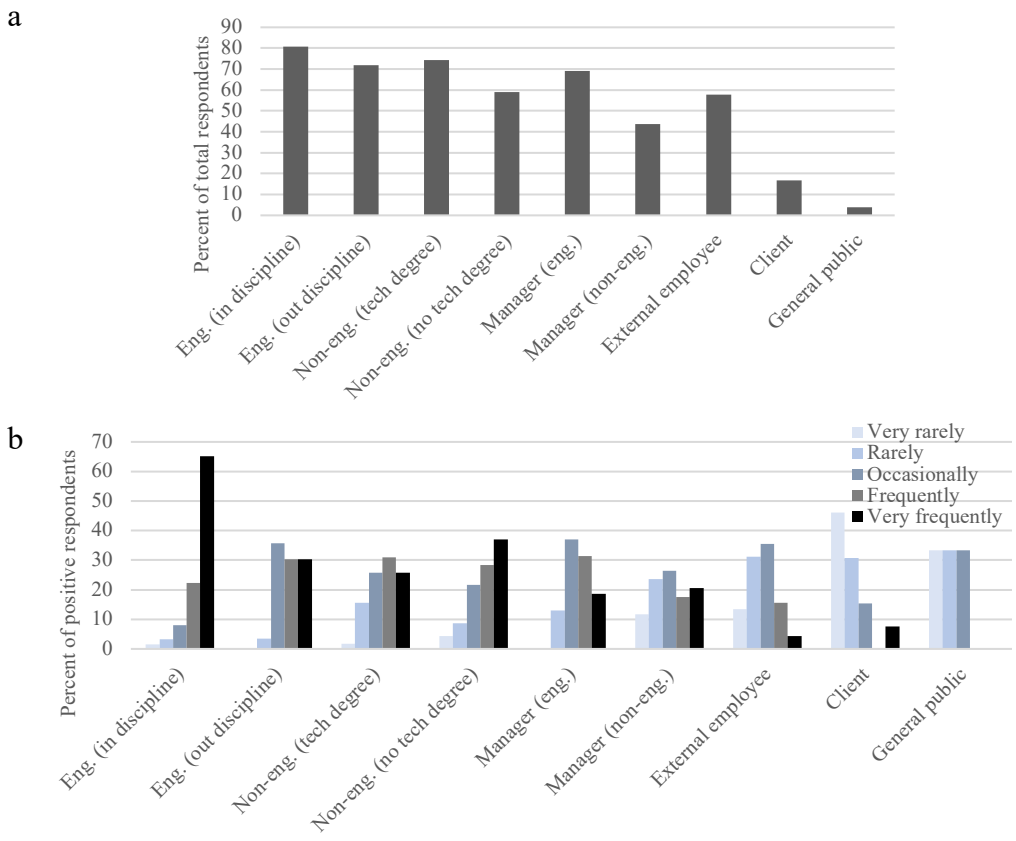


Figure 1. Communication with different audiences. a) Percent of total respondents indicating that they communicated with identified audiences and b) the frequency with which positive respondents (those who spoke with specific audiences) communicated with these audiences.

Students communicated most with engineers (in discipline (80%), out of discipline (72%)), non-engineers (with technical degree (74%), without technical degree (59%)), managers in engineering (69%) and external employees (contractors, suppliers, etc.) (57%). Of these, students had most frequent interactions with in-discipline engineers, with nearly 90% of students indicating very frequent (2-3 times per day) or frequent (1-2 times per day) interactions. Interestingly, 46 of the 77 students indicated interactions with non-engineers with no technical background, with 30 students interacting with them on a daily basis. Similarly, most students interacted with contractors and suppliers, but on a less frequent basis. When asked to comment on their biggest weakness in communication, seven students indicated communication with a non-technical employee, while seven students indicated communicating with contractors and suppliers. Only three students had interactions with the general public, and individual students indicated communication with human resources, government officials and a non-technical manager.

To gauge the effectiveness of the current engineering curriculum, students were asked to evaluate the effectiveness of both their coursework and their internship in helping them communicate with the identified audiences (Figure 2).

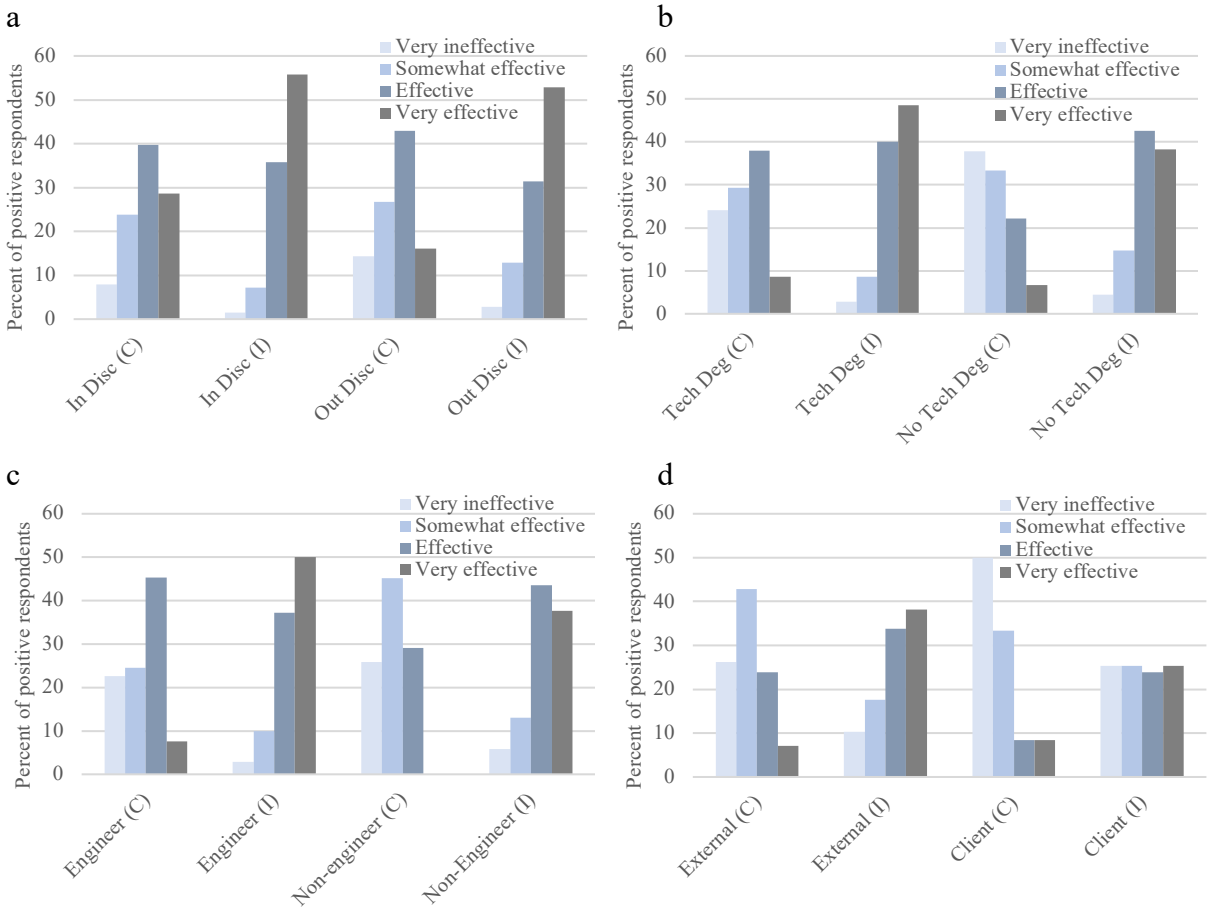


Figure 2. Learning for different audiences. Students were asked to rank the effectiveness of the classroom (C) and the internship (I) in helping them communication with a) engineers both in discipline (In Disc) and out of discipline (Out Disc), b) non-engineers with both technical (Tech Deg) no technical degree (No Tech Deg), c) managers from both engineering and non-engineering backgrounds and d) external employees and clients. The general public was not included due to small response numbers (3 students).

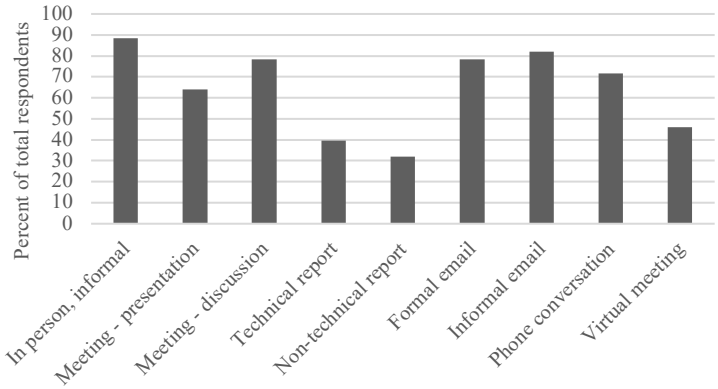
For every audience, students felt that their internships were more effective than classroom teaching in helping them to communicate. This can be seen by the shift in distributions from lower levels of effectiveness (left side of the distribution) towards more effective (right side of the distribution). As could be expected based on current curriculum design, students felt their classroom learning was most effective at teaching them to communicate with other engineers (both in and out of discipline) (Figure 2a), as well as those with technical degrees.

Perhaps the largest shifts in distribution occurred for the non-engineering audiences, both for those with no technical degrees (Figure 2b) and for those in management positions (Figure 2c). For both of these audiences, more than 70% of students indicated their classroom learning as either very ineffective or somewhat effective. Seeing as this population represents one of the most common and frequent audiences for intern communication (Figure 1), it is crucial that engineering programs learn to more effectively teach these communication skills. This could be accomplished through development of assignments with a non-technical target audience or having lower-level undergraduate students serve as an audience for oral presentations or poster sessions. Students also felt that their course curriculum did not help them in communication with external employees

(contractors, suppliers, etc.) or company clients (Figure 2d). To develop these skills, communication with vendors or contractors could be integrated into an engineering design course.

Students were asked to identify the types of communication that they used throughout their internship, as well as the frequency with which they used those forms of communication (Figure 3).

a



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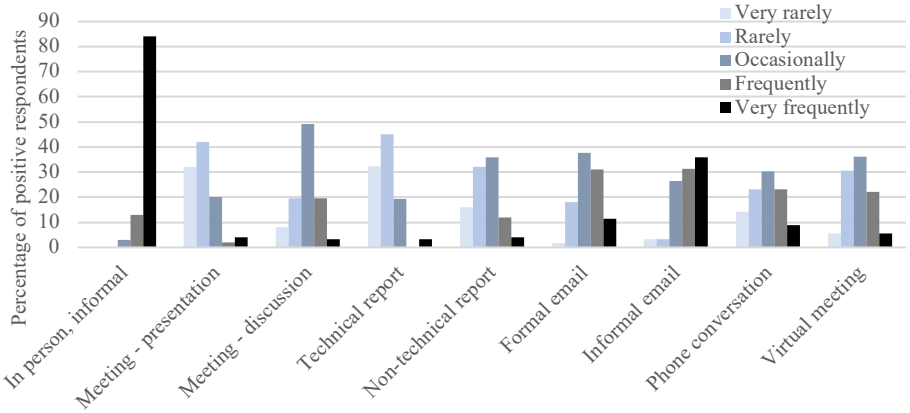

Figure 3. Types of communication. a) Percent of total respondents indicating that they communicated through identified forms of communication and b) the frequency with which positive respondents (those who spoke with specific audiences) communicated through these forms.

The most frequently used forms of communication were informal conversation, meeting discussions, email and phone conversations, with 70% of students indicating they used these forms of communication. Not surprisingly, informal conversation was used most frequently, with over 80% of students indicating that they used informal conversation more than two times per day. The least frequently used forms of communication were the technical report and formal meeting presentation, with over 87% of students indicating that they used these forms of communication rarely (2-3 times per month). Interestingly, 36% of students did not have to complete a formal presentation and 60% of students did not have to complete a technical report.

Students were asked to evaluate how well the classroom and their internship aided in their ability to communicate through different means (Figure 4).

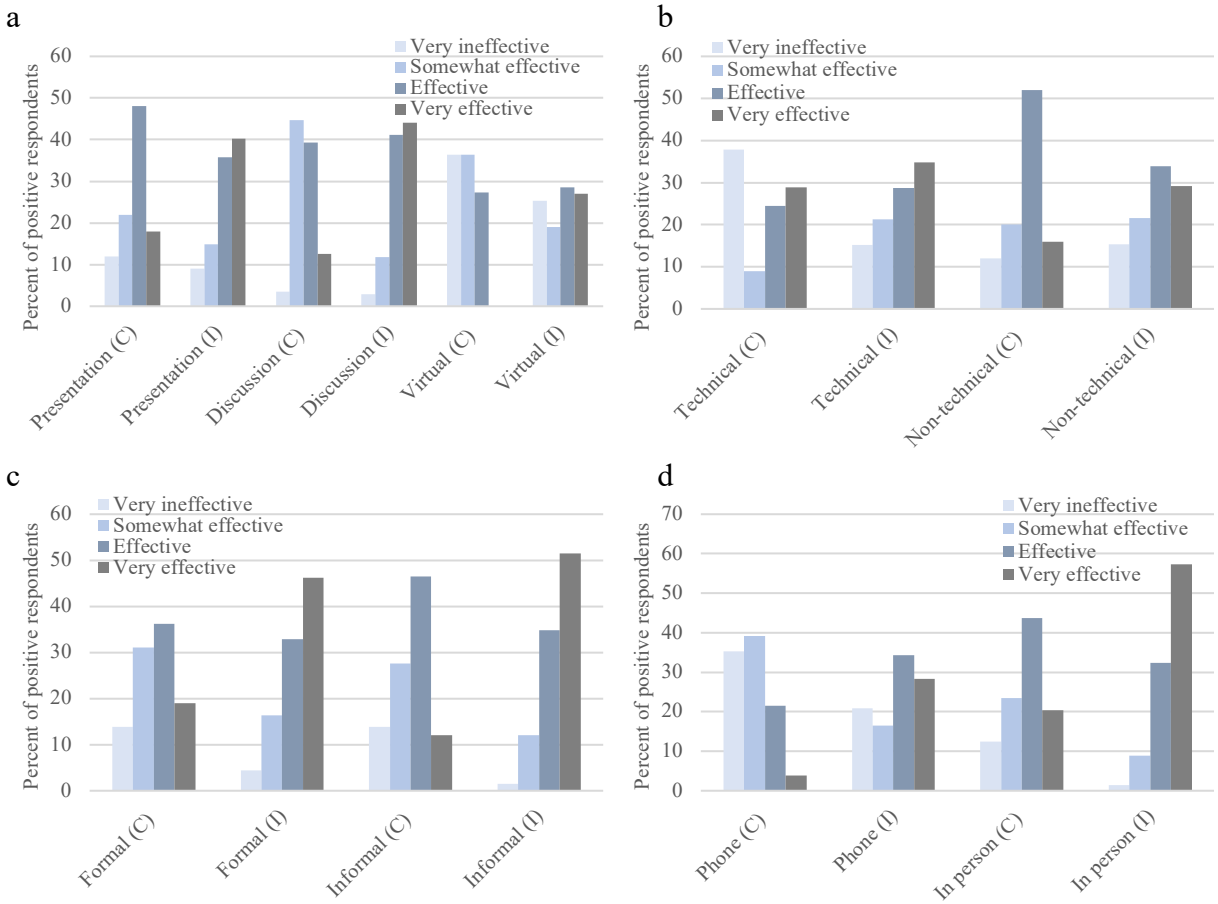

Figure 4. Learning for types of communication. Students were asked to rank the effectiveness of the classroom (C) and the internship (I) in helping them communication through a) meeting presentations, discussions and virtual meetings, b) technical and non-technical written reports, c) formal and informal email and d) phone and in person discussions.

Again, students felt that their internships were more effective than the classroom in teaching all forms of communication. Students felt the least prepared for communication both over the phone (Figure 3d) and through virtual meetings (Figure 3a), with five students identifying each as their biggest communication weakness throughout their internship. Coursework was more effective at preparing students for more formal communication, so faculty face the challenge of learning to develop assignments that target the more informal communication required of industry positions (discussions, emails, phone calls and in-person conversations). These forms of communication can be challenging to teach through assignments, but project teams could be required to integrate conference calls or virtual meetings into their meeting plans. This would expose students to the logistics and challenges associated with these types of communication.

While the internship programs did improve communication through these varied forms of communication, there was still a broad distribution in effectiveness of learning. Students felt that their internships were most effective in improving their presentation, meeting discussion, formal and informal email and in person discussion skills. When comparing between audience (Figure 2) and type of communication (Figure 4), students overall felt more prepared by their coursework for different types of communication than they did for different audiences.

From these results, it is clear that the current curriculum for teaching communication is not effective at preparing students for the broad range of communication skills required during an industrial internship. While most engineering programs focusing on formal, technical communication skills, survey results indicate a need to first address communication to different audiences and second begin to span a broader range of communication styles. While technical communication is important, interpersonal and small group communication skills tend to dominate the engineering practice [6]. In particular, communication to a non-technical audience can be extremely challenging but can be crucial for establishing a connection between work in the field vs. work in the office.

Conclusions and Recommendations

Overall, results highlight two key take-aways: 1) engineering internships provide a significant opportunity for first-hand learning of diverse communication skills and 2) the current curriculum is ineffective at preparing students for communication to broad audiences and through diverse means of communication. Many programs and publications have highlighted the benefits of industrial experience through internships or co-ops programs on student development [7,8]. While it is true that these experiences will allow students to practice communication skills, better preparation from their engineering curriculum will improve student performance during internships and provide a better overall experience. Several students indicated through comments that they entered the program feeling unprepared and that their coursework (including lower level communication courses) was not beneficial for the communication required on the job.

Moving forward, faculty face the challenge of developing a communication curriculum that allows students practice in diverse communication skills. This can be accomplished through varying the type and audience of communication assignments or requiring project teams to meet using diverse meeting styles. While not investigated, it is possible that students are being exposed to beneficial communication through extracurricular activities. Opportunities to collaborate with on-campus organizations might allow for development of workshops that may not be easily integrated into the classroom. For instance, small meetings with alumni or industrial collaborators could allow students to practice industrially relevant communication styles.

While this survey was focused on understanding the communication requirements of an internship program, a similar understanding should be gathered for recently hired bachelor's level students. Because student internship programs are typically short-term, exposure to technical reports and presentations can be limited. Additionally, this survey focused on the frequency of different types of communication. Having an understanding of the importance of these different types of communication can be equally important. For instance, while a technical report or presentation might not occur with significant frequency, successful communication through these means might offer more opportunities for career advancement. A final limitation of the current study is mis-interpretation of survey questions, including communication audiences or types of communication. In-person follow-up interviews could provide insight into common mis-interpretations, allowing for refinement of survey questions for future distribution. Additionally, interviews could provide deeper understanding of where students struggled with communication during their internship program. By developing a strong understanding of the communication requirements of industrial engineering positions, faculty will be able to develop curriculum to bridge the gap between communication in the classroom and communication in industry.

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