

Board 40: Understanding Industry's Expectations of Engineering Communication Skills

Dr. Lilian Maria de Souza Almeida, Utah State University

Dr. Lilian Almeida is a Ph.D. Research Assistant at Utah State University.

Prof. Kurt Henry Becker, Utah State University - Engineering Education

Kurt Becker is the current director for the Center for Engineering Education Research (CEER) which examines innovative and effective engineering education practices as well as classroom technologies that advance learning and teaching in engineering. He is also working on National Science Foundation (NSF) funded projects exploring engineering design thinking. His areas of research include engineering design thinking, adult learning cognition, engineering education professional development and technical training. He has extensive international experience working on technical training and engineering education projects funded by the Asian Development Bank, World Bank, and U.S. Department of Labor, USAID. Countries where he has worked include Armenia, Bangladesh, Bulgaria, China, Macedonia, Poland, Romania, and Thailand. In addition, he teaches undergraduate and graduate courses for the Department of Engineering Education at Utah State University.

Idalis Villanueva, Utah State University

Dr. Villanueva is an Assistant Professor in the Engineering Education Department and an Adjunct Professor in the Bioengineering Department in Utah State University. Her multiple roles as an engineer, engineering educator, engineering educational researcher, and professional development mentor for underrepresented populations has aided her in the design and integration of educational and physiological technologies to research 'best practices' for student professional development and training. In addition, she is developing methodologies around hidden curriculum, academic emotions and physiology, and engineering makerspaces.

Understanding Industry's Expectations of Engineering Communication Skills

In this research paper, engineering communication is explored through the lens of different industrial segments. The research highlights and confirms significant aspects of effective communication in the engineering workplace indicated in previous studies, as well as provides a synthesis of the communication skills expected from engineers working in industry.

Communication is recognized as an important skill for many professional disciplines, and it is considered a highly desirable competence in engineering. According to Werner, Dickert, Shanmugaraj, Monahan, and Wallach (2017), given that the central role of engineers involves working with public health and safety, the significance of communication becomes magnified in the engineering profession. In a systematic review including 52 studies (27 quantitative and 25 qualitative) addressing what competencies engineers need and which are the most important, Passow and Passow (2017) indicated that communication is among the 16 generic competencies that are essential to engineering practice, and that engineers spend more than half of their work day (55% - 60%) communicating. Nathans-Kelly and Evans (2017) added that not only is communication essential, but it can no longer be seen as a distinct element of the engineering practice as proposed by the misleading dichotomies hard skills versus soft skills, or technical skills versus professional skills.

The Accreditation Board for Engineering and Technology (ABET) introduced in 2000 and has kept communication skills as one of the desired outcomes of engineering education (ABET, 2018). However, the need to improve future engineers' performance as communicators continues to be a topic of concern. While engineering students have been exposed to different opportunities to become proficient communicators in academic settings, employers and executives still convey the need for novice engineers to have better communication skills, which suggests that the communication currently learned in academia is not necessarily the same used on the job (Norback, Leeds, & Kulkarni, 2010). From industry's perspective, communication skills of engineering graduates tend to be weak, even though engineering departments have worked specifically at improving communication competence of their students (Donnell, Aller, Alley, & Kedrowicz, 2011). This study seeks to provide a description of the communication skills practicing engineers need while working in industry. Understanding the current expectations of these skills in industry is of importance since a significant portion of an engineer's time is spent in communication interactions. The significance of this study is that by understanding industry's expectations of engineering communication skills, current communication instruction strategies may be revisited or new educational initiatives can be proposed.

Based on information collected from multiple sources (Bureau of Labor Statistics [BLS], 2018; Data USA, 2018; Universum, 2017), four industrial segments that make up a significant percentage of engineers in the U.S. were identified. These include the High-Tech, Automotive, Aerospace, and Manufacturing industries. Their perspectives were explored in this study to shed light in the communication requirements of practicing engineers within these industries.

Engineering Communication in the Workplace

While initiatives to understand the communication practices of engineers in the workplace do not represent a new topic of scientific research, the constant evolution of communication competence makes room for further exploration. Additionally, the scientific research that captures what industry says about the communication skills of engineering graduates is still limited, especially when compared with studies describing what engineering departments should do to teach communication (Donnel et al., 2011). Available studies have some limitations. Some are part of broader projects and not exclusively focused on communication skills of engineers (Nicometo, Anderson, Nathans-Kelly, Courter, & McGlamery, 2010). Others are focused only on writing skills (Conrad, 2017; Kmiec & Longo, 2017; Winsor, 1996) or only on oral communication (Dannels, 2002; Darling & Dannels, 2003). There are some investigations based on just one type of engineering discipline (American Society of Mechanical Engineers, 2011; Conrad, 2017). Other studies available are limited to the perspectives of executives (Norback, Leeds, & Forehand, 2009; Norback et al., 2010), with the main focus on the hiring process and the early years of engineers at the workplace (Norback & Hardin, 2005).

Nicometo et al. (2010) summarized what can be considered the ideal engineering communication skills in the industry setting in three main themes: 1) the ability to effectively speak, write, and interact with audiences outside of engineers' specific discipline, work group, or focus; 2) the willingness and self-motivation to initiate communication with others, and to seek out resource information through informal interactions; and 3) the ability to listen carefully to others in order to do the best work and achieve results that are valued by different stakeholders (clients, managers, coworkers). From the perspective of executives, the communication competencies expected from engineers include effective description of tasks and ideas expression, successful interaction with high-level management, preparation and delivery of effective presentations including high-quality written materials, selection of the most effective medium to communicate the message, effective dyadic face-to-face communication, and appropriate communication with individuals with different cultural backgrounds (Norback et al., 2010). Wisniewski (2018) indicated some characteristics of effective engineering communication from the perspective of managers. This includes: the ability to interact with varied audiences (upstream, midstream, downstream, external) by addressing audience needs and using audience preferred medium (memo, reports, e-mail, text, phone, face-to-face, visuals), the ability to apply communication strategies by using appropriate structure and message focus, using clarity, concision, and a professional tone, and the ability to apply interpersonal skills by delivering information confidently and working as a team.

While engineers are professionally exposed to different communication methods, a significant part of their communication activities may be clustered in two main groups (Knisely & Knisely, 2015): technical writing (e-mails, white papers, site visit reports, operating manuals, literature reviews, feasibility studies, business letters, memos, project proposals, design reports, engineering specifications) and oral communication (meetings, telephone conversations, one-to-one conversations, presentations to technical and non-technical audiences). According to Kmiec & Longo (2017), writing like an engineer or a technical professional includes the ability to

convey specialized information so that the audience is able to adopt and implement technologies for practical purposes. Concerning the oral communication skills of engineers, Dannels (2002) explained that speaking like an engineer is a process of translation, which can be the translation of technical material for non-technical audiences, translation of design results into visual information, translation of numbers into results-oriented structure, or translation of design results into sales discourse. The combination and the use of different modes of communication represent an essential dimension of the engineering profession. Modern engineers not only need to produce technically appropriate designs, but to communicate these designs in written, oral, and graphical form to multiple audiences ranging from their technical peers to the general public (Troy, Essig, Jesiek, Boyd, & Trellinger, 2014).

In order to understand the current industry's expectations of engineering communication skills, verifying how these expectations confirm the current body of knowledge, or if there are new insights that potentially could reshape communication instruction in engineering programs, the following research questions were established for this study:

1. How are the specific communication skills expected from practicing engineers in industry described?
2. What are the communication challenges of practicing engineers?
3. In what ways are engineering communication requirements different across varying industrial segments?

Research Methodology and Methods

Understanding industry's expectations of engineering communication skills is still a scientific research topic that needs more exploration, and according to Creswell (2014), when a phenomenon needs to be explored and understood more deeply, this topic merits a qualitative investigation. For this reason, and due to its purpose of addressing a specific human component of the engineering profession, a qualitative approach was implemented in this study. Additionally, case study was identified and implemented as an appropriate methodology for the development of this qualitative research. As defined by Yin (2017), through case studies a contemporary phenomenon (the case) is investigated in depth and within its real-world context.

The process of conducting a case study starts with the selection of the case(s). For this study, four cases from different industrial segments were selected. The rationale behind the selection of the four industries for this study was the identification of industrial segments with significant hiring rates of practicing engineers, and the most attractive employers from the perspective of students pursuing engineering in the United States. Reliable sources of data were utilized for the identification of these industrial segments: the Bureau of Labor Statistics (BLS, 2018), Data USA (2018), and Universum (2017). The four industrial segments selected for this study were: High-Tech, Automotive, Aerospace, and Manufacturing. These four industries are significant representatives of the main employers of the top engineering occupations: electrical and electronics engineers, civil engineers, mechanical engineers, and industrial engineers (BLS, 2018), and include the most attractive industries for future engineers according to Universum

(2017). Participant organizations selected for this study include one middle size company in the High-Tech segment with around 130 employees, and three global large size companies with more than 10,000 employees, representing the Automotive, Aerospace, and Manufacturing industrial segments. For each industrial segment, two engineers were invited to engage in face-to-face qualitative interviews. Interview is one of the most important sources of evidences in case studies and is commonly found in this research design (Yin, 2017). At the time when the interviews occurred, all participant engineers were working in senior leadership positions, ranging from managers to directors, and had between 15 and 34 years of professional experience. Purposeful and convenience sampling (Creswell, 2013) were utilized in the process of selecting these engineers, since participants were identified from the alumni pool of Utah State University.

In this study, interviews with practicing engineers were expected to reflect their current perspectives on engineering communication skills required in industry, the challenges they encounter in their role, and the communication requirements in the specific industrial segment they work. The interview protocol (Appendix A) was developed with the assistance of a qualitative research expert and an engineering communication expert. Some of the questions were adapted from previous studies on engineering communication (Darling & Dannels, 2003; Norback & Hardin, 2005; Norback et al., 2010).

The four industrial segments or cases were first investigated individually and subsequently analyzed across cases. In this research paper, a summary of the main communication aspects of the four industrial segments (High-Tech, Automotive, Aerospace, and Manufacturing) is presented in the form of differences and similarities across cases. This information is summarized in Table 1 and in Table 2 respectively.

Communication Differences among the Four Industrial Segments

In the **High-Tech** industry, communication is characterized for being very technical and engineers need to have a good understanding of technology in order to communicate effectively. This technical language become a challenge for engineers when it is necessary to translate technical content in more understandable messages especially when the audience is formed by non-technical people. Another specific aspect of this industrial segment is the open communication that is typical of the informal environment of companies in the High-Tech industry. Additionally, engineers are encouraged to communicate in an honest way.

In the **Automotive** industry, the fast-paced communication is one of the main characteristics. In an industry where interactions and activities occur in a high-speed, people expect fast answers. This industry is also global by nature and communication is affected by this specific feature. Engineers need to learn how to communicate globally, by having the capability to understand and be sensitive to cultural differences when interacting with people from other countries. Additionally, the cross-generation communication is a challenge. More experienced and younger engineers need to overcome the communication barriers related to the use of technology and other behaviors based on generation differences.

Communication occurs in a very formal way in the **Aerospace** industry and is frequently linked to different types of documents. Communication is also more planned and tied with goals and

priorities. One of the requirements to communicate effectively in this industry is the ability to collaborate with multiple organizations. The flow of information is very dense in this industry and this is considered a challenge for engineering communication.

Communication in the **Manufacturing** industry is affected by the high number of people normally involved in manufacturing activities and requires a great deal of flexibility from engineers as communicators. Communication in this industry is more egalitarian and less hierarchical. The (putatively assumed) introverted nature of most engineers may affect their communication performance in this industry.

Table 1

Communication Differences among the Four Industrial Segments

Communication Aspects	Industrial Segment			
	High-Tech	Automotive	Aerospace	Manufacturing
General communication features	Communication is very technical	Communication is more fast paced, people expect fast answers	Communication is very formal	Non-hierarchical communication
Specific communication requirements	A good understanding of technology is required	Global communication is prevalent and requires cross-cultural interactions	Collaborative communication involving multiple organizations is required	Communication involving a great number of people requires more personal skills
Communication strategies	Open and honest communication	Communication must consider cultural differences	Communication is more planned, tied with goals and priorities	Communication must be flexible
Communication challenges	Translating technical content into clear messages	Cross-generation communication inside the industry	Dealing with and disseminating high volume of information	Introverted nature of engineers affect their communication performance

Table 2

Communication Similarities among the Four Industrial Segments

Communication Aspects	Industrial Segment			
	High-Tech	Automotive	Aerospace	Manufacturing
Communication is considered absolutely critical	✓	✓	✓	✓
Communication is tied to the career performance	✓	✓	✓	✓
Oral communication is the most demanded modality of communication	✓	✓	✓	✓
Face-to-face communication is prevalent and the preferred form of communication	✓	✓	✓	✓
Update meetings are very frequent	✓	✓	✓	✓
Written communication, especially e-mail, is the second most demanded modality of communication	✓	✓	✓	✓
Written communication is expected to be clear, concise and precise	✓	✓	✓	✓
Multiple types of audiences: coworkers, customers, suppliers, contractors, vendors, government entities, stakeholders	✓	✓	✓	✓
Communication is tailored according to the audience and the situation	✓	✓	✓	✓
Multiple types of mediums: e-mails, instant messages, text messages, phone calls, conference calls, presentations, meetings	✓	✓	✓	✓
Video conference is frequently used	✓	✓		
Miscommunication in writing is a challenge	✓	✓		
Public speaking is a challenge			✓	✓
Technology has affected communication by increasing the speed of interactions, the volume of information, and the number of e-mails	✓	✓	✓	✓

Communication Similarities among the Four Industrial Segments

Communication is considered absolutely important in all industrial segments investigated in this study. Engineers in the four industries also recognize that their communication performance is intrinsically associated with their career advancement and success, as explained by one of the participant engineers:

I've seen some engineers do it really, really well, they're good at it, and some are not. And those that are good at that communication are the ones that tend to advance more rapidly in their career progression. So I feel it's a very important principle that if done well can enhance an individual's career (Engineer 1, Interview 1, Lines 108-112).

Oral communication, especially face-to-face communication, is the most frequent and preferred form of communication among engineers in all the industrial segments. This specific form of communication occurs in constant update meetings, dyadic interactions, team work, and public speaking. The participant engineers emphasize this idea:

So to me, probably the most important is face-to-face communication. Because I haven't ever found anything that would replace that so I encourage my people if at all possible, you know please communicate face-to-face. So I think face-to-face communication is the best (Engineer 5, Interview 5, Lines 90-94).

So my team, which would be a team of engineers, I mostly communicate with them. And the medium we use are our stand-up meetings (Engineer 2, Interview 2, Lines 84-88).

Written communication, especially e-mails, is very important as well and requires that engineers are able to express themselves in a clear, concise, and precise manner, as mentioned by the participant engineer:

So you've got to really read your own communications with a, how can people misinterpret this? And make sure that I've really clearly conveyed my intent. Because your message goes out to a lot of people so you may not have the opportunity to clarify (Engineer 6, Interview 6, Lines 339-346).

In both oral and written communication, engineers are exposed to various audiences and need to communicate accordingly. This includes tailoring their messages and selecting the appropriate mediums, since a wide range of communication channels is available to engineering professionals. The participant engineer elaborates on this idea:

So you have to be very self-aware of who your audience is, what message you're trying to convey and then, how you convey it. You can have two completely different groups of people and you can present the exact same message in a completely different way. At the end of the day, what's important is whether or not that message has been effectively received (Engineer 8, Interview 8, Lines 105-109).

Engineering communication has been directly affected by technology in the four industrial segments. The main perceived effects of technology are the acceleration of the communication

interactions, the high volume of information available, and the number of e-mails exchanged among engineers.

Discussion

The critical role of communication in the engineering professional environment is widely discussed in the literature (Bjekic, Bjekic, & Zlatic, 2015; Knisely & Knisely, 2015; Nathans-Kelly & Evans, 2017; Werner et al., 2017), and was unanimously supported in the case studies developed in this research. All participating engineers acknowledged the importance of communication for the effectiveness of engineering activities. In all industrial segments, oral communication, especially face-to-face update meetings, is very frequent and demands that engineers have the appropriate abilities to communicate in teams and in dyadic interactions. This was echoed by Keane and Gibson (1999). In the four industrial segments, engineers communicate with a wide range of audiences and need to tailor their messages accordingly, as well as to select the most appropriate medium to get the message across, as recommended in many previous studies (Darling & Dannels, 2003; Knisely & Knisely, 2015; Norback, Leeds, & Forehand, 2009; Troy et al., 2014; Wisniewski, 2018). Engineers are also involved with frequent writing activities, and challenges related to miscommunication in this mode are persistent in at least two industrial segments: High-Tech and Automotive. These challenges were previously indicated by Gunn (2013). Writing is expected to be clear, concise and precise, as suggested by Knisely and Knisely (2015) and Norback et al. (2009).

Different communication requirements can be identified among the four industrial segments investigated in this study. In the **High-Tech** industry, having a good understanding of technology is important because in this specific setting the discourse of technology is prevalent. This was previously discussed in the study of Darling (2005). In the **Automotive** industry, global communication and the ability to appropriately interact cross-culturally is a common requirement. The research of Kedrowicz and Taylor (2013) indicated the importance of global communication as well. In the **Aerospace** industry, communication is very formal, tied with goals and priorities, and involves many documentations. Flexibility is the main communication requirement in the **Manufacturing** industry due to the high number of people involved in this industrial setting.

Through the comprehensive analysis of the four cases developed in this study, four major themes emerged. In the following sessions, these themes are discussed and compared with the scientific literature.

Theme 1: Prevalence of Oral Communication

Engineering communication in industry is widely dominated by oral or verbal communication used in meetings, interpersonal communication, negotiation, conflict management, and public speaking. Oral communication is also preferred by engineers, and it becomes more important as they advance to leadership positions. The prevalence of oral communication in the industry setting was previously discussed by Darling and Dannels (2003). They argued that the engineering workplace can be considered an oral culture where the interactions are not

necessarily constrained by formal public speaking events and that the development of interpersonal skills is very important.

Particularly, face-to-face communication among engineers occur very frequently and is directly associated with team work interactions. Meetings are the primary setting for face-to-face communication, as previously indicated by Norback et al. (2009). Different types of meetings are constantly taking place in industry, especially update meetings, which have the purpose to engage and align engineers' activities with the organization's goals. In order to participate and succeed in these interactions, engineers need certain skills to communicate effectively. The oral communication skills necessary for effective participation in meetings, which include skills in group communication, negotiation, interviewing, and dyadic communication, are a high priority in the engineering profession (Keane & Gibson, 1999). This notion of oral communication is confirmed in this study. Conflict management is another skill necessary for engineers to succeed in their participation in meetings and in other oral communication genres. The critical aspects of oral communication include being able to explain ideas and answer questions, using simple and direct communication, eliminating ambiguities, making sure that the message is completely understood, using different tones depending on the situation, and focusing on the important points of the message.

Even though public speaking is not necessarily the most frequently used genre of oral communication in the industry setting (Darling & Dannels, 2003), it is considered one of the challenges for many practicing engineers, because their (putatively assumed) introverted nature may affect their oral communication abilities. Successful engineers are able to use oral communication persuasively, by convincing other people about their ideas, and by clearly translating their messages into appropriate and understandable content. This is confirmed by Dannels (2002) and Darling and Dannels (2003). Ultimately, oral genres in engineering communication should bridge the discipline with the larger public (Dannels, 2002).

Theme 2: Multiple Audiences, Tailored Messages, and Appropriate Mediums

Practicing engineers in the industry setting communicate through different modes and are exposed to multiple types of audiences, both internal and external to the organizations where they work. These audiences may include, but are not restricted to coworkers, subordinates, leaderships, customers, suppliers, contractors, vendors, governmental entities, and stakeholders. The wide range of audiences targeted in the engineering communication is confirmed by several studies (Darling & Dannels, 2003; Hynes & Swenson, 2013; Nicometo et al., 2010; Troy et al., 2014; Wisniewski, 2018).

Having audience awareness and the ability to tailor the message accordingly are very important requirements for engineers to communicate successfully. This idea was also discussed in previous studies (Darling & Dannels, 2003; Knisely & Knisely, 2015; Norback et al., 2009; Wisniewski, 2018) and it is the reason why Mottart and Casteleyn (2008) argued that engineering students should be exposed to the idea of various audience perceptions during their college engineering preparation.

Tailoring the message according to the audience is a strategy that should be applied by engineers in industry both in oral and written communication. One of the biggest challenges of communicating in any modality is to translate technical information into messages that are understandable to non-technical audiences. Sometimes, the same message can be communicated in different ways with different groups of people, as long as the message is understood by the target audiences.

Since many different mediums are utilized by engineers in industry, the selection of the appropriate communication channels to get the message across is considered equally important as observed in previous studies (Tenopir & King, 2004, Norback et al., 2010; Wang, 2008). Depending on the choice of the medium, the message transmission can be negatively affected. Therefore, it is important to consciously select the best medium for each situation.

Theme 3: Clear, Concise, and Precise Written Communication

In addition to having good oral communication skills, engineers need to be proficient in writing. This is the second most important mode of communication in industry. Many types of documents are written in the engineering profession, including engineering requirements, technical specifications, design documents, manufacturing documents, work instructions, test reports, analysis reports, status reports, presentations, and all types of e-mails. E-mails are the most frequently used form of written material.

The variety of documents written and read by engineers was discussed in other studies (Norback & Hardin, 2005; Kmiec & Longo, 2017) as well as the characteristics of excellent writing (Knisely & Knisely, 2015; Norback et al., 2009). The need for standards of excellence in written communication was also revealed in this study. This included: being clear, concise, and precise. A clear message can be defined as free from being misinterpreted. Conciseness is the ability to simplify the message and to focus on specific and important points. In order to make sure that the message is precise, it is necessary to write with the most appropriate words and exact numbers, if the message includes quantitative data. A precise message is also one that is grammatically correct and does not contain misspellings. Since miscommunication in writing is frequently observed among engineers in the industry setting, it is necessary to proofread the message before sending it through e-mails, memos, or other documents.

Theme 4: The Increasingly Importance of Global Communication

The impact of globalization in several industrial segments has been a reality for many years. Engineers need to adapt themselves to be able to communicate in an increasingly global workplace and interact effectively with different international audiences. By being part of virtual teams formed by different experts located around the globe (Kedrowicz & Taylor, 2013), or by making connections with international suppliers and customers, engineers need to develop the skills that allow them to successfully communicate cross-culturally. This specific ability requires sensitivity and respect for the cultural differences. As observed by Norback et al. (2009), an example of how to practice a correct cross-cultural communication is by avoiding idioms, slang words or phrases, and acronyms.

Many other cultural distinctions may affect how to communicate with foreign colleagues as well as the selection of mediums to better interact with them. E-mail is the primary tool to communicate internationally, but, unlike the concise style that is suggested for general written documents, sometimes it is necessary to provide as much detail as possible in order to avoid misinterpretations from the reader.

Appropriate communication with individuals with different cultural backgrounds (Norback et al., 2010) is no longer just a desirable engineering skill, but is currently a necessary competence for engineers to succeed in the workplace because interactions with international peers and other stakeholders is becoming more and more common in different industrial segments. Kedrowicz and Taylor (2013) suggested that the development of this ability should start in engineering programs by preparing engineering students to communicate in the global workplace and across disciplines and cultures.

Conclusions

Communication is an essential part of engineers' professional life and is intrinsically associated with their career advancement and success. Engineers in the industry setting spend a significant amount of time communicating in different forms and need to be proficient in oral and written communication, while keeping constant audience awareness. They are especially required to communicate orally in multiple contexts such as meetings, one-to-one interactions, negotiation, and public speaking. The prevalence of oral communication requires that engineers are able to communicate effectively and persuasively, but does not change the importance of written communication as the second most demanded mode of communication. Engineers produce a wide range of documents and are expected to write clearly, concisely and precisely. The messages produced in both oral and written communication need to be tailored according to the audience. Since engineers in industry interact with multiple audiences, they are required to be flexible enough to shape the message accordingly and select the best medium option to communicate with the target audience. Contemporary engineers are also required to communicate globally, since interactions with peers and other audiences located in different parts of the world are very common in most industrial segments.

The communication challenges of engineers in industry include difficulties with public speaking and miscommunication in writing. Expertise in these two communication aspects need to be more appropriately developed among engineering students in order to prepare them to the industry demands. Cross-generational communication challenges or difficulties related to communication between older and younger generations of engineers were also one of the communication challenges revealed in this study. Evidences found in this research indicated the preference for face-to-face communication by older generations and technology-mediated interactions as the preferred way of communication when it comes to younger generations of engineers. This study also indicated that technology has affected engineering communication in industry. Interactions have been accelerated by the several new options of communication mediums, such as texting and instant messages, the volume of information exchanged among engineers is increasingly higher, and the number of e-mails sent and received is significantly time consuming.

By comparing the communication aspects of four different industrial segments, this study confirms many insights previously discussed in the existing knowledge-base, while revisiting them in a different and current context. The identified differences among the High-Tech, Automotive, Aerospace, and Manufacturing industries suggest that the standardized communication instruction implemented in engineering programs can be insufficient to effective engineering communication at workplace, while demanding that engineers adapt part of their communication skills according to the specific industry to which they become part.

Recommendations

Communication instruction in engineering programs could increase the emphasis in oral communication, including the skills required for successful interpersonal and team work interactions, and not necessarily focused only on public speaking. The relative emphasis currently given to written communication in many programs could be better balanced with an emphasis in oral communication. Educators could be rigorous when evaluating grammar, spelling, logical structure and other important elements of effective written communication. Deficiencies could be reflected in grading to motivate students to improve their writing skills. Communication instruction could also be more situated within practices that are important for the engineering discipline. In order to develop the cross-cultural communication skills of engineers, educators could introduce international topics in regular learning experiences and assessments, such as case studies and writing assignments. Additionally, student groups formed with ethnical diversity could be encouraged.

The differences in the engineering communication requirements across multiple industrial segments could be further explored through a quantitative or mixed method approach. Additionally, the selection of the industrial segments could be based on different criteria. Further analysis of the engineering communication aspects across different engineering disciplines instead of different industrial segments could bring new insights for communication instruction. Additional research on how engineering programs could incorporate the specific global communication skills expected from engineers is also recommended.

Limitations of the Study

While the intention of this qualitative study was to explore the current expectations of engineering communication through the lens of four different industrial segments, its findings cannot be considered generalizable. The cases were purposefully selected according to pre-established criteria (industrial segments with the highest engineering employment rates in the United States), but access to the participant companies relied mainly on contacts from the database of Utah State University, which limited the research to companies located only in the State of Utah. Additionally, participant engineers were selected through convenience sampling. In future research exploring the same topic, the sampling process of participant engineers could be done differently, including a more heterogeneous and larger number of interviewees.

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APPENDIX A: INTERVIEW PROTOCOL

Participant General Information

Name: _____

Job Title: _____

Size of organization: _____

Highest Degree Earned

BS Major: _____

MBA

MS Major: _____

PhD Major: _____

Number of years in industry: _____

Research Question 1

How can the specific communication skills expected from practicing engineers in industry be described?

Interview Questions

- Tell me about your role as an engineer and how communication is used in your position.
- How do you define communication in your role and is it tied to your success as an engineer?
- Out of the primary communication strategies that you use in your position regularly, which ones do you consider be the most important? Please explain.

- In your specific role as an engineer in industry, how are your communication skills used differently compared to communication your everyday life?
- What are the main kinds of audiences you normally communicate with and which are the most frequent mediums utilized to communicate with them?
- Which forms of communication are more frequently demanded in your work? Can you describe what some of these communication activities entail?
- In your experience as an engineer, provide some examples where you have applied different communication strategies in different situations or groups of people.
- Based on your experience in industry, what critical factors of written communication do you apply routinely? What about oral communication?
- In your role as an engineer, what types of documents do you frequently write?

Research Question 2

What are the engineering communication challenges of practicing engineers?

Interview Questions

- Did you have any previous coursework in technical communication before working as an engineer in industry?
- Does your organization offer training in communication?
- What is your perception about yourself as a communicator in your role?
- What challenges do you experience (if any) in terms of communication in your role?
- What challenges in terms of communication have you noticed your engineering team experiences. Please explain.
- As an engineer in your position, how has technology changed your communication practices or requirements?

Research Question 3

In what ways are engineering communication requirements different across varying types of industries?

Interview Questions

- Tell me about the specific communication requirements in your role in this industry.
- In your experience, how different are the communication requirements of your current role compared to other industries?
- Are your communication skills assessed in performance evaluations? If yes, please explain.