

# Preparing for Engineering Work: Interpersonal Relationships in the School to Work Transition

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**Abstract** — Research on engineering work emphasizes the centrality of collaboration in practice, and research on students' transition from school to work highlights the deep social and organizational learning new engineers experience as they build the working relationships needed to function effectively in their roles. Yet even as engineering programs incorporate communication and teamwork into curricula, little work has been done to examine how students learn to build such relationships as they move from the relational structures of school to those in contemporary workplaces. To better understand this transition, this paper draws on data from a multi-institution study that followed graduates from four U.S. universities through their first year of engineering work, including reflective journals from participants' first three months and interviews at 3, 6, and 12 months of work. The findings highlight three critical themes that characterize participants' challenges related to interpersonal communication at work: 1) building working relationships with a diverse set of colleagues, 2) managing negative relationships, and 3) interacting with appropriate confidence. The findings point to the importance of targeted mentoring and collaborative projects that emphasize workplace cultures in undergraduate education. While such learning often happens in the design projects students undertake in their final year ("capstone" or "senior design"), it also points to the need for sustained attention to these skills throughout the curriculum.

**Keywords**— *Professional Skills; Engineering Profession*

## I. INTRODUCTION AND BACKGROUND

Research on engineering work emphasizes the centrality of collaboration in practice; as Trevelyan has argued, engineers spend much of their time coordinating the work among colleagues. He explains, "In practice, oral communication and physical presence are the foundations on which trusting

relationships depend. These relationships are important for the elaborate technical collaboration performances that form the greater part of an engineers' work" [1]. Moreover, research on students' transition from school to work highlights the deep social and organizational learning new engineers experience as they build the working relationships needed to function effectively in their roles [2, 3]. Such relationship building is perhaps even more critical in the complex contexts needed to address grand challenges such as sustainable development, climate change, and disaster resilience, which bring together global teams with highly diverse educational backgrounds [4, 5]. Yet even as engineering programs have incorporated communication and teamwork into curricula, little work has been done to examine how students learn to build such relationships as they move from the relational structures of school to those in contemporary workplaces. To that end, this exploratory paper draws on data from a study of the school-to-work transition to answer the question, "What types of interpersonal relationship challenges do new engineers experience as they move from school to work?"

## II. METHODS

Data for this paper is drawn from a large U.S.-based multi-institution study that followed new graduates from the end of their capstone design projects through their first year of work.

### A. Data Collection

Following accepted case study methods [6], four sites were selected to provide both literal and theoretical replication. Literal replication is grounded in the pedagogical approach used in the capstone courses at each site, which includes an explicit focus on preparing students for work by simulating an authentic industry context, relying exclusively or predominantly on

industry-sponsored projects, designing assignments and assessments oriented toward workplace expectations, and providing guided mentoring focused on both technical and professional development. In addition, three of the four sites were mechanical engineering programs; the engineering science program at the fourth site was one source of theoretical replication. Mechanical engineering was used as the primary disciplinary focus because 1) it is the largest discipline in the U.S. in terms of number of baccalaureate degrees annually of its relative size in the U.S. [7], and 2) it has a strong connection to industry employment, with most graduates pursuing employment rather than advance graduate studies. Engineering science was selected as the counter case because it provided a wide base of student interests (including electrical and civil engineering) to help identify potential disciplinary variations that could be explored in subsequent work. In addition to the disciplinary counter-case, theoretical replication factors also included program size (from ~30 students to ~400 students), geographic location (mountain, southwestern, mid-Atlantic, and northeastern U.S.), and institution type (public-comprehensive, public-technical, and private).

Participants were recruited in two successive graduating years in the late 2010s to mitigate cohort effects. Data for the study includes reflective responses collected weekly during participants' first twelve weeks of work to probe significant challenges and accomplishments, and to identify ways in which the capstone course prepared students for those experiences. These responses were followed by in-depth semi-structured interviews after approximately 3, 6, and 12 months of work to provide richer and more detailed explorations of participants' transition from school to work. Across both cohorts, 140 students participated in introductory interviews prior to beginning work, 110 participated in the weekly reflections, 87 participated in 3-month interviews, 86 participated in 6-month interviews, and 76 participated in 12-month interviews. Full details on the research methodology, including site characteristics, data collection instruments and a full accounting of all data collected, are available at [8].

#### B. Data Analysis

While the project was originally designed as a multi-case study, as described above, previous analyses have shown few if any differences between sites [e.g., 9] and for this paper, the data from all sites has been combined and treated in aggregate. Prior analysis identified five themes associated with participants' transition from school to work: engineering identity, self-directed learning, teamwork & communication, technical work, and adulating [10]. As reported previously, each of these themes included a range of emergent subthemes [10], and participants' experiences related to each theme were classified as challenges, accomplishments, or "neutral" events (i.e. participants simply describing their daily work).

This study focused on excerpts from the subcode "Interpersonal Communication – General" in the Teamwork & Communication theme that were categorized as challenges. The excerpts were reviewed iteratively using a combination of descriptive and in vivo coding, followed by pattern coding [11] to identify central themes.

### III. FINDINGS

This exploratory data analysis yielded three broad themes that characterize the challenges new engineers experienced relative to interpersonal communication during their first year at work: building working professional relationships with diverse individuals, having difficult conversations, and managing negative attitudes.

#### A. Building Working Relationships With Diverse Individuals

As these new engineers entered a range of workplaces, they transitioned from a school environment where they were surrounded primarily by peers of their own age, educational level, technical expertise, and organizational function. As they moved into new jobs, however, participants found themselves working closely with individuals whose functions, roles, and experiences within the organization were markedly different from their own, and far more diverse than in previous experiences. This breadth creating a range of challenges with respect to building productive working relationships with their new organizations. In some instances, the challenge is as simple as learning to interact across significant age gaps, as one participant explained,

[My friends] are also working close with very young people around them versus me who's working with people who are very older than me like my dad's age basically. [...] it was difficult for me to work because I had nothing to really talk about with older people.

But in many cases, participants recognize that much more than age differences are involved, as another participant explained:

In my role now [...] not only am I looked to from the other engineers and the co-ops and interns, but now my pool of 57 operators. [...] It's really learning how to manage 57 different people, and how they learn, and how they deal with stress, how they with an issue. If a line ruptures with operator A, they might know to go find the isolation valve and close it, and that's their first instinct. But, some of them might see that line rupture and freeze in their steps and not know what to do, and potentially put themselves or other people in harm. It's just making my guys the most successful based on their mannerisms, their temperaments, how they learn, just really the people side.

As this excerpt suggests, participants recognize that they are managing interactions across functional roles as well different needs, personalities, and working styles in ways that are far more expansive than they experienced in school. The complexity itself poses challenges as participants are immersed in a range of different relationships that all require nuanced modes of interaction. Another participant frames it as follows:

I think the most challenging, well, maybe not the most challenging, but a challenging part has been trying to take in all of the information that our process covers, so trying to be aware of everything we do as well as keeping track of all of the different relationships between myself and the guys on the shop floor, and kind of managing those relationships as well as myself and the other engineers in my group, and then as well as myself and the customer, the ultimate customer,

and I know it's very broad, but I think that sort of dynamic has been the most challenging thing for me, but I think that goes back to the idea of being a professional, and that's probably the most foreign thing to me, but I mean [...] I think just because I've never really done it before. I've done it enough to not be walking around blind, but I still feel like I don't know ... We'll have meetings, and I don't really know what to say or how to contribute.

Even when participants entered workplaces knowing they would encounter difference personalities and communication styles, they often still found it challenging to practice and apply that knowledge as they encountered widely different subcultures within their new organizations. One participant explained,:

I think one of the biggest things that I didn't prepare for was ... And again, it's kind of weird 'cause my answer is kind of communication styles, but it's a different side of things. I think I was prepared for dealing with people who are very unlike myself. I've worked in a lot of teams where everyone just wants to get the job done and they're very action oriented. There are a lot of other people, especially in the [Region] that are action oriented, but they do it in a different way. And they get very offended if you say things in certain ways or are not taking their feelings into consideration. And that was something I had never been exposed to that before and that's something I have learned very quickly that everyone is different and you need to be prepared for that and adjust yourself.

Similarly, another noted more generally,

And then with other departments it's been a little bit more difficult to read people, but also knowing how to communicate with them via ... if it's via phone or email or in person. People respond in frequency with different type of methods. Some people never answer their phone, but they'll answer you if you email them. Learning that type of stuff has been interesting.

The shift from school to work, as these comments suggest, immerse new engineers into a much more complex, much less homogeneous environment than they experience in residential universities such as the ones our participants attended. Thus even when they recognize and are prepared for encountering a range of different individuals, they may struggle to build so many new working relationships at once across so many boundaries. The challenge is even more acute because unlike their educational experiences, new engineers are entering situations in which most of the people there already have long-established patterns of interacting. These patterns may be very structured, as in the experience of a participant who "didn't understand how the whole union thing worked" and "started out really bad." Or they may be more subtle, as for the participant who explained, "I don't know if I really have gotten to a place where I understand the hierarchy and dynamics in the work place work. So that's something that I find different and I'm still adjusting to." Similarly, another participant recognized the cultural differences that marked different parts of the organization:

There's a whole aspect of interacting with [this group] that's completely foreign to me, and a lot of times intimidating and

scary because they take their job very seriously, as they should. They have their own kind of culture that they're used to working with, and I'm not used to working within that culture. [...] It can be challenging sometimes and definitely intimidating and feeling like I'm not doing the right thing or saying the right thing.

Overall, as the comments within this theme suggest, the dynamics of workplace relationships are often far more complex than those students experience in their educational environments, and learning those dynamics and interacting, as one participant put it, "in a mature way, a responsible way," can require significant adjustment.

### *B. Managing Negative Relationships*

In addition to learning to build productive working relationships with a wide range of individuals, participants also described challenges related to particularly negative relationships. Some participants, for example, encountered colleagues they perceived as competitive, whose actions made work more challenging. One participant, for example, explained,

There is one guy in my group who I'm pretty positive he preferentially withholds information from me because it gives him a chance to have a leg up in the next meeting and look good for going above and beyond what he was supposed to do. But really, it's like something he should have shared with me because I had time to work on and basically it's like that's kind of my role on the team.

Similarly, another participant contrasted a workplace colleague to their capstone experience, explaining, "This person is actually blocking progress towards the team, which is a crucial thing [...]. This person right now literally does not want to offer help, so it's making it very hard. It wasn't the case with [capstone]. I think still everybody in [capstone] was still a team, had the team spirit, you know?"

While some participants encountered active opposition that created interpersonal challenges, as in the cases above, others grappled with what they perceived as indifference or even apathy. One participant, for example, worked in a group where "there's a lot of people retiring [...]. They're just like 'Why do I have to put in effort? You don't tell me what to, my manager tells me what to do.' " Another compared their current environment to their capstone: "Capstone is really different because there was so much energy in my team [...] Here it just feels like people are just half-assing their work all the time." Another explained,

I think my biggest challenge is seeing guys and girls who've been there for longer than me starting to ... I don't want to say 'settle,' but they're just there for the eight hours on the dot. If they have issues on the floor, they avoid fixing them until someone else deals with it. [...] I feel like sometimes there's a lot of wasted time and just inefficiencies from people just not doing what they need to do [...] and then my product also suffers because of their lack of responsibility.

In other cases, participants recognize that many of their coworkers may simply be taken up with their own responsibilities and the organizational culture does not promote the kinds of collaboration they experienced in school. One

noted, for example, “[That group is] not interested and they don’t want to get really involved with this stuff because everyone has the mentality of top down, top down, top down. We just do our stuff; no one talks to anyone else.”

While it is often easy for students (or even faculty) to mythologize workplaces as environments where everyone pulls together as a team and contributes productively to the organizational mission, many of our participants encountered more complex realities. Even as they found strong coworkers, they also encountered colleagues who either actively created challenges or – whether because of workload or burnout or other personal or professional factors – presented a kind of passive resistance or indifference that they had to negotiate with in order to complete their own work successfully.

### *C. Interacting with Appropriate Confidence*

Finally, many of our participants were deeply aware of their own inexperience and reflected the challenge of balancing that awareness with the need to be confident and assertive at work when required. One participant, for example, noted, “I was at first uncomfortable with those interactions because there are people that have been working here for 30 years and they’re asking me for help.” The age and experience dynamics create situations in which participants are unsure of themselves and unsure how and where to bring the knowledge they do have to the fore. But participants recognize that they need to present themselves to their colleagues in ways that highlight their value and knowledge, as one explained:

I think for me [the challenge has] been trying to advocate for myself. I still haven’t figured out how to do that without kind of losing how I approach situations. So, I know that when I approach or I request something from someone, I don’t do it in an assertive manner. So, I think I need to figure out how to assert myself more in not only asking for people to do things, but also in meetings and making my presence known.

Participants often described being intimidated by more experienced colleagues or supervisors and struggling to voice ideas or questions, as when one noted, “I think I just found it difficult that I actually don’t know a lot of things and I’m a little worried about asking.” Other participants explicitly framed this tension in terms of establishing personal credibility as they recognized the ways in which their inexperience could limit their ability to interact productively, as in the following comment:

I think being the youngest person on this whole team is a little bit different [...] I’d say the trust building is the hardest part because, I mean, I am new to, I’m new to the workforce. I don’t have 20 years of industry experience under my belt like a lot of these guys do, so they have more inherent credibility just by having spent time in different roles throughout their life. That’s the hardest part, is building that credibility.

Like a number of our participants, this individual recognizes that while they may have something to contribute, they need more than simply working relationships. They need to establish their own presence and value to their colleagues.

That lack of credibility can be a distinct source of frustration for participants when it limits their ability to do their job. For several of the women in our study, gender dynamic compound

age dynamics in interpersonal relationships, as in the following comment:

Unfortunately because I’m one of the younger ones, one of the younger employees and also a female, a lot of people don’t take my requests very seriously. So for example, we kept getting customer products that our team is supposed to use for our application and they would just randomly disappear without anyone knowing. So I would put up signs saying don’t touch it and they would still disappear. Then I would talk to people or send out emails and people would kind of like brush me aside. So since I don’t have that power to enforce that, I would always lean on my boss and my executive just so that they can communicate it and it just gets frustrating at a point where you have to rely on other people to have your concerns taken seriously.

Participants also recognized that their lack of experience also limited their ability to simply communicate their ideas clearly. One participant explained, “You can’t work off the assumption that somebody is stupid. I mean, most of the guys know what’s going on. So if they don’t understand it, it’s not because they don’t understand; it’s because I didn’t do a very good job of explaining.” Another participant framed it more broadly when they explained, “I still struggle with it, still something that I’m working on, is communicating my ideas and just getting my point out there. It’s definitely something I’m still working on.”

These interpersonal dynamics can be particularly difficult when participants have to push colleagues, supervisees, or vendors. One participant explained,

I don’t know [...] how to be more assertive ‘cause I know there’s been certain aspects of my job where I have to talk to someone else and I have to push back on them. And I don’t exactly push back as hard as my supervisor or mentor would like me to, and so then they have to [take] over so that things keep moving. It’s kind of punishing.

Another participant, voicing similar challenges related to accomplishing work tasks, explained, “Part of [the challenge], I think, is because I’m asking the wrong people. Part of it is because I don’t think I’m persistent enough. And then part of it, yeah ... I don’t know .. I don’t really feel like I’m important at the company, so that plays a role in this perspective.”

As the examples in this theme suggest, many of our participants recognize their status as newcomers, as young, as inexperienced, and acknowledge the ways in which that positionality creates interpersonal challenges as they interact with colleagues. They are learning to express themselves to diverse audiences, to establish credibility, to push for responses from others with more experience or seemingly more pressing responsibilities. They may possess the relevant knowledge and abilities, but they have not yet built the corresponding professional identities needed for the kinds of interpersonal challenges they encounter.

## **IV. CONCLUSIONS**

The complex network of interpersonal relationships in any organization posed significant learning challenges for the participants in this study across a range of dimensions. Though many had experienced diversity with respect to traditional

demographic markers (e.g., race, class, gender/gender-identity, sexual orientation), the residential universities our participants attended were primarily characterized by traditional-aged undergraduate students living on or near campus and attending the university in order to take and pass classes and graduate with degrees that would lead to employment. Even as they also engaged with diverse faculty and graduate students, the focus of most of those interactions centered on students' academic and professional development in the context of courses, departments, and common co- or extracurricular activities. And when students enter a new context – transitioning from high school to college, matriculating into a major, starting a new class – everyone else is also entering a new situation, creating something of a level playing field. Within this context, which in many ways mirrors the context of K-12 educational settings, the patterns for building working relationships are relatively well-established (though research on social and navigational capital among undergraduate engineering students highlights the ways in which those patterns are not equally accessible to all students).

Entering engineering workplaces, however, our participants encountered a much wider and more complex range of organizational cultures and subcultures, as well as individual variations, that made establishing positive interpersonal relationships challenging. At one level, the sheer diversity of personalities, subcultures, and organizational hierarchies and divisions required steep learning curves as participants slowly came to understand how to interact with various people and groups. But participants also encountered workplace dynamics that exacerbated those challenges, from interpersonal conflict and competition to perceived indifference to divergent priorities. Finally, underlying these challenges is the process of building both the personal confidence and the professional credibility needed to sustain productive relationships. Our participants recognized their own inexperience and the steep learning curve they faced (see [12] for more detail on learning), and often found themselves insecure or uncertain as they sought to voice ideas, extract needed information, negotiate decisions, and more. Those uncertainties were in some cases reinforced as they worked with more experienced colleagues who may not have trusted their judgement. Notably, while three of the four sites included in the study were mechanical engineering programs, our initial analysis of these findings around interpersonal relationships showed no differences between the mechanical engineering graduates and the engineering science graduates, or by industry sector. Company size, however, may play a role and will be explored further in future work.

Our exploration of these interpersonal challenges builds on and extends work by other scholars looking at the organizational learning of new engineers. Significant work in this area has been done by Korte and colleagues[3, 13], who has explored the ways in which both new engineering graduates and experienced engineers changing jobs must learn the social and cultural norms of their new organizations. Similarly, recent work by Lutz and Paretti [2] highlights the ways in which such learning happens at organizational, work group, and interpersonal levels in the school-to-work transition. And Trevelyan's work has repeatedly emphasized the ways in which engineers' work often centers on coordination of activities across a wide range of individuals and

requires complex interactions and negotiations [1, 14, 15]. Future work in this area can and will link these finds to current research in industrial and organizational psychology

Findings such as these help reinforce the deep contextual students experience as they graduate and move into professional work, and can provide an important counterpoint to the numerous studies highlighting the ways in which new graduates are “unprepared” for work. With respect to the kinds of interpersonal challenges our participants experience, for example, university environments will always be limited because they cannot fully represent the complexity of professional work. Industry-oriented design experiences – in the capstone context but also throughout the curriculum – afford some opportunities for learning, but even then, students are typically functioning on teams with other students, even when teams are interdisciplinary. Internships and other forms of work placement can help, but many of our participants had such placements and still found new challenges as they moved from the relatively protected role of intern into the role of professional. As interns they may have had only a single project, often had mentors to “protect” them or run interference, and were often insulated from organizational politics.

Certainly there are things educators can attend to as they develop, teach, and supervise design projects and work placements, but it is also important to recognize the limits of those educational experiences and the inevitable challenges students face as they move from school to work. Certainly some students have access to a range of other experiences within and beyond their engineering coursework that can help develop their interpersonal capacities, but again, such experiences are not equally accessible to or leveraged by all students, and both programs and organizations need to continue to examine how best to support students' and new hires' professional development in this area.

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