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What Early Career Civil Engineers Wish They Had Done Differently: Lessons For Students and Faculty

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Introduction

That the school-to-work transition can be challenging for many recent engineering graduates is well known [1]–[7]. However, current students and faculty rarely get an opportunity to learn directly from the mistakes, regrets, and hindsight of recent graduates during their first few years in the workplace. In order to help make students' transition to engineering practice easier, and, relatedly, to help faculty prepare them in salient ways, this paper addresses the following research questions: 1) What do newcomer civil engineers believe are the biggest mistakes they made in their first few years on the job? and 2) If they could go back to when they began their jobs, what would they have done differently? As part of a mixed-methods, longitudinal study that aims to explore organizational socialization in engineering practice, sixteen early career civil engineers who worked in different firms around the country were asked about their work experiences, including their biggest mistakes and what they would have done differently at work knowing what they know now. Participants said their biggest mistakes related to not asking enough questions, undervaluing/not advocating for oneself, and staying in a position they dislike. Less mentioned issues included specific personal habits, attitudes, and unrealistic expectations from university education. When asked what they would have done differently from the first day at work until now, most responses related to having more confidence, networking and socializing more, and other specific personal behaviors, such as better organization. Less mentioned themes included requesting a higher salary, asking more questions, learning more material, and advocating for their own interests. The results have important implications for successfully preparing civil engineering students to begin their careers. By identifying these gaps in preparation, the paper points to recommendations for the civil engineering community.

Literature Review

This literature review summarizes some of the leading gaps and misalignments between engineering education and practice that have been identified in prior literature. One indication of misalignment is the predictive ability of previous academic performance. It has been shown that engineering students' performance during their undergraduate program is not necessarily correlated with first time job success [8]. Studying practicing engineers in chemical, civil, structural, electrical, environmental, and mechanical engineering, it was found that interpersonal skills and mental agility, among others, were indicators of workplace success, whereas school performance was not [9]. Another line of research indicating misalignments shows that newcomer engineers often have inaccurate expectations of engineering practice [6], [10], [11]. Prior research has also found that newcomer engineers need to acquire new knowledge and competencies they did not learn in school [4], [7], [12]. Given these gaps and misalignments, newcomer engineers will need to ask many questions in order to accomplish their tasks; however, research on school-to-work transitions has found that newcomer engineers tend to hide their insecurities and not ask questions to not appear incompetent or annoying, resulting in fewer interactions with upper management [10], [13].

Several explanations for these gaps and misalignments have been offered. One is that engineering education, with its emphasis on math and science, is not reflective of the "technical coordination" that characterizes engineering practice [14] or the amount of "non-technical" work their jobs require [4], [6], [15]–[20]. Additionally, project experiences and design experiences do not adequately replicate workplace responsibilities and can even instill negative habits that students incorporate into their future jobs [21], [22]. Even multiple internships do not seem sufficient to create accurate expectations [23]. Hence, in multiple ways, engineering education is not replicating the work that new graduates will face in a job setting.

As they navigate these challenges, relationship-building is key to newcomer engineers' success [10], [24]–[26]. Extra effort is often needed to foster these relationships [24]. For instance, newcomer engineers at a manufacturing facility were confronted with topics they were unfamiliar with and had not learned in school, and their method of learning largely depended on relationships with coworkers [24], [25], [27].

Thus, there are opportunities for better preparing graduates for a wider range of tasks, with more accurate expectations, relationship-building skills, and knowledge of engineering practice. This study adds to the existing body of literature by contributing a civil engineering-specific analysis that is based on a unique set of questions posed to participants. Posing these questions provided more nuanced understandings about the salience of social aspects of newcomer civil engineers' experiences. As discussed below, the findings may have particular relevance in light of prior findings on the importance of relationship-building.

Methods

Participants and recruitment

As summarized in Table 1, the participants in this study are sixteen civil engineers who work at different firms in the eastern and midwestern United States. Ten identify as women and six identify as men. Ten identify as white, five identify as Latina or Hispanic (or white and Latina/Hispanic), and one identifies as Arab and white. The participants are early career engineers who began their careers in 2017 and 2018. Their work spans all of the major civil engineering areas, including structures, transportation, geotechnical, and environmental. Further details about where each participant worked are withheld to protect anonymity.

The universities they attended were large, public, research-intensive universities, with the exception of two small, private universities and one large, private, research-intensive university. Some participants had involvement in professional organizations while they were in school, but the details of such involvement were not systematically asked about in the interviews and cannot be reported for all students. They have been participating in a longitudinal study that began in 2019. As part of that study, they complete surveys every two months and participate in an interview every six months. Participants receive incentives in increasing amounts for each year of participation, beginning at $250.

Table 1: Participant characteristics

Gender*	Race or ethnicity*	Highest Degree
Woman	White	Bachelors
Woman	White	Bachelors
Woman	White	Bachelors
Woman	White and Latina	Masters
Woman	Latina	Bachelors
Woman	White	Masters
Woman	Arab and White	Bachelors
Woman	White	Bachelors
Woman	White	Bachelors
Woman	White	Bachelors
Man	White	Bachelors
Man	White	Masters
Man	White and Hispanic	Bachelors
Man	Hispanic	Bachelors
Man	Hispanic	Masters
Man	White	Bachelors

*Self-identified, with no pre-determined categories provided by researcher

The aim of the overarching study is to better understand the organizational socialization experiences of newcomer civil engineers, including differences across genders. The participants were recruited in 2017 through listservs and social media postings of engineering organizations and programs, including the Society of Women Engineers, the American Society of Civil Engineers Younger Member Groups, and Solar Decathlon. In order to maximize diversity within the participant sample, recruitment help was also sought from other minority-serving engineering societies, but was not obtained. Potential participants were invited to contact the second author if they were interested in participating in the study. Only 18 participants who responded ultimately decided to participate, and all of them were enrolled in the study. Two of those withdrew from the study after the first interview.

Data collection and analysis

This paper focuses on two questions asked to participants in 2021: 1) "What are the biggest mistakes early career engineers make?" And 2) "If you could go back to your first day of work, what are three things you would have done differently between then and now?" These open-ended questions were asked in a Qualtrics survey with response fields wherein participants could write whatever they wanted. Responses were analyzed with open thematic coding [28] in order identify emergent themes.

In years prior to these two questions, participants were asked, among other topics, about the biggest challenges they encountered and the most important things they were learning in their jobs, the environment of their workplaces, changes they underwent after graduation, work-life balance, and aspects of organizational socialization, including co-worker support, politics, people, performance proficiency, and work group socialization. Findings from other parts of the study are reported

elsewhere [2], [3], [12], [23], [29]. Among other findings, these prior publications identify ways in which workplace cultures and environments affected participants' early career development, and that data relates to some of the findings in this paper as well.

Findings

Question 1: What are the biggest mistakes early career engineers make?

The first question received responses which followed several common themes. Table 2 lists the themes and their frequencies among the participants, with the most commonly reported theme normalized to one and the least reported normalized to zero. The most common mistakes were not asking for help, undervaluing oneself and skills, and personal habits and attitudes at work. Less mentioned mistakes included not advocating for oneself, staying in a disliked position, and believing that their engineering education prepares them for engineering practice. Distinct differences between women and men were not found in these responses, but given the small sample size, this is perhaps not surprising.

Table 2: Mistakes early career engineers make

Theme	Count	Normalized Frequency
Not asking questions/not asking for help	9	1
Undervaluing oneself	5	0.5
Personal habits/Attitude	5	0.5
Not advocating for oneself	3	0.25
Staying in a position they dislike	3	0.25
Believing that university prepares them for the workplace	1	0

The mistake mentioned the most among participants was not asking enough questions. The most common reason for not asking enough questions was fear. For example, one participant explained that:

> I think the biggest mistake an early engineer makes is not asking enough questions. I think my biggest problem at the start was feeling like I was expected to know more than I knew. After identifying people that would be there to help you learn, asking whenever you hit a road block would be the biggest thing needed to not feel isolated and underqualified.

Another participant explained that this fear originates in how their coworkers view them, responding that the biggest mistake is "Not asking enough questions to avoid seeming not knowledgeable or because they think it will be a bother for others."

Elaborating on that point, several participants also mentioned the detrimental effects of not asking questions. These included wasting time and falling behind schedule on their work. For example, one participant said: "I think some of the biggest mistakes are not asking questions and spending too much time trying to solve a problem when it can be easily answered by a co-worker."

Feelings of insecurity and lack of confidence came across in these responses in words such as "underestimating" and "underqualified" to convey their feelings about themselves. One participant

directly gave an example of how these feelings manifested in the workplace by describing the mistake of assuming that coworkers with more experience were always correct.

Echoing these sentiments of fear and low self-worth, participants noted the difficulty of advocating for oneself regarding career development, field choice, and salary. For instance, one participant discussed self-advocacy regarding salary:

> I think many engineers out of college, including myself, are too timid or afraid to ask for high starting salaries. Once working, I think many engineers find themselves in situations where they are working extra hours without getting paid for it or are being taken advantage of and don't want to put in place solid boundaries to divide work life from personal life.

Similarly, another participant described the challenge of making decisions about their career, listing the biggest mistake as: "Not advocating enough for themselves and where they want their career to go. Instead, I think they can be steered by where others want them to go."

Several participants mentioned feeling a sense of inertia with regard to staying in positions they disliked, and even being "siloed" into a particular skill set. One participant clearly described this as: "Feeling like they're locked [into] a particular role, company, or work environment."

Workplace habits and attitudes were another category of mistakes brought up by the participants. Participants voiced workplace habits such as not spending enough time on their own learning and not checking their work. One participant described an attitude of complacency or entitlement:

> I think the biggest mistakes early career engineers make is thinking that their company or coworkers owe them something. At least in [this state] there is a very large job market for engineers. So we are told to advocate for ourselves to make sure we get a job and pay that we deserve and desire when selecting where to begin our careers. Once that decision is made, I think some engineers can carry that over into their work and think they don't have to show passion and devotion to their job. Engineers coming out of college need to recognize that yes, they are valuable to their company, but we must respect the job and be dedicated to what we are asked to do.

While many of these responses implicitly speak to university preparation, one participant mentioned university preparation explicitly, stating that university did not adequately prepare newcomer engineers for the workplace. The participant stated that the biggest mistake was: "Not [getting] the full experience of what [it's] like being an engineer in the workplace. [Believing] that university will prepare for the transition."

Question 2: If you could go back to your first day of work, what are three things you would have done differently between then and now?

The themes that emerged in response to this question are summarized in Table 3, normalized in the same manner as above. Reported themes included to have more confidence, more networking and socializing, change personal habits, ask more questions, asking for a higher salary, learning specific material, and improve self-advocacy. Several of these themes overlap with responses from

the first question. Again, distinct differences between women and men were not found in these responses, which given the small sample size is perhaps not surprising.

Table 3: What early career engineers wish they had done differently

Theme	Count	Normalized Frequency
Having more confidence/Caring less about what others think	7	1
More networking and socializing	7	1
Different behaviors and habits	7	1
Asking more questions	4	0.4
Learning more material	3	0.2
Negotiating a higher salary	3	0.2
Advocating more for self	2	0

The most mentioned item was having more confidence and not caring what others think. As one participant stated, "I would…think less about people judging you. Everyone is really in their own world, no one is going to judge you until your review period came around." Other participants wished they had "be[en] less critical of [themselves]" and "been less timid in integrating with my group of coworkers." Another participant stated: "Relaxed more. I thought the company's expectations of me were higher than they actually were, which led me to be unnecessarily stressed. It didn't take long for me to start to burn myself out."

Networking and socializing were two items mentioned by many of the participants. Participants expressed wishing they had formed stronger relationships with coworkers and industry professionals. For example, two participants expressed: "I would have attended more networking events to establish connections with people in and outside of my company" and "Talking more with other project managers or higher-ups in the company." One participant noted how being intimidated hampered their socializing with coworkers:

> I would have been more outgoing in introducing myself to my coworkers. My company has a great "buddy" system to get new employees incorporated into the social atmosphere of the office, but I was slightly intimidated at first. After a few weeks of getting to know everyone, I know that we are all welcoming and understanding of what [it's] like to be a new employee.

Personal work habits and behaviors were also mentioned. One particular aspect mentioned by two participants was setting boundaries between work and personal life. For example, one participant noted: "[I] would've focused more on out of work activities…[and] kept up more with friends from college and not let work get in the way of life." Other behavioral aspects were mentioned, such as managing frustration: "Even when frustrated with a project, I would not express that frustration in saying I [didn't] like working on that part of the project." A participant even wondered about their career choice to become an engineer, stating "I would potentially not even become an engineer." Other concrete habits were mentioned, such as "slow down and check my work more closely often", "being more organized on projects from the beginning. Having a better system for keeping emails, papers, and tasks organized", and "setting realistic time oriented goals."

Asking questions was another theme identified among participants. For example, one participant notes:

> I would tell myself to ask more questions early and often to supplement my own lack of knowledge. Second, I would tell myself to try to develop those questions beyond the point where I typically would be at, as I would typically hit a road block and shut down. This would result in me asking questions that were relatively simple that if I had taken a minute to think about would have been easily solved.

Participants noted how not asking questions impeded their progress, stating; “I refrained from asking questions sometimes, but this almost always led to me doing something incorrectly and having to correct it later on” and “I wouldn’t have been so afraid to ask for help. I would’ve asked what kind of progress is expected of me and how I could do better.”

Learning specific material, particularly software, was another item mentioned by some participants. For example, one person wished they had “become more familiar with the standards we use”, while another wished they had “Spent more time learning the fundamentals [and]…practice the computer programs more.” Another participant echoed this sentiment, stating “I would have focused more on learning software-based analysis and calculations.”

Lastly, advocating for one’s interests was also raised among participants. For example, participants listed: “Speaking up about which projects and project types I enjoy working on most" and “[Make] my interests more clear. I sometimes expected things to be different but never expressed it explicitly." Again, this line of thought matches participant responses to the first question, in which the one of the biggest mistakes was not advocating for oneself. Similarly, some participants brought up wishing that they had asked for or negotiated a higher salary when accepting their job offers.

Discussion

This study examined the school-to-work transition for new civil engineers. In particular, we asked what their biggest mistakes were, and what they could do differently. Our findings largely pointed to these new engineers lacking confidence, leading them to be fearful of asking questions or socialize with others. For both questions, the most mentioned responses relate to self-confidence, asking questions, personal habits, and social connections. Several of the participants brought up struggling with undervaluing oneself and being reluctant to ask for help. It is likely that confidence is related to the reluctance to ask questions.

Some of these findings support prior research and extend its relevance to civil engineering specifically. As noted, other studies have also identified reluctance among newcomer engineers to ask questions [10], [13]. Those studies found newcomer engineers disliked asking questions because they felt like burdens, of feared annoying co-workers, which matches our findings. Additionally, as found in prior literature, relationships are extremely important for newcomer engineers. Networking and socializing likewise emerged as salient in this study.

The findings from this study are important because they suggest difficulties to the relationship-building component of engineering socialization. For example, the leading responses to both questions have implications for relationship-building. Because relationship-building is key to socialization and affects learning, adaptation, and ultimately, satisfaction and performance [2], [24], the confidence and ability to ask questions and network should not be underrated. Indeed, they are key to successful socialization. Additionally, this paper adds new findings on the salience of other professional development topics. Transversal skills such as organization, goal-setting, work-life balance, salary negotiation, and advocating for one's interests at work also emerged as salient for our participants. Opportunities to help students and recent graduates develop such skills would be valuable.

Recommendations

By identifying these gaps in preparation, the paper points to recommendations for the civil engineering community. These results provide valuable feedback to improve new engineer work experiences. Based on these results, we identify ways in which these shortcomings can be addressed in civil engineering programs. Perhaps the most salient finding of the survey is that new graduate civil engineers feel disempowered, which is present across the top reported issues: lack of confidence, networking, and not asking questions.

Sharing these findings with students prior to graduation could better prepare them for their first jobs. Educators should provide engineering students with information that normalizes and emphasizes the true culture of the new job; one in which asking many questions is common and where they may not feel as confident as they did in school. Acculturating students to this new role will lead to the behaviors that are necessary to succeed in their new positions, such as asking questions, socializing, and feeling comfortable to advocate for oneself. This knowledge empowers new engineers, and would help alleviate many of the top challenges they cited in their new roles.

Specifically, we suggest the following for engineering educators to consider teaching their students:

- Making clear that they are not expected to know everything in their new position
- Not knowing something is not connected to their own inability, but is instead a normal element of a new position
- Asking questions is a positive aspect and it is better to ask than make mistakes
- Feeling a lack of confidence is common

These ideas could be implemented through multiple means, and we will suggest three possibilities here. One idea would be to include this information in a lecture or module for implementation in capstone courses. A second idea would be to organize panels whereby students can learn from recent graduates directly. These could be college-wide panels, or organized specifically as part of capstone, and panelists could be found by contacting local ASCE Younger Members groups and recent alumni lists. A third idea is that such information could be included in materials or resources for students. For instance, some kind of handbook or guide for early career engineers could be a valuable resource.

Employers should also understand these challenges and plan accordingly. For example, as reported elsewhere, the culture of an organization directly impacts newcomer engineers' ability to ask questions [12]. Incorporating similar contents as described above into onboarding trainings could be valuable.

The above recommendations are all possible outcomes from this project that are currently being explored for implementation in the coming year.

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