Board 272: Examining the Catalysts and Barriers that Early-Career Engineers Experience to Their Adaptability at Work

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CAREER: Examining the Catalysts and Barriers that Early-Career Engineers Experience to Being Adaptable at Work

Abstract

This work-in-progress paper explores the lived experiences of early-career engineers as they navigate work situations that require them to adapt. The paper is part of a broader National Science Foundation-funded research study focused on increasing the adaptability of engineering students and early-career professionals. While adaptability is a top engineering competency, few studies have sought to understand early-career engineers' experiences with adaptability, with related literature suggesting that they may have suboptimal adaptability as a result. Our study analyses the adaptability-related supports and barriers that early-career engineers experience on the job. Semi-structured critical incident interviews were conducted with thirty early-career engineers and analyzed. Preliminary analysis revealed three kinds of factors that early-career engineers reported influencing their work adaptability: personal factors, such as whether the engineer felt confident in and agency over their ability to adapt; interpersonal factors, such as whether the engineer received sufficient mentorship from their managers and coworkers; and organizational factors, such as whether the engineer had access to adaptability-related training and development opportunities. Codebooks for both supports and barriers are presented in this paper, with findings to be explored in more detail (e.g., how adaptability-related experiences varied by social identity and/or work environment) in a later publication. Findings from this study are expected to address a gap in the literature regarding the role of industry and academia in shaping early-career engineers' adaptability and provide guidance to organizations and universities about how to best facilitate engineers' adaptability development. Future work will evaluate specific strategies and interventions to address this issue.

Introduction

Significant social, economic, and technological shifts have profoundly transformed the work and collaborative practices of contemporary engineers [1, 2]. Present-day engineers must adjust to continuously evolving job requirements and tackle progressively intricate and ambiguous problems that demand innovative and interdisciplinary solutions [3]. Adaptability, defined as the ability to respond quickly and flexibly to changing situations and conditions, has thus become a critical attribute for engineering workforce development. For at least three decades, calls for heightened focus on adaptability in engineering education have come from industry, government, and professional societies [4-8], with such anticipated benefits as enhanced workforce size, productivity, and national competitiveness [3]. Despite this, limited research has been conducted to understand engineers' adaptability-related experiences on the job, resulting in a significant lack of clarity about what adaptability looks like in engineering practice and the factors that most help and hinder its development [3]. Such omission may contribute to work challenges faced by both early and late-career engineers in adapting to their roles, as reported in the literature [9-11].

This study represents a steppingstone toward bridging the gap in current knowledge and fostering a more comprehensive understanding of engineers' adaptability. Specifically, the study addresses the question, "What supports and barriers do early-career engineers experience on the job when confronted with situations that require them to be adaptable?" A previous phase of the

project identified six dimensions related to adaptability in engineering work, including creative problem-solving, dealing with uncertain and unpredictable situations, handling work stress, interpersonal adaptability, cultural adaptability, and continuous learning [12]. However, further exploration is needed to uncover and comprehend the nuances that impact the adaptability of early-career engineers across each dimension. A deeper exploration of the supports that propel them toward higher levels of adaptability and the barriers that impede their growth can provide a more holistic perspective on how academia and industry can support them in their professional journeys. Uncovering these dynamics can specifically help educators, employers, and policymakers develop tailored strategies and interventions that support a more supportive work environment; such approaches can, in turn, promote adaptability and enable early-career engineers to thrive and excel int their roles and the engineering workforce to embrace change and continue driving innovation amid ever-evolving demands.

Theoretical Framework

Research on adaptability has been conducted across diverse fields such as psychology, leadership, human resource management, education, personality, and aging since the late twentieth century [13]. Despite the growth in both the general literature on adaptability and interest in fostering adaptability in engineering students, there has been limited exploration of what adaptability entails in the engineering context, with only a few exceptions [14, 15]. For interventions aimed at boosting engineers' adaptability to be effective, in-depth examination of the supports and barriers that engineers experience to being adaptable is imperative.

Research commonly defines adaptability relative to individuals (e.g., employees), groups (e.g., teams, communities), or systems (e.g., organizations, infrastructure) [16, 17]. This study concentrates on individual adaptability, focusing specifically on the adaptability of early-career engineers. Individual Adaptability Theory stands out as the most comprehensive and frequently referenced framework in literature for considering adaptability supports and barriers [18]. Individual Adaptability Theory posits that an individual's capacity for adaptability is dynamic and influenced by previous experiences, contextual (e.g., sociocultural) influences, and personal characteristics. We use Individual Adaptability Theory to determine the personal and contextual factors that help and hinder early-career engineers' adaptability.

Methods

This study is a component of a broader five-year National Science Foundation-funded research project to improve the adaptability of engineering students and early-career professionals. Semi-structured interviews were conducted with thirty early-career engineers who had obtained their engineering bachelor's degrees from a U.S. college or university within the past decade and were currently employed in industry. Maximum variation sampling was used to ensure diversity with respect to industry, gender, and race across the participants. The interviews were conducted using the critical incident technique [19]. During the interviews, participants were asked to recall instances in their work in which they had needed to adapt. For each incident, they were asked to describe (1) their actions and reactions to the situation, (2) the challenges or difficulties they encountered while adapting, and (3) the resources they utilized for assistance. These interviews

were conducted via video call, with each session lasting approximately 60 minutes, and were audio recorded and transcribed.

The interviews were analyzed using a theory-driven deductive-inductive thematic analysis approach [20]. This method allowed for a systematic examination of the interview transcripts, combining our theoretical framework—Individual Adaptability Theory—and emerging patterns and themes from the data. First, we conducted deductive coding to identify instances of supports and barriers related to the early-career engineers' adaptability, followed by inductive coding to capture the specific details of these instances. Employing this approach produced valuable insights into early-career engineers' experiences of adapting to various situations at work. Coding was performed in Dedoose.

Preliminary findings for this paper come from an analysis of three interviews with early-career engineers selected from our overall sample at random: (1) Brandon, a Hispanic/Latinx man employed as an aerospace engineer and approximately two years out from graduating from college, (2) Carolina, a Hispanic/Latinx woman employed as a design engineer and approximately eight years out from graduating from college, and (3) Derek, a white man employed as a software engineer and less than one year out from graduating from college. (All names are pseudonyms.)

Preliminary Findings

This analysis underscored the multi-faceted nature of workforce adaptability found in previous phases of this project [12] and highlighted the factors that impact workforce adaptability for early-career engineers. Factors that positively contributed to early-career engineers' ability to adapt to their professional roles included the engineer's personal attributes (e.g., confidence and a feeling of autonomy over one's ability to adapt), the engineer's previous experiences (e.g., having acquired a solid knowledge base through one's schooling), and organizational factors (e.g., flexible work deadlines, helping company culture, innovative company culture, the ability to pursue passion projects, access to mentorship). Those who received strong mentorship from coworkers and/or managers during their careers reported feeling more prepared to face challenges in the workplace. Additionally, opportunities for continuous learning during education and in the workplace were instrumental in nurturing their ability to adapt and stay abreast of emerging technologies and best practices. Table 1 summarizes the themes that emerged from inductively coding the interview transcripts for adaptability-related supports.

Table 1: Overview of emergent themes related to adaptability-related supports.

Emergent theme	Definition	Example
Personal characteristics		
Communication	Early-career engineer has an easy time adapting at work because they have good communication skills and can easily acquire what they need.	Being adaptability is if you like something, don't be shy about it. Tell them, because then you'll get more stuff and learn more.
Open-mindedness	Early-career engineer has an easy time adapting at work because they are open-minded and consider multiple solutions to a problem.	Being adaptable is being open to doing other tasks that contribute to the overarching goal of the organization.

Previous experiences		
Prior knowledge from school	Early-career engineer has an easy time adapting at work because they have prior knowledge from school which they can draw from to solve emergent problems.	Having acquired a solid knowledge base from my education, I find it relatively easy to adapt to different CAD software and other tools developed in-house.
Organizational factors		
Job flexibility	Early-career engineer has an easy time adapting at work because their job provides flexibility (flex time, resources) to investigate problems and explore solutions.	Depending on the team you are on, you can have a very relaxed, take your time work schedule, and that fosters learning more things that enable adaptability.
Helping company culture	Early-career engineer has an easy time adapting at work because they receive sufficient help and support from their coworkers or managers.	The company has a culture where workers can easily seek help from their colleagues if needed, so that helps the ability to adapt quickly.
Innovative company culture	Early-career engineer has an easy time adapting at work because their entire company encourages a culture of innovation and flexibility.	Everybody's always trying to think outside of the box because the organization pushes for innovation.

Despite the positive influences, early-career engineers also reported various barriers hindering their adaptability. Personal characteristics acting as barriers included the tendency to self-doubt, whereas previous experiences included a lack of experience on the job. The engineers also discussed various organizational factors that served as barriers, such as a lack of documentation for internal company processes, insufficient guidance and mentorship from coworkers and managers, inadequate compensation (tied to the motivation to adapt), and a lack of training opportunities. These barriers posed challenges for engineers as they navigated their work environments, affecting their ability to adapt effectively to changing circumstances. Table 2 summarizes the themes that emerged from inductively coding the interview transcripts for adaptability-related barriers.

Table 2: Overview of emergent themes related to adaptability-related barriers.

Emergent theme	Definition	Example
Personal barriers		
Self-doubt	Early-career engineer has difficulty adapting at work because they lack self-confidence in their abilities.	Sometimes, I don't think I can do what I want to do, so I don't even try.
Organizational barriers		
Lack of documentation	Early-career engineer has difficulty adapting at work because their company does not have well-documented internal processes to help know what to do.	Most of the things that are worked on are in-house, and there is no documentation, so things are difficult to work on.
Lack of guidance	Early-career engineer has difficulty adapting at work because they don't receive sufficient guidance or mentorship from their coworkers and managers.	You have to adapt, but it's hard, because nobody is there to, like, hold your hand.

Lack of training	Early-career engineer has difficulty adapting at work because their company does not offer adaptability-related training or professional development.	We don't have any training that will help make workers adaptable.
Low compensation	Early-career engineers has difficulty adapting at work (tied to motivation) because they don't perceive themselves as being paid well enough.	The company doesn't pay people well for their talent and the contribution they bring to the company, so people aren't going to go above or beyond.

Discussion

Preliminary analysis revealed several personal, experiential, and organizational factors that early-career engineers said influenced their work adaptability, including (among other things) whether they felt confident and/or autonomous in their ability to adapt. These factors could be traced to specific supports and barriers the engineers reported experiencing in school or work, including mentorship from coworkers or managers and access to continuous learning opportunities. These findings underscore the significance of a supportive and conducive learning environment during an engineer's education and early career stages. They particularly emphasize the critical role that mentors and supervisors play in shaping the adaptability of early-career engineers. By providing guidance, support, and opportunities for continuous learning, these supports can empower engineers to embrace change and thrive in dynamic work settings. On the other hand, the identified barriers serve as critical areas for improvement and intervention. Addressing issues such as self-doubt, a lack of documentation, and inadequate guidance can lead to a more confident and adaptable workforce. Furthermore, enhancing compensation and providing comprehensive training programs can boost engineers' ability and motivation to navigate challenges and stay flexible in the face of evolving demands. By investing in these supports and addressing barriers, organizations can cultivate a work environment that nurtures and sustains adaptability, leading to enhanced performance and success for both engineers and the companies they work for.

As the demands of the industry continue to change and new technologies emerge, engineers must possess the ability to adapt and embrace these transformations effectively. While the significance of adaptability is widely recognized, there is a gap in understanding how academia and industry contribute to the development of this vital skill among early-career engineers. Traditionally, engineering education has focused on technical knowledge and problem-solving skills, with relatively less attention given to adaptability as a distinct competency. As a result, many early-career engineers may enter the workforce with limited understanding or explicit guidelines on what it means to be adaptable in a professional setting. The findings of this research thus shed light on the current state of adaptability education in engineering academia and industry. Early-career engineers expressed a need for more explicit guidelines and instruction on adaptability, indicating that the current approaches may not fully equip them to navigate the dynamic challenges of their careers effectively. As such, we offer several recommendations for educational practice and research for addressing the gap in workplace adaptability for early-career engineers.

Regarding educational practice, a potential avenue for improvement lies in curriculum enhancement within engineering schools and universities. By incorporating explicit modules on

adaptability, educators can provide early-career engineers with the necessary knowledge, skills, and best practices for embracing change and uncertainty in their future careers. Collaborating with industry experts and practitioners can further enrich these modules with real-world case studies and practical insights. In addition, establishing robust mentorship programs and fostering partnerships between academia and industry can significantly contribute to the development of adaptability among early-career engineers. Drawing from their own experiences, mentors can offer valuable guidance on navigating challenges and adapting to different work environments. Industry partnerships can facilitate internships and practical training opportunities, allowing engineers to gain firsthand experience and exposure to real-world adaptability scenarios. Encouraging and supporting continuous professional development is essential to nurturing adaptability among engineers throughout their careers. Industry employers can provide regular training sessions, workshops, and seminars focused on adaptability and its relevance in specific engineering domains. This ongoing learning process will equip engineers with the tools to stay ahead of industry advancements and embrace change proactively. Finally, academia and industry can work together to cultivate a culture of adaptability within the engineering community. Encouraging a growth mindset and valuing adaptability as a core competency can create an environment where engineers are empowered to explore innovative solutions and embrace change as an opportunity for growth.

Regarding educational research, future work will focus on a more in-depth analysis of our thirty interviews with early-career engineers to develop a complete picture of the supports and barriers that they experience to being adaptable in their job roles. We will also link supports and barriers to specific adaptability outcomes (e.g., whether the engineer was successful or unsuccessful, the impact it had on their overall experience) to understand their long-term impacts. In addition, future studies can focus on identifying specific strategies and interventions to address the gap in early-career engineers' adaptability development. These initiatives can be targeted at both academia and industry, ensuring a comprehensive and integrated approach to enhance adaptability in engineering education and professional settings.

Conclusion

This research addresses a gap in the literature regarding the role of academia and industry in shaping the adaptability of early-career engineers. The findings suggest that early-career engineers require more explicit guidelines and instruction about how and what it means to be adaptable in the engineering workforce. Looking ahead, tailored strategies and targeted interventions can be implemented to enhance adaptability education and support among early-career engineers. By investing in these initiatives, academia and industry can work collaboratively to foster a workforce that is agile, resilient, and poised for success in the ever-evolving engineering landscape.

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