Identifying the Challenges Aerospace Engineers Face During the Transition from University to Industry

1. Abstract

Important direct outcomes of new engineer socialization include understanding one's roles and responsibilities, learning the knowledge and skills required to perform one's job, understanding one's company culture, and gaining acceptance into one's workgroup. Studies have shown that achieving these outcomes positively impacts job retention, satisfaction, and performance. However, while the proactive behaviors new engineers implement to achieve these outcomes have been a primary focus of recent literature, there is a lack of understanding regarding the challenges new engineers face while attaining these outcomes. It is crucial to understand the challenges new engineers face to mitigate these obstacles and better prepare engineering students to enter the workforce. This research aims to (a) identify the specific challenges newly hired engineers face and the actions they take to overcome these challenges during the socialization period, and (b) identify aspects of undergraduate education that new engineers believe can be improved. Researchers interviewed 26 participants from four of the largest aerospace and defense organizations in the United States, and their responses were analyzed using an open coding method. Coders identified 26 unique challenges and 13 distinct solutions during this study. Challenges included a lack of engineering knowledge, unclear role boundaries, lack of organizational support, and navigating an unfamiliar environment. Of those 26 challenges, 15 significant challenges faced by newly-hired engineers are presented in this paper. Several solutions involved interacting with coworkers, shadowing and observing coworkers, and utilizing available resources. Knowing what challenges newly-hired engineers will face and what solutions they may use is helpful for undergraduates entering the workforce. When asked how undergraduate engineering education could be improved, the newly-hired engineers desired a more significant focus on practical training, more exposure to industry-like environments, and a greater emphasis on soft skills such as technical writing. This study aims to minimize the gap between academia's and industry's expectations for new engineers' required knowledge and skills, help prepare engineering students for the potential challenges they will face during the socialization period, and highlight potential areas of improvement within engineering organizations and undergraduate engineering education.

Keywords: Proactive behavior, engineering education, organizational socialization, challenges, aerospace engineering

2. Introduction

This study's motivation is to identify and understand the challenges newly-hired aerospace engineers face during the transition from college to industry and how they overcome these challenges. During this study, 26 participants from four of the largest aerospace and defense organizations were interviewed about their experiences during the socialization period. This study uses a qualitative approach and identifies 15 distinct challenges that newly-hired aerospace engineers experience during the transition into their new jobs and 13 solution actions they utilize to manage these challenges. This paper also offers suggestions on how organizations and

academia can better prepare engineering students and newly-hired engineers to enter the industry.

3. Literature Review

3.1 Challenges Encountered by New Engineers

Upon beginning their new jobs and entering the workforce, newcomers and newly-hired engineers are subject to many different challenges and obstacles. A critical challenge is the stress newcomers endure in response to their new surroundings (Katz, 1985). When newcomers find themselves in unfamiliar situations and new professional landscapes, they often become stressed and uncomfortable due to a lack of experience or knowledge concerning their new job. Many studies investigate how organizational socialization can help combat newcomers' feelings of stress and minimize potential stressors (Frogeli et al., 2019; Raub et al., 2021). Stress can stem from and coincide with many other challenges, including social anxiety, relationship conflict, role ambiguity, and role conflict.

Previous research has shown that some of the challenges newcomers face arise from their personalities. For instance, if a newcomer is generally shy and introverted, they may experience anxiety when interacting with their coworkers due to negative perceptions and thoughts of themselves and how others may perceive them. If the newcomer believes they will be poorly received by their coworkers, they may feel anxious when seeking information from their coworkers and asking questions (Schlenker & Leary, 1982).

Sometimes, it is not just the unfounded expectation of a negative reaction that causes the newcomer stress and anxiety. In some cases, newcomers experience relational conflicts between themselves, their coworkers, and managers (Nifadkar & Bauer, 2016). These relational conflicts arise when newcomers feel unsupported by their supervisors (Jokisaari & Nurmi, 2009), are subverted by their coworkers and managers (Kammeyer-Mueller et al., 2013), or experience verbal aggression from their supervisors (Nifadkar et al., 2012). These relational conflicts serve as legitimate evidence in the newcomer's mind that the conflict's recipient will negatively receive them. Because of the newcomer's perceived damaged relationship with their coworkers, newcomers may feel anxiety and stress over future negative interactions with their coworkers.

Another major stressor for newcomers is the lack of understanding of their role and responsibilities (Van Sell et al., 1981). When newcomers lack knowledge of the details of their job, they may feel they are doing too little or too much work. This can cause anxiety for the newcomer if they are unsure whether they are performing their job correctly or to the fullest potential. Role ambiguity describes a situation in which the employee lacks knowledge and information that would assist their understanding of company expectations and how to complete tasks necessary for their job (Onyemah, 2008; Raub et al., 2021). When newcomers are unsure of their role within their company, they can be taken advantage of and pulled into many different and conflicting roles. Sometimes, newcomers may unknowingly overstep their bounds and take on the responsibilities of another coworker's role.

Role conflict arises when employees receive multiple expectations with conflicting interests (Onyemah, 2008; Raub et al., 2021). Unremedied role ambiguity and role conflict produce

feelings of helplessness (Onyemah, 2008), job dissatisfaction (Jackson & Schuler, 1985), and tension or anxiety (Jackson & Schuler, 1985). These negative psychological effects due to role ambiguity and role conflict have drawn great interest in organizational stress theory and perspectives because of their impact on job performance, satisfaction, and retention (Kowtha, 2011; Major et al., 1995; Tubre & Collins, 2000).

3.2 Solution Actions

To effectively minimize these challenges, newcomers take various proactive actions and develop different coping mechanisms. In 1993, Elizabeth Morrison found that newcomers seek various types of information to adjust to their new surroundings (Morrison, 1993). A few years later, Ashford and Black (1996) expanded on this thought by compiling different actions that newcomers take during the socialization process. Their study identified seven distinct actions, including information seeking, feedback-seeking, general socializing, networking, building relationships, negotiating job changes, and positive framing (Ashford & Black, 1996). Then, in 2012, seven more actions were identified by Cooper-Thomas, Anderson, and Cash: minimizing, proving, giving, flattering, befriending, teaming, and exchanging.

3.3 Socialization Outcomes

These challenges and solution actions impede and help newcomers successfully integrate into their jobs and workplaces, respectively. One of the accepted ways of analyzing whether a newcomer has reached a satisfactory amount of socialization depends on the achievement of socialization outcomes. Successful outcomes of role clarity, task mastery, acculturation, and workgroup integration are direct indicators of successful organizational socialization. Role clarity is defined as understanding one's roles and responsibilities within their organization, while task mastery is defined as understanding the skills and tasks essential to fulfilling those roles. Acculturation measures the newcomer's integration into the organization's culture, and workgroup integration is defined as having the ability to gain support and respect from one's workgroup (Kowsikka & James, 2019; Morrison, 1993). Morrison's research suggests that the achievement of each of these outcomes links to higher job performance, satisfaction, and retention (1993).

3.4 The Gap

While previous research has emphasized the importance of identifying the actions newcomers take to achieve organizational socialization and its outcomes (Ashford & Black, 1996; Cooper-Thomas et al., 2012; Morrison, 1993), there has been a minor focus on the various challenges newcomers face while displaying these active behaviors. Several areas of continued research revolve around managers' perspectives of areas in which newcomers are unskilled for their jobs, efforts to bridge the gap between industry expectations and education requirements, and the general challenges newcomers face during this transition (Arnold, 2018; Candy & Crebert, 1991; Kleckner & Butz, 2020; Murphy et al., 2010).

Within engineering, these research areas are critical to understanding engineers' perspectives of their challenges and methods to cope and overcome adversity when transitioning from collegiate education into the industry. While there have been several studies conducted to help prepare newly-hired engineers for the workforce and identify the challenges they will face (Baytiyeh & Naja, 2012; Hawse, 2017; Jampala & Madani, 2020; Stiwne & Jungert, 2010; Winberg et al.,

2020), little of the literature on organizational socialization specifically addresses aerospace engineering (Dong, Ahn, & Tobey, 2021; Wingerter, 2019; Wingerter & Ahn, 2020). While aerospace is an engineering domain, there may be distinctive nuances in newly-hired aerospace engineers' challenges compared to other engineering fields.

3.5 Theoretical Framework

This study uses Morrison's framework for active newcomer socialization, which indicates four proximal outcomes of newcomer socialization: role clarity, task mastery, acculturation, and workgroup [social] integration (Morrison, 1993). Since organizational socialization is such a vast and prominent field of research, several different expressions can refer to the same proximal outcome. For example, other phrases that refer to role clarity include understanding (Taormina, 1997) and politics (Chao et al., 1994). Morrison's framework aptly connects many of the different ideological frameworks for newcomer socialization and thus was used as the foundation for this research.

This study will focus on the challenges faced and proactive actions taken within each of the proximal outcomes of role clarity, task mastery, acculturation, and workgroup integration.

3.6 Aim of Present Study

Proactive actions that newcomers take, and the proximal and distal outcomes of socialization processes have been, and continue to be, deeply investigated (Ashford & Black, 1996; Cooper-Thomas et al., 2012; Dong, Roy, et al., 2021). Knowing which actions lead to specific outcomes is essential; however, it is also crucial to understand newcomers' various hindrances and challenges when taking these actions to pursue socialization outcomes. Once these challenges are identified, socialization processes can include different methods to minimize these challenges and encourage newcomer proactive behaviors. On an organizational level, organizations and companies can improve their onboarding and socialization processes to minimize the perceived challenges their newly-hired employees face. While several papers highlight the engineering industry (Ashforth et al., 2007; Foor et al., 2007; Korte, 2009; Kowtha, 2011), only a few specifically focus on the aerospace engineering and defense industry (Dong, Ahn, & Tobey, 2021; Dong, Roy, et al., 2021; Wingerter & Ahn, 2020). Of those that contain the unique perspective of the Aerospace and Defense (A&D) industry, there is a lack of discussion on the challenges that newly-hired engineers face during the socialization process. This paper will consider specifically the A&D industry. The purpose of this research is to identify the challenges newly-hired aerospace engineers face regarding role clarity, task mastery, acculturation, and workgroup integration within their organizations.

4. Methods

This study considered the experiences of 26 newly-hired engineers and followed a qualitative approach to understand the participants' challenges and solutions within their respective contexts. Employing qualitative research methods allowed for the use of Morrison's socialization framework when studying the responses of newly-hired engineers.

4.1 Data Collection

Twenty-six participants were selected from four of the largest A&D organizations in the United States based on the following criteria: (a) participant has received an undergraduate degree in any engineering discipline from a U.S. university, (b) participant is currently working full-time in an aerospace engineering organization, and (c) participant has been working in an aerospace organization for three to 36 months since the graduation of their undergraduate degree. Each participant was given a one-on-one semi-structured interview. Semi-structured interviews were an appropriate method of data collection because they allowed the interviewers flexibility in word choice and the opportunity to ask follow-up questions when appropriate. Each participant was compensated with a $99.99 Amazon gift card following their interview session.

Of the 26 participants who entered this study, 42.3% were women, and 4.88% were Asian or Hispanic, Latino, or Spanish. The participants represent six different majors, including aerospace, mechanical, industrial, and computer engineering. Their working experience ranges from three to 22 months.

The interview questions were divided into four sections. Section 1 consisted of questions about past experiences, such as having an internship, initial work environment, the proactive steps taken when transitioning from their university to organization, challenges they encountered during this process, and how they overcame said challenges. Section 2 included questions that focused on the participants' socialization process, based on Morrison's (1993) framework. These were broken down into four categories: role clarity, task mastery, acculturation, and workgroup integration. Section 3 highlighted the participants' opinions of the adequacy of their undergraduate engineering education program. Finally, section 4 allowed interviewees the opportunity to contribute additional information that may not have been covered in previous questions.

The research team was granted permission from the Institutional Review Board (IRB #18-243) to continue with recruitment and data collection. Recruitment was done through electronic flyers explaining the study's purpose, participant eligibility, and a request to engage in the study. These flyers were sent out in the spring of 2019.

4.2 Data Analysis

The interviews lasted an average of 60 minutes. Each interview was audio-recorded and then transcribed. The transcripts were then analyzed using open coding and constant comparative methods. First, the research team compared the audio files and their respective transcripts to ensure that each audio file was transcribed correctly. Then, all 26 transcripts were read independently by each member of the team and were used to develop the initial codebook. Each team member used an open coding method and followed a qualitative analysis approach (Burla et al., 2008).

The research team then individually coded the 26 transcripts based on the participants' responses. Each team member created new codes for the first transcript based on the participant's responses and previous literature. Then, for the following transcripts, new codes were created when deemed necessary. Afterward, the team met to discuss their codes, each member advocating for the codes they felt were best suited. Codes were decided based on unanimous agreement during the group discussion and a majority vote due to time limitations. The resulting

codebook was then used to code the remaining seven transcripts. The minimum number of coders per transcript was three, and this process of individually coding followed by group discussions was repeated until all coding discrepancies were resolved.

5. Findings

In accordance with the finalized codebook, 15 challenges and 13 solutions were identified during the participants' transition from academia to industry. While 26 challenges were identified in total, 15 challenges, each appearing in at least five participants' interviews, were considered suitable for the scope of this paper. Nevertheless, this research uses a qualitative approach, and all codes are viewed as equally significant social phenomena, under the assumption that frequency does not correlate with value. Thus, the latter 11 codes will be introduced in a future paper.

5.1 Challenges

These 15 challenges were divided into four categories: (a) Intrapersonal Challenges, (b) Interpersonal Challenges, (c) Organizational Challenges, and (d) Third-Party Challenges. Intrapersonal challenges include all internal challenges newly-hired engineers face within themselves, such as personality barriers and academic competency. Interpersonal challenges consist of relational obstacles that occur during social interactions. Organizational challenges are all challenges created by the newly-hired engineers' company or organization due to the structure and management of the company. Lastly, third-party challenges include challenges created by an outside force, not including the newcomer's organization.

5.1.1 Intrapersonal Challenges

Frequently, newly-hired engineers are faced with internal conflicts and struggles. These types of challenges have been labeled as intrapersonal challenges. Intrapersonal challenges include feeling isolated due to one's personality, lacking social awareness, and any perceived challenge directed at oneself.

1. **Difficulty Reading Others** (in Task Mastery and Acculturation): Newly-hired engineers struggle to decipher and interpret the feelings and opinions of their coworkers. They experience difficulties in knowing how their coworkers will react and respond when socializing, and they find it hard to know their coworkers' professional and social opinions and thoughts.

2. **Personality Barriers** (in All Domains): Newly-hired engineers feel their personalities or the personalities of others within their workgroup hinder their ability to interact socially and build relationships with others. Social anxiety, pride, and introversion are examples of traits that can cause newly-hired engineers to experience more difficulties when interacting with others and asking questions.

3. **Lack of Engineering Knowledge** (in Role Clarity and Task Mastery): Newly-hired engineers feel unprepared by their college or university and lack the necessary engineering knowledge required to perform their job.

Lack of Conceptual or Fundamental Understanding (in Role Clarity and Task Mastery): Newly-hired engineers feel they lack the basic knowledge of engineering fundamentals, advanced understanding of task concepts, task purposes, and procedures.

Lack of System-Level Understanding (in Role Clarity and Task Mastery): Newly-hired engineers lack the necessary understanding of how various elements or parts combine to operate as a system. They are also unfamiliar with the corresponding standards and regulations they must adhere to, which guide and frame their designs.

4. **Limited Time for Learning** (in Role Clarity and Task Mastery): Newly-hired engineers find they need more time to learn the skills and knowledge taught by their organization to perform their job correctly. They experienced difficulties in sufficiently learning the material due to time restraints.

5.1.2 Interpersonal Challenges

Interpersonal challenges involve all challenges newly-hired engineers face that involve the presence or influence of others. These challenges include lacking social skills and experiencing difficulties while interacting with others.

5. **Age/Experience Gap** (in Workgroup Integration): Newly-hired engineers feel their young age and minimal work experience compared to their coworkers puts them at a disadvantage when forming relationships with their coworkers. Because of the newly-hired engineer's age and lack of experience, coworkers sometimes look down upon the newcomer and ignore their professional input.

6. **Coworker's Divergent Practices/Opinions** (in Role Clarity and Task Mastery): Newly-hired engineers feel their coworkers' work practices are incompatible with their own practices, federal regulations, or standards set by their organization. These differing methods and practices can cause conflict between newly-hired engineers and their coworkers. Sometimes, due to these disagreements and opposing methods, one of the parties will disregard the other party's recommendations and requirements. This subversion can cause delays and subsequent involvement from management, questioning why the job is incomplete, incorrect, or behind schedule.

   Coworker's Outdated Practices (in Task Mastery): Newly-hired engineers perceive their coworkers' practices as outdated and ineffective compared to current practices used by the newcomer, other coworkers, or their organization.

7. **Incompatible Personal Work Practices** (in Task Mastery and Acculturation): Newly-hired engineers find that their pre-existing work practices and habits are not the most effective or beneficial methods in performing their job and must replace those ineffective approaches with improved habits and practices. Newly-hired engineers discover that the learning and working habits they may have utilized during undergraduate and graduate education are not appropriate for the workplace.

8. **Insufficient Communication** (in All Domains): Newly-hired engineers experience difficulties expressing their thoughts, opinions, and questions with coworkers. This lack of communication can also arise from coworkers' conflicting schedules or priorities. If a coworker is working remotely or preoccupied with their own tasks, the newly-hired engineer might not receive the quality or amount of communication necessary to gain a better understanding of their roles or tasks.

9. **Insufficient Social Gatherings** (in Workgroup Integration): Newly-hired engineers feel they do not get together with their coworkers as often as they would like to. Sometimes, their coworkers are traveling to different locations or working from home. Other times, the newly-hired engineer and their workgroup are all working remotely and living in different cities or states. Often, newly-hired engineers and their coworkers are too busy and do not make the necessary effort or time to meet up with one another.

10. **Lack of Collaboration Among Workgroups** (in Acculturation and Workgroup Integration): When working with other workgroups, newly-hired engineers feel separated and disconnected due to the other workgroup's varying priorities and values. One workgroup might value a quick work output, while another group might value the quality of the work done. Because of these diverging focuses, workgroups might dismiss the work of other workgroups or disregard communicating and working with the other workgroups.

11. **Unclear Professional Relationship Boundaries** (in Workgroup Integration): Newly-hired engineers are unsure of the social and work boundaries between themselves and their coworkers. They have trouble knowing when to be more personal and social with their coworkers or focus on their work. Newly-hired engineers want to be friendly and build relationships with their coworkers, but they do not always know how to balance making friends and getting their work done.

5.1.3 Organizational Challenges

Organizational challenges include all challenges the organization presents, deliberately or unintentionally. Some organizational challenges include the organization not providing the proper support for their employees, confusion due to changing organizational infrastructure such as the merging of two companies, and not properly clarifying the boundaries of the newly-hired engineer's position within the organization. These challenges are unavoidable because they are out of the newly-hired engineer's control. Without the support of their organization, newly-hired engineers can only strive to overcome these challenges.

12. **Lack of Organizational Support** (in Role Clarity and Task Mastery): Newly-hired engineers feel the information and learning resources offered by their organization are inadequate in quantity or quality when understanding their roles and skills needed to perform their jobs.

13. **Unclear Role Boundaries** (in Role Clarity and Acculturation): Newly-hired engineers find themselves in situations where they are unsure of the scope of their role. They encounter problems in knowing what their responsibilities are, where their responsibilities end, and

where their coworkers' responsibilities begin. This ambiguity can cause newcomers to feel over-extended and exhausted more quickly.

14. **Unfamiliar Environment** (in Role Clarity, Task Mastery, and Workgroup Integration): Newly-hired engineers enter entirely new working environments. Newcomers struggle to understand certain people's roles or available resources when navigating these new environments.

5.1.4 Third-Party Challenges

Third-party challenges include all challenges created by an organization or force outside the newly-hired engineer's company. Third parties can include government agencies responsible for running background checks, security clearances, and other external companies and organizations. Similar to organizational challenges, these challenges are also out of the newly-hired engineer's control and must be resolved by the third party.

15. **Lack of Clearance** (in Role Clarity and Task Mastery): Newly-hired engineers do not always start their jobs with the proper clearances. Often, they are left waiting for their security clearances to come through. Because of this, newly-hired engineers can be pulled into different roles and responsibilities because they cannot perform the job they were hired for until they receive clearance. Other times, newly-hired engineers need internal organizational clearance to access various computer software. This lack of clearance can confuse the newcomer or delay production time.

5.2 Solutions

Newly-hired engineers take several actions to overcome the challenges they face at their workplace. The 13 identified proactive actions were divided into two categories: (a) Intrapersonal Proactive Actions, and (b) Interpersonal Proactive Actions. Like the challenge categories in section 4.1, intrapersonal proactive actions are all actions newly-hired engineers can take independently of others, such as accessing organizational resources or investing extra time and effort into learning more about their job. Interpersonal proactive actions are all actions that require the assistance, presence, or consideration of the newly-hired engineer's coworkers.

5.2.1 Intrapersonal Solutions

Often, newly-hired engineers experience situations within their workplace that require them to either change themselves or their surroundings without the help of others. Newly-hired engineers can take intrapersonal proactive actions such as creating their own resources, reassuring themselves of their worth, and prioritizing their work.

1. **Adjust to Changes** (in Task Mastery, Acculturation, and Workgroup Integration): Newly-hired engineers must be comfortable with change and adapt to unfamiliar, uncomfortable, and inconvenient situations. They must be open-minded, flexible, and willing to adjust their working practices to perform their job.

2. **Create Resources** (in Role Clarity, Task Mastery, and Workgroup Integration): Newly-hired engineers create resources when they find current resources lacking. Sometimes, the resources they need do not exist. Other times, resources are deficient in quality, so the newly-

hired engineer feels the need to improve the provided resource. These resources are meant to either help themselves or future employees. After creating such resources, the newly-hired engineer continually refers to the created resource as a guide or aid in performing their job. They either provide the resource to the organization, to benefit future and existing members, or personally loan the resource out.

Create Organizational Resources (in Role Clarity and Task Mastery): Newly-hired engineers create new resources and update pre-existing organizational resources when they find the resources provided by the organization inadequate for learning their roles, necessary knowledge, and job skills. Sometimes organizational documentation is missing or hard to access, so, for example, the newly-hired engineer will create a list of instructions for a certain set of processes and either update the pre-existing document or share their work with their coworkers.

3. **Have Good Work Ethic** (in Acculturation and Workgroup Integration): Newly-hired engineers aim to act professionally and respect their coworkers, work hard, complete high-quality work, and finish their tasks on time.

4. **Have Self Assurance** (in Task Mastery, Acculturation, and Workgroup Integration): Newly-hired engineers remind themselves of their intrinsic value and worth. Newly-hired engineers take comfort in remembering that their opinions are valuable, they belong at their position in their workgroup, and that it is okay to ask questions and make mistakes. They often compare themselves with their coworkers to help bolster their self-esteem.

5. **Prioritize Important Tasks** (in Role Clarity): Newly-hired engineers manage their work by prioritizing their tasks according to the task's deadline or importance. This helps them gain a better sense of their role by focusing on their main tasks before accepting additional work from others.

6. **Shadow/Observe Coworkers** (in All Domains): Newly-hired engineers shadow their coworkers and observe their work behaviors, interpersonal relationships, and the various interactions amongst their coworkers. These observations help newly-hired engineers better understand their workplace environment and the role they play within their organization.

7. **Spend Extra Time/Effort** (in Role Clarity and Task Mastery): Newly-hired engineers are proactive about learning and put in extra time and effort after work to acquire new skills and knowledge.

8. **Undertake Practical Tasks** (in All Domains): Newly-hired engineers participate in challenging work or projects to gain experience or knowledge. These practical tasks include any work given to them by their organization in which the newly-hired engineer actively learns from the completion of the work or task.

9. **Utilize Resources** (in Role Clarity, Task Mastery, and Workgroup Integration): Newly-hired engineers use various technical and non-technical pre-prepared resources to gain a better understanding of their role and how to perform the tasks within their job. These resources can

include textbooks, manuals, tutorials, documents, guidebooks, Google, YouTube, and Wikipedia.

Utilize Organizational Resources (in Role Clarity and Task Mastery): One of the types of resources that newly-hired engineers use are those provided by their organization. These resources can include organizational documentation, manuals, and staff directories.

Self-Study (in Task Mastery): Newly-hired engineers utilize available resources to independently study various topics and skills that help provide a clearer picture of their roles and the required skills and knowledge they need to learn to perform their job. Self-study arises from the utilization of these resources and is perceived as an effect of having access to and using organizational and non-organizational resources.

5.2.2 Interpersonal Solutions

An important aspect of engineering is working in a team. Newly-hired engineers often engage with their coworkers to build relationships and gain knowledge concerning their work and company culture. Interpersonal proactive actions include all steps taken by newly-hired engineers that require the help and presence of their coworkers.

10. **Consider Coworkers' Personal Attributes** (in Acculturation and Workgroup Integration): Newly-hired engineers consciously consider their coworkers' habits, feelings, and personalities. They pay attention to the relationship between themselves and their coworkers and interact with their coworkers accordingly.

    Adjust Social Behaviors (in Workgroup Integration): Newly-hired engineers pay attention to their coworkers' behaviors and adapt their behavior accordingly. They consider their relationship with their coworkers and change their actions to be more assertive and effective when interacting with them.

11. **Interact With Coworkers** (in All Domains): Newly-hired engineers communicate with their coworkers and managers. They ask questions, engage in conversation and discussion, and directly involve themselves with their coworkers. These interactions help newly-hired engineers gain more knowledge about their roles, tasks, company culture, and help them build relationships with their coworkers.

12. **Interact With External Professionals** (in Role Clarity): Newly-hired engineers communicate and interact with people outside their organization to better understand their roles and responsibilities.

13. **Attend Meetings** (in All Domains): Newly-hired engineers attend meetings hosted by their workgroup or organization. During these meetings, the newly-hired engineer is an active participant. Sometimes, the newly hired engineer organizes these meetings to solve issues within their workgroup.

5.3 Links Between the Challenges and the Solutions

Newly-hired engineers participating in this study were asked how they overcame their particular challenges regarding Morrison's four domains of organizational socialization. The research team analyzed each response to determine which solution actions mentioned directly impacted the challenges faced by the participant. The analysis included a preliminary identification of which actions were mentioned in response to certain challenges. Then, a series of discussions were held in which the research team determined whether a specific solution action fully or partially solved a particular challenge. In some cases, multiple actions were identified as solving a particular challenge when combined. A clear connection between one challenge and one solution action was identified in other cases.

The following group of figures depicts the corresponding solution actions for each challenge identified within the four domains of socialization. Some participants did not include solution actions for certain challenges they faced, so challenges that do not have clear connections to solution actions will be excluded from this list.

Figure 1: Links Between Challenges and Solution Actions Within Role Clarity

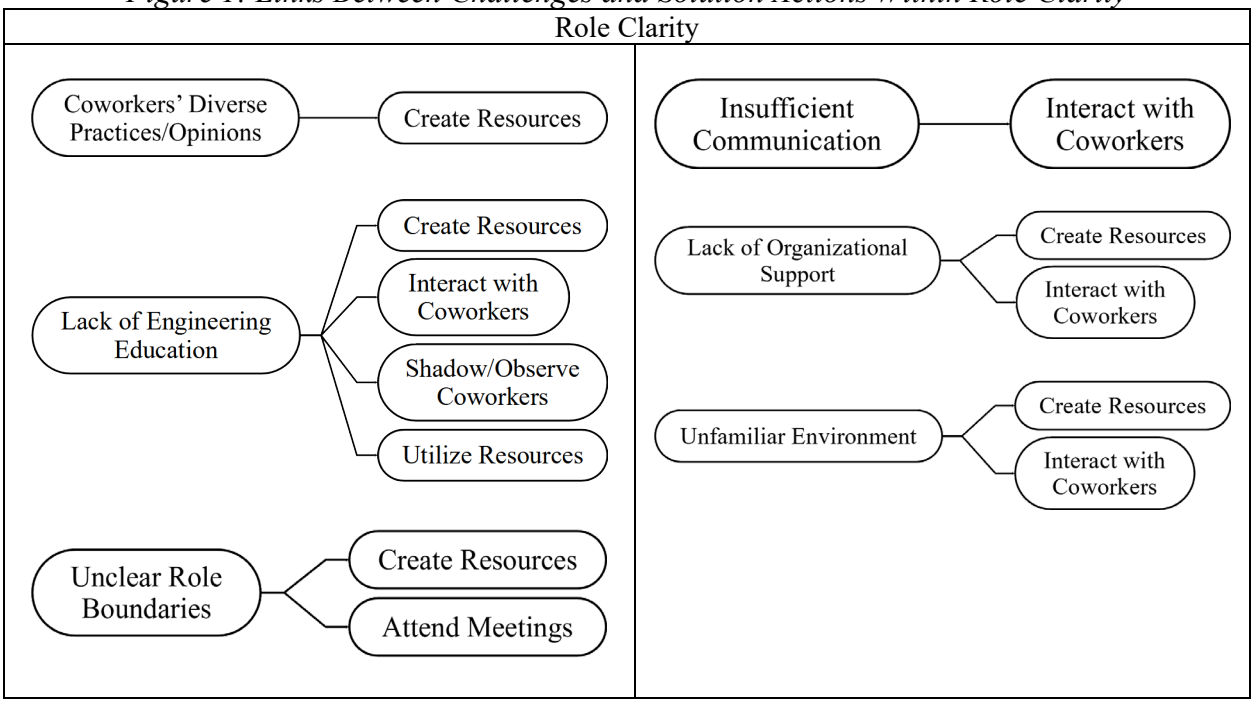


Figure 2: Links Between Challenges and Solution Actions Within Task Mastery

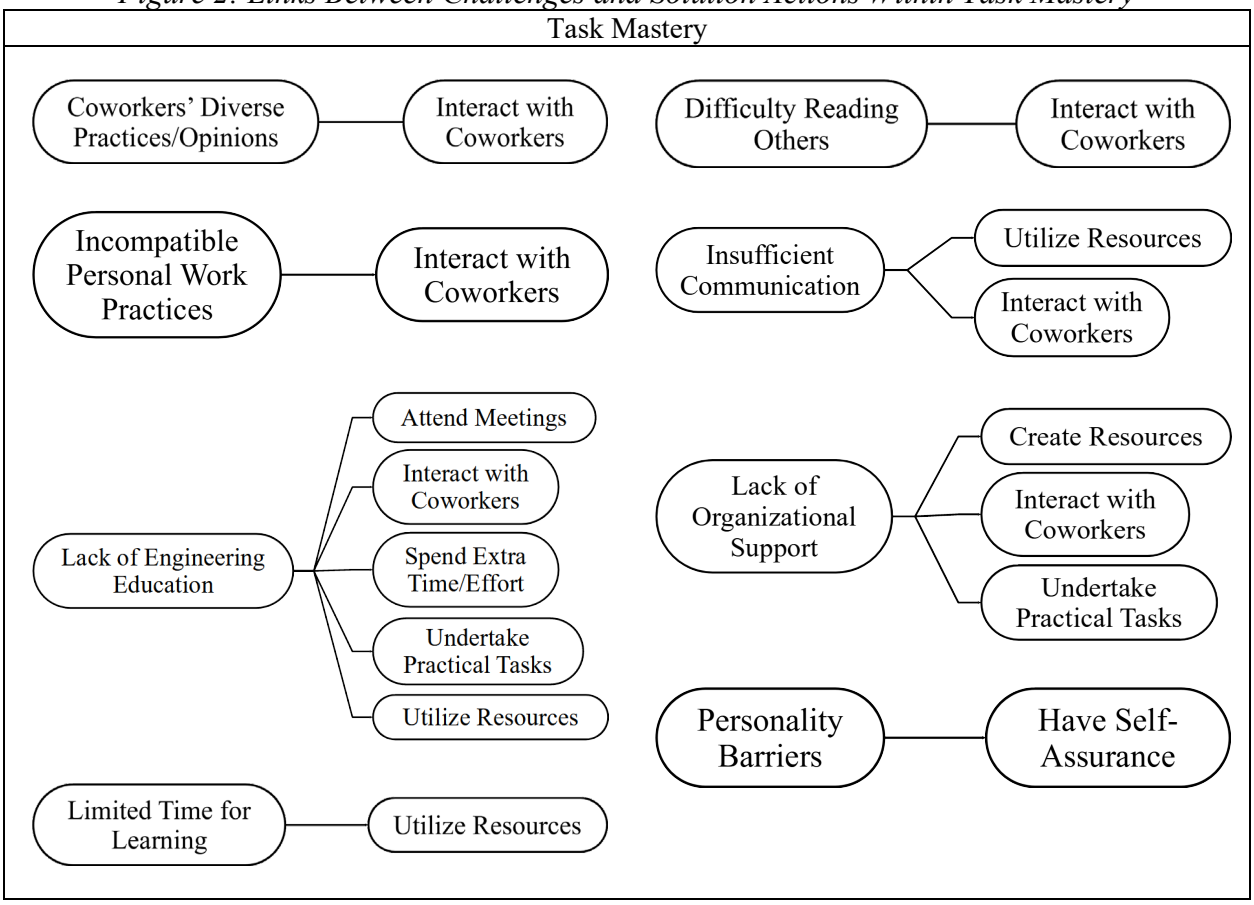


Figure 3: Links Between Challenges and Solution Actions Within Acculturation

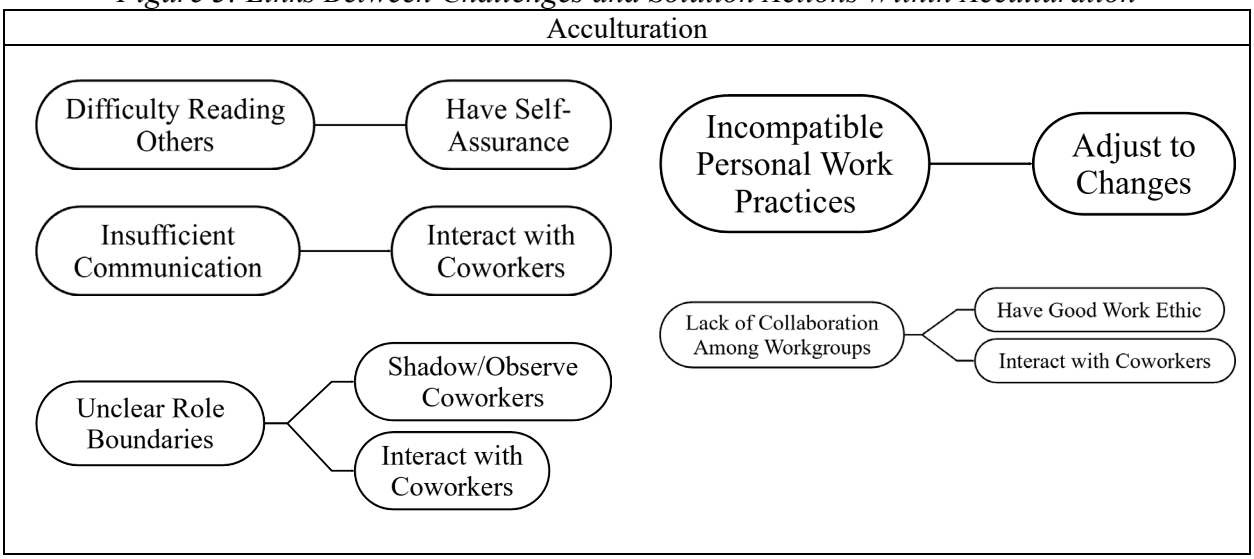
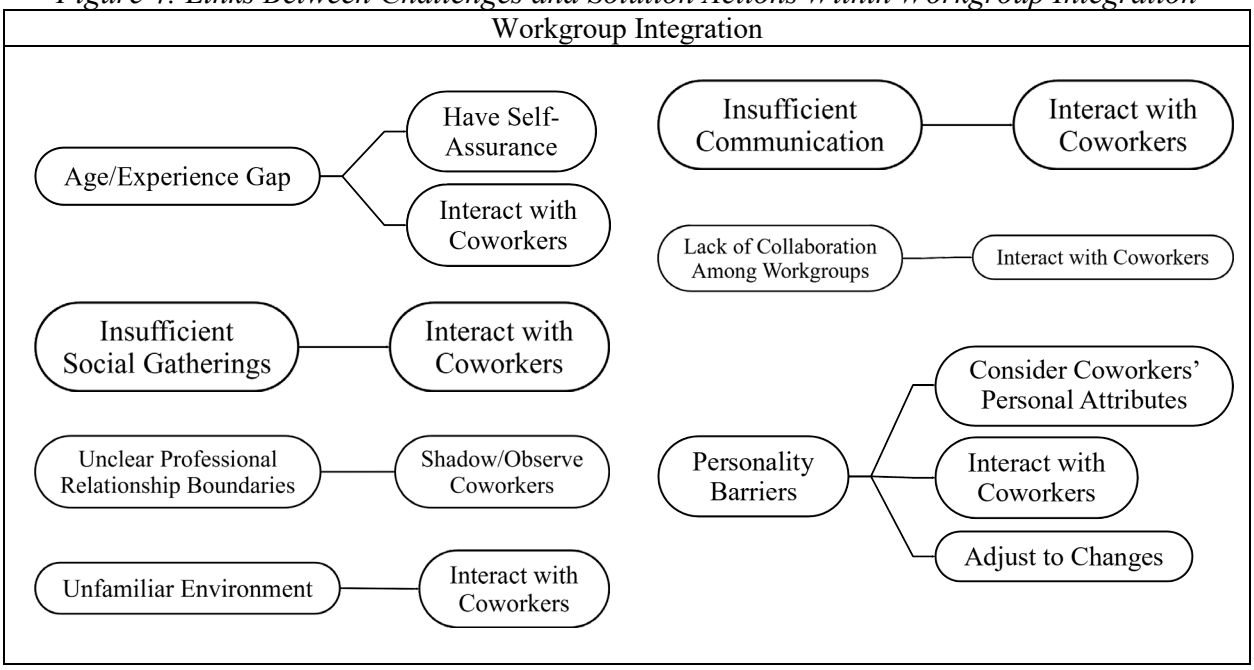


Figure 4: Links Between Challenges and Solution Actions Within Workgroup Integration



5.4 Improving Undergraduate Engineering Programs

Newly-hired engineers participating in this study were asked what they thought could be changed within their undergraduate program to better prepare them for entry into the industry. Seven different areas of improvement were identified: (a) Practical Training, (b) Pre-Professional Exposure, (c) Humble Attitude, (d) Professional Skills Training, (e) Curriculum and Class Organization, (f) Alumni Network, and (g) Collaboration Across Departments/Groups.

1. **Practical Training**: Newly-hired engineers felt there should be a greater focus on theoretical application, problem-solving, and practical use of theory, procedures, and instrumentation.

    Adaptability Training: Newly-hired engineers felt that undergraduate educators should teach students to adapt to different approaches to problem-solving and completing tasks.

    System-Level Training: Newly-hired engineers wished they had learned about individual engineering components and how they integrate into complex systems.

    Software Training: Newly-hired engineers felt undergraduate programs could include more training on using or creating specific software and programs.

    Hardware Training: Newly-hired engineers thought undergraduate programs could include more training on using specific hardware and physical items such as circuits or electronic instruments.

    Trade Training: Newly-hired engineers felt undergraduate programs could include more training on manual skills for specific jobs, such as electrical trade, plumbing trade, and HVAC trade.

2. **Pre-Professional Exposure**: Newly-hired engineers felt undergraduate programs should offer students more exposure to the concept of professional working environments in industry or specific organizations. Undergraduate programs can offer presentations, workshops, and projects that mimic professional tasks and settings. Schools should expose students to an industry-like environment and introduce them to industrial procedures.

    Industry-Driven Projects: Newly-hired engineers felt undergraduate programs should require more in-class projects that directly interact with industry and give students insight into the professional world.

3. **Humble Attitude**: Newly-hired engineers thought undergraduate engineering programs should communicate with students that they are new to their jobs and have many things to learn.

4. **Professional Skills Training**: Newly-hired engineers felt undergraduate engineering programs should teach students non-technical soft skills to interact more effectively, thus contributing to their overall professional development.

    Technical Writing: Newly-hired engineers thought undergraduate programs should improve students' technical writing skills by writing documentation, reports, and other technical documents.

    Communication Training: Newly-hired engineers felt undergraduate engineering programs should offer more training on interacting and verbally communicating within a professional setting.

5. **Curriculum and Class Organization**: Newly-hired engineers felt undergraduate classes could be better organized, more accessible, and better taught. They also thought the curriculum could be structured to better fit classes to their knowledge, ability, and schedule.

6. **Alumni Network**: Newly-hired engineers thought that a strong college-specific alumni network would be a good resource for students to connect to professionals.

7. **Collaboration Across Departments/Groups**: Newly-hired engineers felt that more cross-collaboration among departments or groups within departments could provide students an opportunity to interact with people from diverse academic backgrounds. This cross-collaboration could express itself through classes and projects where students from different technical backgrounds must work together to complete tasks.

5.5 Summary of the Results

Newly-hired engineers face many challenges with themselves, their coworkers, and their organizations. They experience difficulties expressing themselves, adjusting to their new work environment, and working well with others. Newly-hired engineers also face obstacles concerning their organization. They lack an understanding of the scope and breadth of their role within their company, the necessary resources provided by their organization, and are generally

unfamiliar with the people and resources available to them. They further feel educationally unprepared for the skills and knowledge they need to exhibit daily at their job.

While newly-hired engineers face many obstacles, they take specific actions to help them overcome these challenges and succeed in their positions. They maintain a positive outlook on their jobs by prioritizing their tasks, reassuring themselves of their worth, and adjusting to their roles and company changes. Newly-hired engineers actively learn on the job by using and studying available resources, repeating tasks, and completing challenging work and projects. They also seek the guidance, advice, and opinions of others, observe their surroundings, and interact with professionals outside their organization to better understand their roles, skills, and the knowledge they need to perform their job.

To minimize the challenges newly-hired engineers face when transitioning from academia to industry, undergraduate programs can improve their curriculum to include more exposure to various problem-solving methods, industry-like environments, and help students develop soft skills such as public speaking and technical writing. Universities can also provide students with more opportunities to network, work with students of other technical backgrounds, and improve the structure and curriculum of their classes. Lastly, undergraduate programs can help instill a humble attitude in their students, so they will be better prepared to adapt to and learn new things once in the industry.

6. Discussion

This study's findings identified the challenges newly-hired engineers in the A&D industry face and the specific actions they take to overcome these challenges. While similar studies have been conducted in the general sphere of engineering, this research investigates the specific social complexities of aerospace engineering.

6.1 Challenges

Previous literature identifies several challenges engineers face during socialization, including working under pressure, taking responsibility, working alone, responsibility for results, working with people from a different background, fear of failure, dealing with superiors, not knowing enough, and learning on one's own (Baytiyeh & Naja, 2012). Building off of these challenges and the challenges mentioned previously in section 3.1, this study agrees with and reflects the challenges of social anxiety and personality (Personality Barriers), role ambiguity (Unclear Role Boundaries), and relational conflict (Unclear Professional Relationship Boundaries), while adding unique perspectives including lack of organizational support, lack of collaboration among workgroups, lack of clearance, unclear professional relationship boundaries, and insufficient social gatherings. It is important to note that many of these identified challenges are out of the new engineer's control. While many previous studies focus on the internal conflicts new engineers face, this study's findings offer a more diverse view and take into account the actions of the organization as well as the individual. This study offers a rigorous and fundamental approach to identifying these challenges while highlighting additional new challenges engineers face during the socialization process.

The challenge categories of Coworker's Divergent Practices/Opinions, Incompatible Personal Work Practices, Age/Experience Gap, and Personality Barriers help capture a complete picture of the previously-identified challenge of working with people from a different background. They help separate and simplify what may constitute a "different background" and provide deeper insight into why these incompatibilities occur. Similarly, the challenge categories of Lack of Engineering Knowledge and Limited Time for Learning explain why newly-hired engineers feel they do not know enough, and the categories of Insufficient Communication and Difficulties Reading Others address challenges with superiors and coworkers. These previously-identified challenges reinforce the relevancy of this study and its alignment with previous research. While previous studies mainly focus on personal and social challenges, this study highlights six new challenges attributed to newly-hired engineers' organizations.

6.2 Solution Actions

This study provides 13 solution actions newly-hired engineers use to overcome the difficulties they face during the socialization process. For example, the solution action categories of Adjusting to Changes, Having Self-Assurance, Having a Good Work Ethic, and Prioritizing Important Tasks are ways that newly-hired engineers pursue self-improvement at their jobs (i.e., Positive Framing from Cooper-Thomas et al., 2012). The strategies of Shadowing and Observing Coworkers and Considering Coworkers' Personal Attributes help newcomers learn through observation and gain a better sense of a particular position or work environment from a more experienced coworker (i.e., Observing from Cooper-Thomas et al., 2012). Newly-hired engineers interact and socialize with their coworkers and external professionals to build relationships, seek information, ask for help, and network at work. The category of Undertaking Practical Tasks allows the newly-hired engineer to learn by doing their job, that is, to learn from their successes and failures while completing assigned tasks and responsibilities (i.e., Experimenting from Cooper-Thomas et al., 2012). Lastly, newly-hired engineers utilize resources as another method for seeking information (i.e., Reading from Cooper-Thomas et al., 2012). This study's findings reflect and support previously-identified proactive actions and highlight methods newly-hired engineers employ when overcoming the aforementioned challenges.

6.3 Implications

This study offers valuable insight into the areas of engineering education and the A&D industry. This research can benefit engineering education educators, undergraduate engineering students planning on working in the A&D sector, and A&D organizations and management.

6.3.1 Implications for Engineering Education

For educators, this study identifies the challenges newly-hired engineers experience during their transition from undergraduate studies into the workplace. The identification of these challenges can aid educators in framing their curricula and classes. Educators can stress the importance of understanding fundamental engineering theory in the workplace to help motivate students to take courses more seriously. Classes can include brief introductions to federal regulations and various organizational standards within their subject matter and emphasize how different mechanical and electrical parts and features work together to form a system. Educators can offer tips during class on effective ways to learn and understand the material being taught. Classes can institute more group projects with individual grades. This approach will give students more experience in communicating with others, working effectively with others, and adjusting their work strategies

and practices accordingly. While this enhances students' social skills, it can also encourage students to prioritize their tasks, utilize their resources, build their network, ask questions, and learn from their work. It will also teach them the importance of fulfilling their responsibilities by grading each student individually, based on their complete work.

For students, this study offers an example of the various challenges present in the workplace. It can help prepare students for the obstacles that lie ahead of them and provide options and actions they can take to overcome these challenges. For example, students can focus more intently on their studies during their undergraduate years to feel less unprepared for engineering knowledge when entering the industry. They can ask more questions during classes and office hours and build relationships with their faculty mentors and professors. This practice will help prepare their communication skills for future jobs and build their network.

6.3.2 Implications for Engineering Industries and Organizations

For engineering organizations, this study identifies key areas in which organizations can improve to assist newly-hired engineers during their onboarding process. Organizations can improve staff directories, documentation on specific job roles and responsibilities, and informative organizational resources to aid newcomers in finding people and resources to help them best perform their job. They can encourage managers to engage in a more "hands-on" approach when onboarding newly-hired engineers. Engineering managers can urge newly-hired engineers to ask questions and take various classes offered by the organization to benefit their newcomers. While managers should not coddle newly-hired engineers, they can offer themselves and others as resources should newcomers need advice or help.

6.4 Limitations and Future Studies

In this study, we did not use quantitative research methods nor examine the frequency of the identified challenges and solution actions to determine how prevalent or effective these challenges and actions are. This approach is due to the qualitative nature of this study and its purpose to explore and identify these challenges and actions. Future studies can work to continue this research and investigate the relationships between certain challenges and actions, the general effectiveness of the actions, and the challenges and actions relevant to other socialization outcomes.

Further studies could also include a greater number of participants with a wider variety of demographics, which would allow future research to focus on how people of different genders, races, and specific demographics face particular challenges compared to other demographics.

7. Conclusion

This study identified 15 challenges newly-hired engineers face and 13 proactive actions they take to overcome these challenges. The challenges were classified into four categories: Intrapersonal, Interpersonal, Organizational, and Third-Party. The study results contribute to current research and literature by corresponding to previously-identified challenges and solution actions and increasing the number of known challenges newly-hired engineers face during the socialization period within A&D organizations. The findings from this study can benefit engineering

education researchers, collegiate engineering educators, undergraduate engineering students planning on working in the A&D industry, and A&D organizations and management.

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9. References

[1] Katz, R. (1985). Organizational stress and early socialization experiences. In T. A. Beehr & R. S. Bhagat (Eds.), Human stress and cognition in organizations (pp. 117–139). New York: Wiley

[2] Frögéli, E., Rudman, A., & Gustavsson, P. (2019). The relationship between task mastery, roleclarity, social acceptance, and stress: An intensive longitudinal study with a sample of newly registered nurses. International journal of nursing studies, 91, 60-69.

[3] Raub, S., Borzillo, S., Perretten, G., & Schmitt, A. (2021). New employee orientation, role- related stressors and conflict at work: Consequences for work attitudes and performance of hospitality employees. International journal of hospitality management, 94, 102857.

[4] Schlenker, B. R., & Leary, M. R. (1982). Social anxiety and self-presentation: A conceptualization model. Psychological bulletin, 92(3), 641.

[5] Nifadkar, S. S., & Bauer, T. N. (2016). Breach of belongingness: Newcomer relationship conflict, information, and task-related outcomes during organizational socialization. *Journal of Applied Psychology*, *101*(1), 1.

[6] Jokisaari, M., & Nurmi, J. (2009). Change in newcomers' supervisor support and socializationoutcomes after organizational entry. *Academy of Management Journal*, *52,527–544*.

[7] Kammeyer-Mueller, J., Wanberg, C., Rubenstein, A., & Song, Z. (2013). Support, undermining, and newcomer socialization: Fitting in during the first 90 days. *Academy of Management Journal, 56,1104–1124*.

[8] Nifadkar, S. S., Tsui, A. S., & Ashforth, B. E. (2012). The way you make me feel and behave:Supervisor-triggered newcomer affect and approach–avoidance behavior. *Academy of Management Journal, 55,1146–1168*.

[9] Van Sell, M., Brief, A. P., & Schuler, R. S. (1981). Role conflict and role ambiguity: Integrationof the literature and directions for future research. *Human relations*, *34*(1), 43-71.

[10] Onyemah, V. (2008). Role Ambiguity, Role Conflict, and Performance: Empirical Evidence of an Inverted-U Relationship. *Journal of Personal Selling & Sales Management, 28*(3), 299-313.

[11] Jackson, S. E., & Schuler, R. S. (1985). A meta-analysis and conceptual critique of research on role ambiguity and role conflict in work settings. *Organizational behavior and human decisionprocesses, 36*(1), 16-78.

[12] Major, D. A., Kozlowski, S. W., Chao, G. T., & Gardner, P. D. (1995). A longitudinal

investigation of newcomer expectations, early socialization outcomes, and the moderating effects of role development factors. *Journal of applied psychology, 80*(3), 418.
[13] Tubre, T. C., & Collins, J. M. (2000). Jackson and Schuler (1985) revisited: A meta-analysisof the relationships between role ambiguity, role conflict, and job performance. *Journal of management, 26*(1), 155-169.
[14] Kowtha, N. R. (2011). School-to-work transition and newcomer socialisation: The role of job-related education. *Journal of Management & Organization, 17*(6), 747-763.
[15] Morrison, E. W. (1993). Longitudinal study of the effects of information seeking on newcomer socialization. Journal of applied psychology, 78(2), 173.
[16] Ashford, S. J., & Black, J. S. (1996). Proactivity during organizational entry: The role of desire for control. Journal of Applied psychology, 81(2), 199.
[17] Cooper-Thomas, H., Anderson, N., & Cash, M. (2012). Investigating organizational socialization: A fresh look at newcomer adjustment strategies. Personnel review.
[18] Kowsikka, F. M. J. J., & James, R. (2019). Newcomers' socialization: the proactive behaviors, satisfaction and social integration. *Journal of Business Studies, 6*(1).
[19] Candy, P. C., & Crebert, R. G. (1991). Ivory tower to concrete jungle: The difficult transitionfrom the academy to the workplace as learning environments. *The Journal of Higher Education, 62*(5), 570-592.
[20] Murphy, K. A., Blustein, D. L., Bohlig, A. J., & Platt, M. G. (2010). The college-to-career transition: An exploration of emerging adulthood. *Journal of Counseling & Development, 88*(2), 174-181.
[21] Arnold, W. W. (2018). Strengthening college support services to improve student transitioning to careers. *Journal of College Teaching & Learning (TLC), 15*(1), 5-26.
[22] Kleckner, M. J., & Butz, N. (2020). Addressing undergraduate skill gaps in higher education:Revisiting communication in the major course outcomes. *Journal of Education for Business*, 1-12.
[23] Stiwne, E. E., & Jungert, T. (2010). Engineering students' experiences of transition from study to work. *Journal of education and work, 23*(5), 417-437.
[24] Baytiyeh, H., & Naja, M. (2012). Identifying the challenging factors in the transition from colleges of engineering to employment. *European Journal of Engineering Education, 37*(1), 3-14.
[25] Hawse S. (2017) Transitioning to Professional Work: A View from the Field. In: Wood L., Breyer Y. (eds) Success in Higher Education. Springer, Singapore.
[26] Jampala, A. K., & Madani, V. (2020, December). Making Graduating Engineers Industry Ready. In 2020 21st National Power Systems Conference (NPSC) (pp. 1-6). IEEE.
[27] Winberg, C., Bramhall, M., Greenfield, D., Johnson, P., Rowlett, P., Lewis, O., ... & Wolff, K. (2020). Developing employability in engineering education: a systematic review of the literature. *European Journal of Engineering Education, 45*(2), 165-180.
[28] Wingerter, J. J. (2019). An empirical overview of newcomer engineer socialization in the USaerospace and defense industry (Doctoral dissertation, Iowa State University).
[29] Wingerter, J. J., & Ahn, B. (2020). A snapshot of the socialization process: Socialization tactics, behaviors, and outcomes in the US Aerospace and defense industry. *IJEE International Journal of Engineering Education, 36*(3).
[30] Dong, Y., Ahn, B., & Tobey, U. J. (2021). Exploring Engineering Managers' Perspectives onthe Actions of Engineering Managers and Newly Hired Engineers During the New Engineers' Socialization Period. *Engineering Management Journal*, 1-14.

[31] Burla, L., Knierim, B., Barth, J., Liewald, K., Duetz, M., & Abel, T. (2008). From text to codings: intercoder reliability assessment in qualitative content analysis. Nursing research, 57(2), 113-117.
[32] Morrison, E. W., & Phelps, C. C. (1999). Taking charge at work: Extrarole efforts to initiateworkplace change. *Academy of management Journal, 42*(4), 403-419.
[33] Bauer, T. N., & Green, S. G. (1998). Testing the combined effects of newcomer informationseeking and manager behavior on socialization. *Journal of Applied Psychology, 83*(1), 72–83.
[34] Taormina, R. (1997), Organizational Socialization: a Multidomain, Continuous Process Model. *International Journal of Selection and Assessment*, 5: 29-47.
[35] Chao, G. T., O'Leary-Kelly, A. M., Wolf, S., Klein, H. J., & Gardner, P. D. (1994). Organizational socialization: Its content and consequences. *Journal of Applied Psychology, 79*(5),730–743.
[36] Foor, C. E., Walden, S. E., & Trytten, D. A. (2007). "I wish that I belonged more in this wholeengineering group:" Achieving individual diversity. *Journal of Engineering Education, 96*(2), 103-115.
[37] Korte, R. F. (2009). How newcomers learn the social norms of an organization: A case studyof the socialization of newly hired engineers. *Human Resource Development Quarterly, 20*(3), 285-306.
[38] Ashforth, B. E., Sluss, D. M., & Saks, A. M. (2007). Socialization tactics, proactive behavior,and newcomer learning: Integrating socialization models. *Journal of vocational behavior, 70*(3), 447-462.