

Twelve Tales of Engineering in the “Real World:” Narratives of Newcomers’ Agency in Transitions to Engineering Work

Christopher Gewirtz

Dissertation submitted to the faculty of the Virginia Polytechnic Institute and State University in partial fulfillment of the requirements for the degree of

Doctor of Philosophy
In
Engineering Education

Marie C. Paretti
Jennifer M. Case
Lee Vinsel
Elizabeth D. McNair

July 23rd, 2021

Keywords: Identity Development, Engineering Practice, Critical Pedagogy, Workplace Transitions



This work is licensed under a [Creative Commons Attribution-NonCommercial 4.0 International License](https://creativecommons.org/licenses/by-nc/4.0/).

Twelve Tales of Engineering in the “Real World:” Narratives of Newcomers’ Agency in Transitions to Engineering Work

Christopher Gewirtz

Abstract

Reports that call for change in engineering education date back to the Mann report (1918), but more recent reports like “The Engineer of 2020” (NAE, 2004), and “Lean Engineering Education,” (Flumerfelt et al., 2015) describe the need for engineers who are creative leaders, who have sustainability and ethics skills. Two narrative threads emerge from these reports: that engineering education does not adequately prepare engineers with the skills needed for industry, and that preparation for industry is imperative in order to address problems in society. However, these threads conflict with research from engineering education, science and technology studies, and higher education. There may not be a gap between school and work (Modestino, Shoag & Balance, 2016), and if there is one, it might be a socio-cultural gap that is unreasonable for universities to accept the full responsibility of narrowing. More problematic is that establishing “preparation-for-work” as the purpose for education threatens the goal of preparing students for life outside of work and does not necessarily prepare them to act towards benefit for society.

The goal of this study was to critique these narratives using narratives of newcomer engineers’ lived experiences. I had two research questions: 1) *Who are new engineers asked to be at work?* 2) *Who do new engineers choose to be in response?* I answered these by constructing and analyzing narratives of 12 newcomer engineers, based on interviews collected as part of the Capstone to Work study (Paretti et al., 2021). Using the figured worlds framework of identity development (Holland et al., 1998), I investigated the structures of work, which constrained who newcomers could become, and newcomers’ agency, which they used to improvise identities within those constraints.

The structures of engineering work that I examined required newcomers to acclimate to ongoing practices at their companies, which did not conform to newcomers’ expectations of creative engineering work. Newcomers were objectified: their value and identity was often defined in terms of how much money they made for their company. They were alienated: their engineering problems were rarely defined in terms of their societal impact. They faced sexism: they were denied respectable identities based on gender. In response, some newcomers sought the identity of “asset” for their companies. Other newcomers sought new jobs that would give them opportunities for creativity, growth or societal benefit. And some newcomers worked to create opportunities at their jobs to be who they wanted: leaders, engineers working for environmental benefit, whole persons outside and inside of work.

The results of this study suggest limitations of preparation narratives: They do not account for objectification, alienation, and sexism that newcomers face. Engineers also may unfortunately be prepared with stereotypes that do not match the realities of engineering work. This study suggests that we need to educate engineers in a way that recognizes them as human and prepares them for these realities. It also shows us that socio-technical change requires change at the structural level and cannot be limited to changes in education.

Twelve Tales of Engineering in the “Real World:” Narratives of Newcomers’ Agency in Transitions to Engineering Work

Christopher Gewirtz

General Audience Abstract

Reports like “The Engineer of 2020”, and “Lean Engineering Education,” describe the need for engineers who are creative leaders, and who have sustainability and ethics skills. Engineering education researchers and practitioners use these preparation narratives to justify their funding to grant-awarding institutions, to develop research agendas, and to align their education efforts with these national calls.

Two threads emerge from typical preparation narratives: that engineering education does not adequately prepare engineers with the skills needed for industry, and that preparation for industry is necessary for engineering to address societal problems. These, however, conflict with research from engineering education, science and technology studies, and higher education. If there is a gap between school and work, it might be a socio-cultural gap that is unreasonable for universities to accept the full responsibility of narrowing. More problematic is that establishing “preparation-for-work” as the primary purpose of education threatens the goal of preparing students for life outside of work and does not necessarily prepare them to act towards benefit for society.

This study critiques these narratives by referring to newcomer engineers’ lived experiences and identity development. I had two research questions: 1) Who are new engineers asked to be at work? 2) Who do new engineers choose to be in response? I answered these by constructing and analyzing narratives of 12 newcomer engineers, based on interviews collected as part of the Capstone to Work study. Using the figured worlds framework of identity development, I investigated the structures of work, which constrained who newcomers could become, and newcomers’ agency in becoming different kinds of engineers within those constraints.

Newcomers were generally required to acclimate to ongoing practices at their companies, which did not conform to their expectations of creative engineering work. Newcomers were objectified: their value and identity was often defined in terms of how much money they made for their company. They were alienated: their engineering problems were rarely defined in terms of their societal impact. They faced sexism: they were denied respectable identities based on gender. In response, some newcomers sought the identity of “asset” for their companies. Other newcomers sought new jobs that would give them opportunities for creativity, growth or societal benefit. And some newcomers worked to create opportunities at their jobs to be who they wanted.

The results of this study suggest limitations of preparation narratives: they do not account for objectification, alienation, and sexism that newcomers face. Engineers also may unfortunately be prepared with stereotypes that do not match the realities of engineering work. Engineers should be educated in a way that recognizes them as human and prepares them for the realities of work. The study also confirms that efforts for socio-technical change cannot be limited to educational changes, because of structural constraints.

Dedication

To Brian.

Acknowledgements

To my advisor and committee chair, Dr. Marie Paretti: Thank you for your patience. You are the reason this dissertation is at all understandable. Beyond that, many of my opportunities for my own identity improvisations have depended specifically on your patient support, and our sensemaking together.

To the other members of my committee, Drs. Jenni Case, Lee Vinsel, and Lisa McNair: Thank you for taking these ideas seriously, for collectively giving me the freedom to follow these ideas to some of their ends, and ultimately for not taking education at face value.

To my family, my titi and aunties, my cousins: Thank you for hanging in there, for lamenting but not resenting my absence, for saving a space for me. I will come back to it.

To Ramon, Laura, Abram, Sarah and Hani: Thank you for being critical sounding boards and inspirations. Our frustrations with the status quo of engineering education never needed preamble.

To my other friends Alan, Chris, Manda, Sam, Victoria: Like my family, thank you for being there, as touchstones for my sanity. And thank you for trusting our friendship with the distance this and other projects have thrown our ways.

To my pets (there are 7 now): Not that you can read this but thank you for being wild and unconcerned with human affairs. Thank you for helping me maintain that all important capability of relationship with other species.

To my cohort and my other graduate school colleagues: Thank you for an explosive entrance into the world of graduate school, and for your dedication to seeking knowledge. Since the beginning I have been inspired, and I will remain inspired by your curiosity and tenacity.

To the participants of this study: Thank you for inviting me into your worlds and for your honesty. Of course, these accounts would not exist without you all.

To my partner, Tatiana: Thank you for sticking by me through mean vegetable syndrome, for helping me remember what I do this for, for embodying justice and love - keeping these things close to me when they would have otherwise gone. Without you I would be very lost.

TABLE OF CONTENTS

CHAPTER 1: INTRODUCTION	1
1.1. Introduction	1
1.2. Research Questions and Project Scope	5
1.3. Significance of the Study	8
1.4. Limitations.....	13
1.5. Summary	14
CHAPTER 2: LITERATURE REVIEW	15
2.1. Introduction	15
2.2. A Gap Between School and Work	16
2.3. The Automatic Beneficence of Engineering Work.....	24
2.4. Agency and Engineering Identity	27
2.5. Summary	36
CHAPTER 3: METHODS.....	38
3.1. Introduction	38
3.2. Positionality Statement.....	39
3.3. Data Collection (Making the Data).....	43
3.4. Data Analysis (Handling the Data)	59
3.5. Summary of Quality Measures.....	70
3.6. Limitations.....	71
CHAPTER 4: NARRATIVE SUMMARIES	75
4.1. Participant A.....	75
4.2. Participant B.....	77
4.3. Participant C.....	79
4.4. Participant D.....	81
4.5. Participant E	83
4.6. Participant F	85
4.7. Participant G.....	88
4.8. Participant H.....	90
4.9. Participant J.....	92
4.10. Participant K.....	94
4.11. Participant L	98
4.12. Participant M.....	101
CHAPTER 5: CROSS-NARRATIVE ANALYSIS.....	104
5.1. Structure and Agency in Figured Worlds in Participants' Narratives	104
5.2. Patterns by Demographic Variables.....	121
5.3. Emergent Themes	126
CHAPTER 6: DISCUSSION.....	145
6.1. Who Are Engineers Asked to be by Work?	145
6.2. Who Do Engineers Choose to be in Response?	150
6.3. Explanatory Critiques	154
CHAPTER 7: CONCLUSIONS	164
7.1. Challenges to Narratives	164
7.2. Realistic Opportunities for Change	170
7.3. An Alternative Preparation Narrative	177

7.4. Future Work	179
APPENDICES	184
Appendix A – Interview Protocol	184
Appendix B – Codebook	189
Appendix C – Full Narratives	191
REFERENCES	353

CHAPTER 1: INTRODUCTION

1.1. Introduction

Engineering education is often guided by the persistent traditional narrative describing a gap between school and work that must be filled through educational reform to ensure that engineers to meet the needs of society. Reports such as the National Academy of Engineering's "The Engineer of 2020," (2004) and "Rising Above the Gathering Storm," (2007) or, more recently, from the American Society of Mechanical Engineering, "Lean Engineering Education," (Flumerfelt, Kahlen, Alves, & Siriban-Manalang, 2015), all call for the restructuring of education to better suit industry and meet societal needs. These reports, and others over the past century, consistently claim that engineers need new skills to be able to solve societal problems and compete in a global innovation and knowledge economy, and education must provide those skills (ASEE, 1955; Mann, 1918). Two intertwined facets of this narrative need to be scrutinized: 1) that the purpose of education is to prepare students for work, and 2) that preparation for work equates to preparation for solving societal problems.

On the surface, it may seem obvious to claim that education should close the gap between school and work, but this claim does not hold up to scrutiny from higher education and critical pedagogy. The professional organizations reproducing this narrative generally argue for reform framed in terms of either technical skills (e.g. programming, mathematical problem solving, knowledge of fundamental theories in physics and chemistry) or professional skills (e.g. communication, time-management skills) - or sometimes both. First, this aspect of the narrative neglects research on situated learning and transfer that highlights the importance of context and suggests that in the transition from school to work, students need time to adapt and adjust skills learned in classrooms to the specific situations in their workplaces (Johri and Olds, 2011; Lutz and Paretti, 2021; Wenger, 1998). This aspect of the traditional narrative also neglects a significant body of scholarship that describes

education for purposes other than preparation for work. Education can instead be about the emergence and maintenance of democratic ideals, the development of a liberated and self-determined populace, and/or the development of agentic adults prepared to navigate life. Education as preparation for work may conflict with these goals when they are framed as secondary (or are absent) and are afforded fewer resources (Judson-King & Pister, 2015; Kitcher, 2017). Some scholars argue, in fact, that the gap narrative seems to support neoliberal approaches to education, which are more concerned with the value students can provide to industry than with the development of students as individuals (e.g., Hohendahl, 2011). Moreover the gap may be a myth that serves to orient education towards corporate benefit rather than a valid representation of a legitimate skill deficit for newcomers (Hora, Benbow & Oleson, 2016; Hyslop-Margison & Welsh, 2001). Overall, the narrative framing education as preparation to close a gap is often detrimental to liberal and liberatory purposes of education, and may not match the experiences of engineers entering work.

Similarly, when professional organization and engineering educators argue that engineers must be prepared to contribute to societal benefit through work for industry, they neglect studies of the relationship between engineering and societal benefit. In fact, multiple studies have shown that engineers' efforts are more often aligned with corporate benefit than with societal benefit or justice. Prior studies in engineering education and STS have explored the limits of engineering work and engineering mindset. Engineers sometimes define their problems in a narrowly technical way, which hinders them from acting with social justice as a priority or design principle (Leydens & Lucena, 2017). According to some scholars, engineers' belief that technology provides universal and inevitable human benefit is at the root of their lack of social consciousness and their inability to address socio-technical problems satisfactorily (Downey, 2014; Jasanoff, 2003).

In response to engineers' evident lack of social consciousness, and the disconnect between engineers' work for industry and looming societal problems, educators and researchers have proposed a

“holistic,” or “heterogeneous” engineering education. Holistic engineering education is meant to set itself apart from traditional engineering education by preparing engineers for helping society and focusing on the development of socially conscious, ethically aware, multidisciplinary engineers who will enter work and change engineering practice (Bucciarelli & Drew, 2015). However, even when students are holistically trained, research suggests that they enter engineering workplaces that constrain the aims of their work in ways that may conflict with societal benefit (Buch, 2016). Holistic education narratives do acknowledge that not all engineering efforts are beneficial, but they often assume an unconstrained connection between engineering education and practice, and reproduce the traditional assumption of a gap between education and work, although in those cases students lack sufficient holistic skills rather than traditional skills. Because of those assumptions, holistic education narratives still fail to account for holistically trained engineers’ own difficulties in navigating workplaces and finding work that allows them to put their holistic principles into practice (Rulifson, 2019).

Thus, there are multiple narratives suggesting directions for engineering education, whether those directions are better technical and professional preparation, or more holistic preparation. And these narratives reveal the assumptions of professional organizations, educators and researchers about a gap between school and work that must be filled, about the automatically beneficial nature of engineering effort, and even about the unconstrained connection between education and engineering practice. These assumptions have been called into question from research from numerous fields, yet their corresponding narratives continue to inform calls for engineering education reform. Leaning into the questions that have been raised about the education narratives at play, this study uses narrative analysis to investigate the lived workplace experiences of newcomer engineers – an under-researched area of study. Specifically, narratives of twelve newcomers’ experiences are empirically developed from analysis of interviews collected periodically throughout participants’ first year to two years of work. Their experiences serve to challenge and/or confirm aspects of the existing narratives, and

suggest new narratives for understanding engineers' preparation for work. While the newcomer narratives do not provide "proof" the way a quantitative study might attempt to do, they provide an opportunity to "learn from small numbers," and develop an understanding of how local patterns of engineering necessarily differ from broad patterns described by the traditional narrative (Holland et al., 1998; Slaton & Pawley, 2018). Additionally, the local patterns described by narratives may provide a window into "alternative worlds," settings where the traditional narrative is resisted, rejected or built upon to make way for alternatives.

The narratives of this study are constructed and analyzed according to Holland et al.'s social practice theories of identity and agency in figured worlds. Rather than constructing narratives solely in terms of structure (e.g., engineers do whatever their companies say they do), or solely in terms of agency (e.g., engineers' practices result from their completely autonomous enactment of their engineering identities), the figured worlds framework is used to differentiate and understand the interaction between structure and agency. This approach is meant to directly address problematic aspects of the existing narratives. In opposition to the neoliberal directions of the gap narrative, and dehumanization within higher education more broadly (Kahn, 2017), accounting for agency in newcomers' narratives is intended to clear the ground for new educational approaches based on the humanization of students. The agency, needs, and commitments of students also holds significant implications for liberatory pedagogy (Freire & Ramos, 1970). In opposition to a narrative of automatic societal benefit from engineering work, the focus on agency constrained by structure also provides an indication as to which changes towards engineering benefit are realistic. Rather than arguing that socially conscious engineering students necessarily change engineering practice for the better, the narratives of this study frame change in engineering practice as based on the opportunities that individuals have and work towards once they enter work.

Participants' narratives illustrate the identities that participants take on at work, which are deeply connected to the ways that individual's practice engineering. The narratives are meant to reveal engineers "selves in practice," the ways that individuals work to identify themselves as engineers within their local context ("figured world") - scenarios that may resemble, but necessarily deviate from, broad narratives of engineering. These local instances of new engineers creating "selves in practice" provide insight into the problematic aspects of the preparation narrative under scrutiny. Even by itself, the focus on the agency of newcomers should inspire new narratives that deviate from the traditional narrative, because agency is traditionally neglected in narratives of preparation of engineering students for work.

Overall, this narrative analysis study is a response to traditional narratives in engineering education that are likely inaccurate and harmful to ideals of engineering societal benefit and education beyond preparation for work. The goal of this study is to critique the existing narratives and replace them with empirically developed narratives of structure and agency, based on the experiences of newcomer engineers.

1.2. Research Questions and Project Scope

Based on the aims of this study to critique traditional narratives of work, the use of narrative analysis, and the theoretical grounding of the study in Holland et al. conceptions of identity, agency, and figured worlds, the primary research questions asked by this study are: 1) *Who are new engineers asked to be at work?* (the figured world), and 2) *Who do new engineers choose to be in response?* (the agency).

To answer these research questions, I performed a narrative analysis based on the experiences shared by 12 newcomer engineers in interviews done as part of a larger ongoing study, the Capstone to Work (C2W) study. The C2W study involved interviews with students just before they graduated (from

1 of 4 engineering programs), followed by interviews conducted after roughly 3, 6, 12, and in some cases 24, months of work. Interviews concerned participants' experiences at work, the tasks they were involved with, how prepared they felt for those tasks, and the skills and identities enacted through those tasks. For this dissertation, participants were purposefully sampled from the C2W data set to provide variation in university of origin, gender, and the size of company at which they worked. A total of 52 interviews (4 per participant, totaling to 48, plus an additional 4 participants with a 24-month interview) were used for narrative analysis.

Narrative analysis involved coding transcripts of the 52 interviews, using a priori schemes for narrative and for structure and agency coding, and an emergent coding scheme for emotion coding. Coding helped identify which excerpts of the transcript were relevant and how they were relevant, before the excerpts were used to construct detailed narratives of participants' workplace identity development, in a way described as "thematic analysis of narrative" by Kellam, Gerow and Walther (2015). During narrative construction, I also simultaneously wrote inductive and abductive memos to identify themes across participants narratives that answered the research questions. The 12 constructed narratives were then reduced to short narrative summaries that demonstrated each participant's relationship to the themes and made the themes more comprehensible to the reader.

The cross-case themes formed the basis for an explanatory critique. The explanatory critique approach was rooted in my positionality, including my ontological approach of critical realism. As opposed to moral relativism, explanatory critique is an approach based on ethical naturalism – which asserts some factual/natural circumstances are more ethically desirable than others, particularly those that result in human flourishing (Bhaskar & Hartwig, 2016). Thus, by answering the research questions, and by explaining the themes present in participants' narratives, and the ways that they did or did not demonstrate flourishing (or "liberation"), the themes were used to critique the status quo of engineers'

relationships to work, the pedagogies that produce that status quo, and the traditional narratives that currently explain or encourage that status quo.

More deeply, my positionality entails a commitment to justice and re-envisioning engineering that readers may not share, but which nonetheless underlies my analysis. The narratives and emergent themes were constructed with dual intents of being accurate, but also focusing the reader's attention on a specific family of issues. To use a Buddhist phrase (I am Buddhist), the narrative summaries "drive all blames into one" (Hatch, 2017). Newcomers' narratives were connected to ongoing movements against neoliberalism in education, and described potentially severe implications of these narratives, rather than being founded on a bedrock of attempted objectivity. Trying to account for all potentialities or a more complex interpretation of the narratives might run the risk of being pedantic or over-analyzing, leaving readers without direction (Healy, 2017). Instead, the stories are honed, and in some ways simplified, and in the spirit of "driving all blames into one" the findings are meant for us (as educators or researchers) to orient our actions and thinking in relation to these emancipatory movements, especially by inspiring questioning, so that we may accept responsibilities for change.

In some ways the narrative summaries essentialize participants' experiences, though in other ways they do not. Essentialism, defining identities in terms of firm and absolute characteristics, is seen as a limitation, or at least a faux pas, in social science research because it is antithetical to representing human complexity (Slaton & Pawley, 2018). However, scholars such as Spivak point out that essentializing has the power to unite, at least temporarily, so long as those essential qualities are not hegemonically imposed (Mambrol, 2016). In the case of this study, I do write and analyze as though self-determination, liberation, and engineering for social justice are essentially good, and alienating and objectifying work is essentially problematic, and I have the tendency to view participants stories in terms of these essences, as in clear in the themes that emerged in my analysis. On the other hand, I constructed the narrative summaries with the intent to imagine the many different people that

participants might want to be, which was a practice of anti-essentialism (Escobar, 2018) and which allows readers to envision and explore other themes. Escobar (2018) and others also note the ways that individuality is an essentializing part of colonialism (Smith, 1999) and neoliberalism (Eagleton-Pierce, 2017; Visanich, 2020), and in an anti-essential way, I stray at some points from a focus on individual actions, and individualized liberation, even though this study revolves around individual narratives. The simultaneous essentializing and anti-essentializing recalls another Buddhist lesson, the Heart Sutra, which, paradoxically, tells us that form is empty, and emptiness is form; or, in my interpretation, there is no essential engineering identity, and the focus on freedom of identity development is itself an essence.

Finally, given my underlying approach and positionality, it is intentional that in Appendix C this dissertation contains full narratives that have not been reduced for the development of themes that are explicitly aligned with my own goals and positionality. These full narratives are intended to allow the reader to view participants' experiences in a more complex light, with details that may prove important for their own sensemaking of the data, but which did not enter the analysis because of my orientation.

1.3. Significance of the Study

Newcomers' narratives of their transitions to work serve to challenge or support aspects of a traditional preparation narrative in engineering education. The narrative approach focuses on the agency of newcomers and allows students to be defined outside of their value to industry. This is intended to be generative for new critical pedagogies, ones not focused on preparation for industry, and helps set expectations for what changes to engineering practice are realistic.

Both the intellectual merits and broader impacts of this research are connected to its purpose of underlaboring. Underlaboring refers to working to clear the intellectual ground to make room for change (Price & Martin, 2018). Some of the primary purposes of this study are providing scaffolds for

new, more liberatory, pedagogy, and providing more realistic accounts of change in engineering practice. Achieving these ends requires not taking existing narratives for granted. Instead, the pursuit of these ends is rooted in the representations of participants' narratives that account for agency.

1.3.1. Intellectual Merit

The first area of intellectual merit of this study is the focus on working engineers. While engineering work has become a more significant focus of research in engineering education, and while there is a longer history of studying engineering work in STS, there is still much work to be done with regards to bringing insights about engineering work to bear in engineering education. Calls for engineering education research to reach into the workplace, for connection between the communities of workplace-research and education-research are persistent (Johri, 2010). Some work has been done to fill in this knowledge gap, interviewing and surveying working engineers (Jesiek et al., 2021; Lutz & Paretti, 2021; Trevelyan & Williams, 2018). The results of this study suggest changes in engineering education not only based on principles of liberatory pedagogy, but also based on an empirical analysis of newcomers' experiences in the workplace, and this in and of itself is a unique contribution. Additionally, while the analysis focuses on topics such as liberatory pedagogy and identity development, the narrative construction process was intentionally robust enough to represent participants' experiences even when they were not directly relevant to the cross-case themes, so this study additionally provides narratives for researchers interested in newcomers' workplace experiences and identity development more generally.

A second area of intellectual merit is the investigation and challenge to the competency gap narrative. While the field of engineering education has called for more research into the engineering workplace, often those calls take for granted the presence and nature of the competency gap. Reports of gaps such as "The Engineer of 2020" (NAE, 2004) are often cited as motivation for engineering

education research in ways that conflict with other research in both engineering education and STS. The underlaboring approach of this study draws on prior studies of the history of engineering education, and on narratives of participants' experiences of work, to question the applicability of the commonly accepted competency gap narrative to engineering preparation. The results of this study calls the competency gap narrative into question. Engineering education cannot prepare all newcomers with the idiosyncratic and socio-technical knowledge that newcomers of this study needed for legitimate participation on their companies. Moreover, in order to be deemed an asset, engineers in this study were generally pre-occupied with ongoing profit generating practices, rather than practices of societal beneficence, or practices of innovative, disruptive design. Finally, the conclusion of this study uses the narratives of newcomer agency as the basis for alternative preparation narratives.

The third area of intellectual merit is the application of narrative methods in the engineering education context. In 2010, Case and Light described narrative methods in engineering education as burgeoning (2010). Narrative methods have the potential to challenge prevalent assumptions and produce new intellectual insights in engineering education, as has been shown, for example, by Pawley (2009), or by more recent studies (e.g. Secules, Gupta, Elby & Tanu, 2018). This study fits alongside other studies in mounting recognition of the power of narratives, and their ability to raise questions about taken-for-granted features of educators' and researchers' thinking about engineering education. This study is also a unique example of narrative methods given its larger group of participants (12 for this study), as many existing narrative analyses have focused on smaller groups of one or two students. For other scholars interested in employing narrative analysis, this study's methods provide useful instruction regarding the multiple ethical and validity considerations involved.

Finally, the fourth area of intellectual merit is the development and exploration of agency as a theoretically rich aspect of engineering identity. Prior engineering education studies have connected agency and engineering identity in the contexts of career choice, choosing to stay in engineering

(Godwin, Potvin, Hazari & Lock, 2016). Other studies have demonstrated that engineers have had their agency limited by the contexts they work in (Buch, 2016), and that engineering students' agency is misunderstood – sometimes ignored in research methods (Secules et al., 2018; Slaton & Pawley, 2018), sometimes conflated with structure (Conlon, 2016). Holland et al.'s work frames identity and practice as resulting from a dialogue between the agency of the individual and the local figured world that surrounds them. This framing contributes to the fields of engineering education and STS, which have not yet resolved the dichotomy between engineering identity either deterministically arising from the structures of education and work, or autonomously arising from the choices of the individual. The results of this study also show that newcomer's agency was involved in changing jobs, navigating to different positions, and resisting company directives, in pursuit of identities of stability, "true" engineering or design, enjoyability, growth, and beneficence. These agentic navigations are also shown to be connected with the prospect of liberatory pedagogy in engineering, which should allow students to author their own identities in a self-determined way, rather than deferring to authoritative discourse enforced by companies.

1.3.2. Broader Impact

The first intended broader impact of the study is to make the connection between engineering work and societal benefit clearer. In other words, while some narratives of engineering purport that societal benefit happens automatically as a result of engineering, this research explicitly defines the societal benefits of engineering in terms of justice, and accounts for agency to understand obstacles to engineering justice, so that it may be realistically approached (Bhaskar, 2016; Price & Martin, 2018). Recent studies show that even engineers who are trained holistically have their agency limited by the surroundings of work (Buch, 2016). This study characterizes the obstacles to justice in terms of both structure and agency. Some newcomers were hindered in their beneficence by their agency, as they

were agentially inclined to prioritize the novelty or design-orientation of their job above societal benefit. Other participants were agentially inclined to improvise identities of beneficence, but they were recruited to participate in the ongoing work of the company, which often explicitly involved the bottom line of profit. Beyond identifying these obstacles, this study concludes with a suggestion of pedagogies that bring about justice while also acknowledging potential experiences of newcomers at work.

The second broader impact is its contribution to new pedagogy in engineering. As Kahn documents, higher education research, and higher education more broadly, tends to dehumanize students (2017). At work, newcomers may be dehumanized and are regarded purely for their capacity to generate value for their companies, rather than as whole persons (Schacht, 1970). This research intentionally sets out to re-humanize engineering students and engineering newcomers by paying attention to their drives, needs, and commitments outside of the contexts of value generation and corporate contribution. The consequences of oppressive pedagogy are discussed, and based on the narratives of the 12 participants, this study suggests realistic opportunities and for liberatory pedagogy. Participants sought to improvise “true” engineering identities and identities of being assets for their companies, which sometimes involved objectification for the purposes of becoming human capital for companies, and identities of stereotypically automatic and passive beneficence. In place of these stereotypes, there were instances where newcomers reflected on and rejected them, substituting their own negotiated identities, which involved reflection on the limitations of stereotypes, and the constraining factors of their companies. Students can be better prepared for life after college by being educated on the limitations of stereotypes, the constraints imposed by companies, and their own ability to negotiate new identities.

Third, this study expands upon the experiences of women in engineering, which also has implications for other marginalized groups. While it was not initially a main focus of the study, the

narratives of some of the women had an unavoidable presence of sexism, which also influenced their identity development. The results of this study give more detail about how sexism affects identity development in terms of structure and agency. Some women of this study navigated workplaces that treated their engineering abilities as inauthentic, and encouraged them to adopt masculine approaches to communication that downplayed the importance of their empathy. For these women, it was difficult to reconcile an identity of self-respect and professionalism with the demeaning identities provided by their work and their colleagues. Understanding this marginalization is precursor to liberatory pedagogy – engineering education should prepare women to navigate and resist the sexist structures they may encounter at work.

1.4. Limitations

While this study has multiple intended areas of critique, and the results suggest multiple directions for critical pedagogy and developing new relationships between engineers, their workplaces, and society, there are, of course, limitations to the claims this study can credibly make. These limitations are discussed more in the methods section, but it is important to say that the results of this study are not meant to be generalizable. The narratives of 12 engineering newcomers cannot be used to account for or describe the general experiences of all engineering newcomers in the U.S. Instead, the narratives of these participants are used as starting points, to show how engineers' navigation of their workplaces deviate from stereotypes or grand narratives that would otherwise describe and predict their navigation, to suggest questions that educators and researchers should ask themselves in light of those deviations, and to suggest alternative narratives to capture participants' experiences. Throughout the study, there are also some slight methodological mismatches (for instance, interview questions were not expressly intended to generate narratives), although many of these are mitigated – those mitigations are discussed more in the methods chapter as well.

1.5. Summary

This research relied on empirically derived narratives to challenge two primary aspects of a prevalent narrative in engineering education: 1) that there is a gap between education and work that it is education's responsibility to fill, and 2) that it is imperative to prepare engineers for industry because engineers' corporate efforts solve societal problems. The narratives constructed from interviews with participants focus on their identity development in their first year (or two) of work. Holland et al.'s social practice theory of figured worlds is used to interpret newcomer's identity development as an improvisation, and as a negotiation between structure and agency. The themes that emerged across participants' narratives were used to answer the research questions of *who the participants of this study were asked to be by work*, and *who they chose to be in response*. Afterwards, an explanation of the themes was used to form a critique of the two aspects of the grand narrative. Newcomer's narratives also served as the basis for suggesting alternative preparation narratives, based on principles of liberatory pedagogy, meant to produce liberated students, capable of self-determination, and able to fashion themselves for solving legitimate and pressing problems relevant to their lives, and thus to society.

CHAPTER 2: LITERATURE REVIEW

2.1. Introduction

As discussed in Chapter 1, this study is situated against the backdrop of narratives of preparation that frame the direction of and need for engineering education reform. These preparation narratives have a history over a century long and have shifted throughout that time, yet reproduce two common threads. The first thread concerns the gap between school and work. While the specific skills that engineers are reported to lack for effective practice have changed over time, the narratives about education have consistently called for education to prepare engineers for industry by developing those missing skills. This first thread is reinforced by the second thread, that it is the nature of engineering industrial efforts to address the needs of society. Together the narratives give an engineering account of the shifting needs of society, and the skills that education will need to develop in students in order to provide for those societal needs. This chapter begins by reviewing literature from both engineering education and science and technology studies (STS) to explain these typical narratives of engineering preparation, and, importantly, identify their problematic aspects highlighted by prior research to set the stage for this research.

The chapter then turns from these traditional narratives rooted in skill development to focus on identity as an alternate framework for understanding engineering education, engineering practice, and the relationship between the two. Specifically, the chapter reviews the Holland et al.'s framework of identity as negotiated between structure and agency in figured worlds as the lens used to construct narratives of 12 new engineers' transitions from school to work, or from student to practicing engineer. These narratives are intended as a response or a replacement to the traditional preparation narratives, while the structure/agency framing enables for critiques of the traditional narratives that distributes responsibility fairly between individuals and corporations, invites practical discussions of socio-

technical change, and aligns with this study's focus on liberation and humanization of engineering graduates.

2.2. A Gap Between School and Work

2.2.1. The Existing Narrative

The first significant aspect of the preparation narrative to be investigated is that there is a competency gap between school and work that education must fill. Calls for closure of the competency gap in engineering education, at least in report form, date at least to 1918, with a report written by Charles Riborg Mann ("the Mann Report") (Melsa, Rajala & Mohsen, 2009). In the preface, the purpose of the report is to "to examine the fundamental question of the right methods of teaching and of the preparation of young men for the engineering professions" (p. v) and to aid professors who ask themselves, "Am I teaching as to produce these results in my pupils and in the order of value specified by the engineering profession?" (p. xi, Mann, 1918). While the Mann Report does not mention a "competency gap," it discusses multiple issues that were widely considered "problems of engineering education" to be met with "effective solutions." The listed issues of engineering education were admission, time schedule, testing grading, shopwork, and (most relevant to the current incarnation of narratives of purposes of education) course content. Beyond "effective solutions," other goals, such as "build[ing] character" or "reduc[ing] waste" in education, emerge from the text. According to more than seven thousand engineers surveyed, "Character" was the most important essential trait of engineers (Mann, 1918).

The Engineer of 2020 report, published in 2004 by the National Academy of Engineering (NAE, 2004), brings this narrative of a gap between school and work closer to the present. While the Mann report was an investigation commissioned by a joint committee of professional societies representing various engineering sub disciplines, in order to review the curricula of institutions that had been in

existence for 50 years, at most, the Engineer of 2020 report was developed using scenario planning with a group of industry and academic members of the NAE to consider what the world might need in 2020 and what skills engineers should possess to meet that need. Creativity and leadership are named as primary desired attributes for the engineers of the future, alongside others such as ingenuity, determination and technical competence. The report sets aspirations for the field of engineering, and for education,

We aspire to engineers in 2020 who will remain well grounded in the basics of mathematics and science, and who will expand their vision of design through a solid grounding in the humanities, social sciences, and economics. Emphasis on the creative process will allow more effective leadership in the development and application of next-generation technologies to problems of the future. (p. 49)

The quote illustrates the inclusion of holistic skills, as it suggests engineers should receive a better education in the humanities. Ultimately it frames those holistic skills as necessary for engineers to meet the demands of 21st century industries, and it is the responsibility for education to catch up to those demands.

Finally, the American Society for Mechanical Engineering (ASME) report *Lean Engineering Education: Driving Content and Competency Mastery*, released in 2015, illustrates a more current example of preparation narratives (Flumerfelt et al., 2015). The book was an interdisciplinary analysis of the shortfalls of engineering education in order to describe desirable improvements and to advocate for the use of lean tenets and tools in education. The report includes multiple calls to action for closing a gap between schooling and education to prepare the engineering workforce for year 2030. The existence of the gap is supported with statistics such as the following results from a survey of engineering employers: “39% believe that the current balance of material taught is sufficient, while the demand for more breadth (30%) and more depth (31%) is equally strong” (p. 28). The report is specific about the causes of the competency gap: all are located in colleges and universities. As summarized in one of their figures, the authors assert that gaps persist because curricular “content remains stable over

time,” because “competency mastery is not a learning outcome,” because faculty teach according to their limited training, and because engineering culture and governance tolerate pedagogical gaps (Flumerfelt et al., 2015, p. 5). There is no notable discussion of on-the-job training as potential solution, though the fourth chapter is almost completely occupied by a discussion of the Toyota Production System (TPS) and the effectiveness of the Toyota Education Model (TEM), which heavily involves on-the-job learning. Instead, the TEM is discussed as an example for academia to follow (Flumerfelt et al., 2015). The report is also specific about the skills engineers must develop to meet the needs of industry and thus society. The necessary skills mentioned by the 2015 report are systems thinking, sustainability thinking and ethical development.

Research from outside of professional societies also supports the existence of a gap between school and work. Trevelyan’s extensive work has documented the loss of engineering productivity for engineers’ lack of preparation for social complexity and collaboration skills (2019). Korte et al. (2008) in a qualitative study of recent graduates found that the gap between school and work could be described as a gap in social context that engineers needed to adapt to, as well as a difference between the well-constrained and closed ended problems that engineering students faced in school, and the ill-constrained, open ended problems engineers faced at work. Johri and Olds (2011) echoed those findings in a review of situated engineering learning. Notably, however, their review moves beyond skills and implicates engineering identity as one of the necessary foci for engineering education in closing that gap – in their framing, engineers need to develop not only skills, but also identities that are appropriate for the workplaces they will enter (2011).

Alongside these empirical investigations of a gap between school and work, there have also been calls for holistic engineering education to address engineers lack of awareness of the social impacts of their work. Deviating from more technical definitions of engineering, these studies call for engineering education to prepare engineers to fit into complex networks of actors including local and

federal governance, employers, and stakeholders (Stevens, Johri & O'Connor, 2014). Bucciarelli and Drew, for example, have developed a plan for liberal studies to be integrated in engineering education in order to broaden the idea of what engineering knowledge is, to prepare engineers to solve ill-defined problems, and to appeal to employers who desire engineers with critical thinking skills (2015). This kind of preparation narratives reflects a trend in academic discourse toward more holistic preparation of engineers (Grasso, Burkins, Helble, & Martinelli, 2010); however, the core of the preparation narrative remains the same: education is called on to prepare students for industry work through the development of skills, competencies, or identities. I will argue that this core narrative thread is problematic in the next section.

2.2.2. Why the Gap Aspect of the Narrative is Problematic

Narratives that frame education as having the purpose and responsibility for closing a gap between school and work are problematic in two primary ways: they draw focus away from and hinder the potential liberatory purposes of education, and they conflict with research that calls into question the very existence of gaps between school and work.

The first problematic aspect of the gap narrative becomes evident when other possible purposes of education, and the potential inaccuracy of the narrative, are considered. The narrative frames liberal education as secondary or, more subtly, as an integral part of professional education. In discussions of the gap, the possibilities for education to be concerned with the development of students as persons are neglected in favor of students' development as employees. But beyond professional preparation, education can also be responsible for self-development, self-determination, or self-authorship, often framed as liberal education (as in, the education of free persons). According to Dewey, for example, education should be responsible for students' development of the reflexivity necessary to independently decide how to lead their lives and to uphold democracy (Anderson, 2018). Humboldt's concept of

“bildung” (development) claims a similar goal for the university: to aid students in their maturation and develop their abilities to determine themselves, although he saw this as entirely separate from the maintenance of civil circumstances (Zelić, 2018). Humboldt described the ideal university as

connecting 'objective knowledge/scholarship (Wissenschaft) with subjective cultivation (Bildung)' (Humboldt, 1809/1810, p. 229). On condition that every individual is first a member of humanity and secondarily a citizen of the state, he was convinced that 'the freest cultivation (Bildung) of the human being, directed as little as possible to civil circumstances, should take priority everywhere. (Zelić, 2018, p. 663)

Aside from one particular social order, liberal education can also be concerned with the general changing of social order. Archer, for example, describes a process of morphogenesis, where the reflexivity of individuals can create larger societal shifts (Archer, 2007; Nudelman, 2018). Case argues that education could spur morphogenesis of agency in students, beyond economic purposes, and instead fostering human flourishing (as cited in Kahn, 2017, p. 369). Kahn makes a connection between morphogenetic agency developed by education and justice as described by Nussbaum and Sen's capabilities approach – the agency to develop oneself is a central part of human flourishing (2017). Finally, in a similar way, Freiré described learning and the process of education as a potential tool for human liberation (or oppression if agency and the ability to grow were denied to students) (1970).

Of course, no education is purely liberal education, and no education is purely professional education. These two are not mutually exclusive; a degree program can develop one's capacity to think for oneself while also developing skills, competencies, and identities that prepare individuals for work. However, the two often are framed in conflict, and it is a conflict that professional education seems to win if economic efficiency and international competition are the stated tasks of education (Kitcher, 2017). In the context of U.S. education, the purpose is often assumed (if not stated) to be professional education, while liberal education, on the other hand, must justify itself (Hora, 2018) and is often squeezed out of engineering programs in order to “cover the content” (Silbey, 2015). Any liberal

education of engineers is often separated from and competing with the other purpose of an engineering bachelor's degree: professionalization (Judson-King & Pister, 2015). In general, corporate requests for and endorsements of professional education simultaneously frame liberal education as secondary.

There are more holistic forms of the gap narrative that seem to indicate the importance and primacy of humanities or liberal education of engineers. As Norman Augustine, former CEO of Lockheed Martin, framed the issue, engineers need a well-rounded, liberal education, and “one cannot live by equations alone” (2013). However, this narrative may more accurately be parsed as “one cannot *work* by equations alone.” Many reports calling for what looks on the surface like liberal education are not shy about naming their purpose - namely, the development of a productive workforce (Flumerfelt et al., 2015), and they continue to focus on skills, albeit broader or more “liberal” ones such as communication or creativity or business acumen. Such an approach seems incompatible with many of the goals of liberal education (Gary, 2018), which is about individuals' development of themselves and then perhaps an ideal social order. Often, reports frame their goals in terms of economic indicators or in terms of the personal career success that individuals should expect to experience (Walker, Pettit & Hawkins, 1968). Ultimately, those intending to provide liberal education to engineers should be wary that their efforts are heard as a “more holistic” professional education, as Riley (2015) and McMillan (2018) warn. It is possible that some industry calls for liberal education actually seek the same ends as the educators whose philosophies undergird liberal education. However, redefining (co-opting) liberal education in terms that privilege industry and economic benefit over social goods is a corporate strategy (Eagleton-Pierce, 2017), which in this case influences structures of education. Framing “liberal education,” which should be about self-development, instead to mean “preparation for work,” serves to solidify a status quo of professional education dominating liberal education.

In addition to the problems posed by framing liberal education as secondary to professional education, the gap narratives are also problematic in terms of their simple accuracy: is there, in fact a

gap, and if so, what is it? Outside engineering, the unemployment of recent graduates is used as primary evidence to support the existence of a gap (Augustine, 2013; Hora, Benbow & Oleson, 2016). However, Modestino, Shoag & Ballance (2016) show statistically that unemployment correlates with the levels of skill and experience that jobs require, which is unsurprising. But they also demonstrate that employers set high requirements for skills and experience “opportunistically” – that is, when the supply of employees is high. This finding challenges the premise that skills and experience are demands made in response to increasing complexity of problems, or with advancements in technology, or with failures of education, as might be predicted by the gap narratives. In other words, employers seek to hire the most skilled and experienced employees they can, not because of an accurate assessment of the skills required for the position, but because more skilled and experienced workers are economically beneficial to companies. Even the assessment of employers needs from Flumerfelt et al. challenges assumptions about the significant need for a supply of educated engineers, because it does not consistently describe whether engineering education is too broad, too narrow, or adequate – though “adequate” was the most frequent response at (39%) (2015). Hyslop-Margison & Welsh go as far as to describe gap narratives as propaganda (2001), and others describe it as a “zombie myth” (Krugman, 2014), which persists despite contrary evidence because its existence serves the interests of corporations, in that it motivates educational institutions to appease their desires and provide an ample supply of skilled engineering graduates. Gap narratives focus attention away from socio-economic problems of our current market economy status quo, which include rampant wage inequality, the opportunistic hiring roots of unemployment, and the failure of education to provide opportunities for comfortable livelihood of students (Hora, 2018).

Finally, these two problematic aspects of the gap narrative intersect when we consider sociocultural or situated learning of engineers, which challenges the assumption that skills can be simply and directly transferred from one context (school) to another (work). Socio-cultural learning

theories declare the necessity of authentic learning contexts in order to enter communities of engineering (Wenger, 1998). While numerous studies identify skills that both employers and new engineers considered lacking (Brunhaver et al., 2018, Trevelyan, 2019), research from the C2W study and from other transfer-focused studies has shown the ways that each company represents a unique socio-cultural context for communication (Ford et al., 2021), teamwork (Knight, Gewirtz & Chowdhury, 2019), mentorship (Lutz, 2017) and interpersonal skills (Perry, 2021), to which new engineers necessarily acclimate (Korte et al., 2008). No university setting can perfectly replicate the broad range of social and organizational contexts that new engineers enters, so there must necessarily be a context gap as graduates both adapt knowledge, skills, and abilities developed in school to their new employer and acquire new company-specific knowledge. As a result, many researchers recommend on-the-job training to close this inevitable gap (Ford et al., 2021, Perry et al., 2021). So, if there is a gap as traditional preparation narratives describe it, it may be that only the context specific on-the-job training provided by corporations can close it. This approach conflicts with the gap narrative, which shifts the responsibility of closing the gap (and the cost of educating engineers) onto educational institutions. The alternative implied by traditional gap narratives is a problematic neoliberal ideal, where engineers are educated by and for industry (as in corporate universities like the Googleplex), which limits any possibility for liberatory education. Ultimately, research on socio-cultural learning in engineering identifies just one more way that traditional gap narratives are problematic, because they do not account for context-specific learning, and thus, they inaccurately describe the gap in a way that frames educational institutions as inadequate and improperly assigns responsibility for narrowing the gap.

2.3. The Automatic Beneficence of Engineering Work

2.3.1. *The Existing Narrative(s)*

The other narrative thread we should scrutinize that runs through engineering preparation is the claim that schooling prepares (or should prepare) students to benefit society through work for industry¹. In more technical, traditional preparation narratives, there is an assumption that technology is unilaterally beneficial, which is informed by an understanding of technology as global and responsible for universal “human development” (Downey, 2015). Formation narratives are about engineers who serve “society” in general, rather than particular groups of people; Downey calls this perspective “normative holism” (2015). The narrative upholds an assumption of “technological determinism,” that technologies propel society forward, from less advanced to an inevitable more advanced state (Winner, 1980).

The gap aspect of traditional narratives also is supported by this automatic beneficence aspect of the narratives. In many preparation narratives the gap is between education and an imagined future of high technology and global competition that demands renaissance engineers. Engineers must be prepared to bring the United States to Mars in the year 2000 (Walker et al., 1968); engineers have “the creativity of Pablo Picasso” in order to confront drought, bioterrorism, natural disasters, and global conflict (NAE, 2004); engineers must be educated for sustainability for the swath of available jobs in

¹ Although industry and government engineering work may have structural differences, for this study I conflate them, in part because they are not separated in preparation narratives, or at least there is no acknowledgement of the differences between government and private institutions in terms of solving societal problems through engineering effort.

the year 2030 (Flumerfelt et al., 2015). Finally, engineers' efforts are depoliticized. Technologies are thought to be apolitical, "unbiased" if done correctly, in line with the assumption that technology is of unilateral benefit and contributes to an inevitable goal (Cech, 2014a).

In response to these traditional narratives, recent holistic preparation narratives begin to incorporate an understanding of those affected by technology. Holistic preparation narratives challenge the assumptions of universal benefit of technology and technological determinism, and they recommend engineers become more socially conscious in order to navigate the complex social dimensions of technology (Downey, 2014). Holistic narratives acknowledge certain political dimensions of engineering work, as they recognize that definitions of "benefit" vary among different groups of people (Downey, 2014). If engineers seek to provide benefit for groups of people, they must first understand what that group considers to be beneficial. As discussed earlier, holistic preparation narratives involve new sources of knowledge, from the humanities or liberal studies, in order for engineers to think more critically about the work they will do (Bucciarelli and Drew, 2015; Claris and Riley, 2012; Seely, 1995). Other holistic preparation narratives describe skills and competencies such as transformational listening (Lambrinidou et al., 2014) and empathy (Walther, Miller and Kellam, 2012) as necessary for the engineer.

Both the traditional and holistic narratives conjure images of engineers carrying peoples forward with each new technology that they develop. As in *The Engineer of 2020*, engineers are responsible for "leadership in the development and application of next-generation technologies to problems of the future" (NAE, p.49). As another example of these narratives of social beneficence, *Lean Engineering Education* relies on a list of 15 interconnected global challenges facing humanity developed by The Millennium Project (with items such as "sustainable development," "clean water," "population and resources," etc.) that engineers must be prepared to solve (Flumerfelt et al., 2015).

2.3.2. Why the Automatic Beneficence Aspect of the Narrative is Problematic

The social beneficence assumption of preparation narratives faces critiques when compared to other research in engineering education and STS. Not only is the assumption shown to be inaccurate, given the complex relationship between societal benefit and engineering work, research has also shown how depoliticization and a belief in the automatic benefits of engineering effort stand in place of the understandings needed to work towards engineering justice (Cech, 2014a; Leydens and Lucena, 2017). Finally, even holistic forms of the narrative often maintain the inaccurate and harmful belief that engineers can accomplish socio-technical change if only they enter work holistically prepared.

It would be inaccurate to say that engineering effort is unilaterally beneficial. Research has shown that what has counted as beneficial has shifted over time and context, and technology is not without its historically unsavory impacts. Social Construction of Technology (SCOT) scholars highlight the ways that social and political circumstances allow any given artifact to solve the problems of some social groups while potentially disadvantaging other (often less powerful) groups (Downey, 2014; Pinch & Bijker, 1989). Lucena, Schneider and Leydens challenge traditional relationships between social benefit and technology by pointing out “development” technologies, such as power grids, which were used to destroy indigenous ways of life in Brazil (Lucena, Schneider & Leydens, 2010). At a basic level, technology is political, enforcing circumstances that are good for some, not good for others. The assumption that technology is universally beneficial fails to recognize harmful consequences of engineering (intended or unintended), and precludes any problem framing and political discussion needed to practice democratic pluralism (Jasanoff, 2003). A technology may be intended to help “the human race”, but engineers are unprepared to help if they cannot recognize that “society” is plural, with varying conceptions of benefit (Seron & Silbey, 2009, Vesilind 2010). Unprepared with the necessary political frameworks for understanding and accomplishing social justice,

engineers may cause more harm than good even when they have good intentions (Cech, 2013; Gunckel & Tolbert, 2018; Lucena, 2013; Riley, 2008).

Holistic forms of the preparation narrative are intended to address some of these issues.

However, holistic forms of the narrative still have problematic elements, because they focus on societal benefit as resulting from engineers being educated holistically, which assumes that engineers have a high level of control over technology and neglects the difference between societal benefit and industrial benefit. Historical work done by Noble (1977) and Wisnioski (2012) shows that engineers have increasingly worked primarily in the interest of corporations, having lost their identities of technological leadership. Engineers are commonly tasked with prioritizing efficiency or maximizing profits, which may or may not benefit social groups beyond a company and its stakeholders (Cech, 2014a). At the very least, engineers typically have trouble distinguishing social from economic benefit when they solve problems (Trevelyan & Williams, 2018), which directly challenges the narrative of engineers leading the efforts to solve the problems of society once they enter work. Buch's (2016) recent case study of engineers at an environmental engineering firm show that even when newcomers are prepared to consider the social and political elements of their work, their work is constrained by the company they work for, in a way that interferes with the potential for their work to be societally beneficial. Holistically educated engineering students might be more inclined to leave engineering than to change sociotechnical practice, especially when their options for engineering employment may come with these constraints and preoccupations with solving problems for corporate interests (Rulifson and Bielefeldt, 2016).

2.4. Agency and Engineering Identity

As the previous discussions suggest, traditional narratives about engineering education focus on developing engineers with the skills needed to succeed in industry and thus benefit society. Even many

new narratives about holistic education lean heavily on providing undergraduates with an expanded skill set they can bring to corporations and government agencies to transform disengaged practices into socially beneficent ones. But as work on situated learning suggests, education is not only about the knowledge, skills, and abilities (KSAs) student learn (Johri and Olds, 2011; Stevens et al., 2008; Vanasupa, Stolk and Herter, 2009). Rather, it is about identity, about who they become both at school and at work. Identity is also central to liberal education and liberatory pedagogies, which seek to develop persons rather than employees. As a result, in response to these traditional narratives of engineering education and their critiques, this study seeks to suggest new narratives, rooted in empirical accounts of newcomers' identities as they develop in the school-to-work transition. In doing so, it addresses the following research questions:

1. Who are new engineers asked to be at work?
2. Who do new engineers choose to be in response?

To answer these questions, this study relies broadly on socio-cultural learning theories to understand the identities that engineers employ at work, the contexts they enter, and ultimately narratives of their identity development within those contexts. In constructing and analyzing participants' narratives, my work is informed by multiple identity frameworks, but I primarily rely on Holland et al.'s approach to social practice theory and their conceptions of identity as an agentic improvisation within the structures of figured worlds. The structure/agency aspect of the framework was inspired by the previously discussed critiques of preparation narratives. A focus on agency is meant to counteract the human capital aspects of preparation narratives, which regard students as resources to be used for corporate benefit and is meant to be generative for new liberatory narratives of education. A focus on structure is meant to counteract holistic narratives, which do not often account for the ways that the contexts of work constrain engineers. This section will go into more detail about

socio-cultural learning theories, and then how the figured worlds structure/agency framework can be used to understand engineers' structure and agency.

2.4.1. Socio-cultural Learning and Identity Development

Socio-cultural (or “situated”) learning frameworks define learning as identification with the practices of a cultural group (Johri & Olds, 2011). Socio-cultural approaches to learning are generally alternatives to compartmentalized skills approaches (positivist or cognitivist), which rarely account for the context in which behaviors and identities are considered “skillful.” Newcomers to a community of engineers must adjust their activity so that they belong to the culture, as opposed to learning about engineering “on paper.” For example, rather than students learning how to “communicate effectively” in a conceptual, de-contextualized sense, as may be seen in ABET accreditation criteria (2018), students must learn how to communicate in an engineering way – using words and manners of speaking that are recognized by their peers as engineering (Allie et al., 2010; Gee, 2000; Paretto, 2008; Paretto & Mcnair, 2012; Tonso, 2006). Rather than learning about engineering ethics in a conceptual, de-contextualized sense, a newcomer must learn to hold themselves responsible for ethical behavior for ethics education to effectively influence their practice (Loui, 2005). A lack of attention to context may be the cause of vague or myriad conflicting definitions of skills (Gilbuena et al., 2015; Walther, Miller & Sochacka, 2017). Socio-cultural frameworks describe a newcomer’s learning more comprehensively than a discussion of skills; describing how social context affects who is and isn’t considered a valid engineer (Cech, 2014b; Johri & Olds, 2011), newcomers’ ability to use technologies competently (Hatmaker, 2012; Wenger, 1998a), their adoption of a workplace’s set of values (Pawley, 2009), their ability to communicate and collaborate effectively with new colleagues (Ford et al., 2021; Korte, 2008), or their ability to draw from diverse bodies of knowledge that are unique to them (Wilson-Lopez, Mejia, Hasbún, & Kasun, 2016).

Where does identity fit into the socio-cultural approach to learning? Socio cultural theories describe learning fundamentally as shifts in identity that both enable and reflect participation in communities (Wenger, 1998). Identity is also what informs practices such as engineering. As newcomers enter a work community, who they are affects how they interact with the value systems of work, their approaches to problems that the community exists to solve, and their adoption of techniques and practices the community uses to solve those problems (Wenger, 1998). As individuals are recognized by the community, their identities shift. Accomplishing a task may make you the “office hero” and spending 30 years at a company will likely make you an “old-timer” (Wenger, 1998). A socio-cultural learning perspective predicts that newcomers become full-fledged practitioners through “legitimate peripheral participation,” slowly taking on more responsibility and becoming more integrated as they develop the identities necessary for participation (Wenger, 1998). The transition, that is, requires more than a set of generic skills that can be directly transported from one context to another.

Studies of identity have gained significant traction in engineering education research in recent years, with scholars focusing on what engineering identity is, as well as how students develop (or fail to develop) engineering identities or come to identify with the field. As students’ identities develop in education, they learn what activities and ways of thinking might be valued in an engineering workplace, they develop understandings of what it means to be an engineer, and they develop new understandings of themselves in relation to engineering (Stevens et al., 2015). Multiple dimensions of identity development have been shown to affect student’s decisions to choose engineering as a career, including interest, students’ beliefs in their own competence, and students’ desires to be recognized as an engineer (Godwin et al., 2016). Tonso’s (2006) ethnographic research on engineering students also described multiple dimensions of students’ engineering identity development, including thinking about oneself as an engineer, performing an engineer self, and being thought of as an engineer. Her work also involved the theory of figured worlds, the ways that engineers referred to a range of “cultural forms” in

developing their identities, the ways those forms were profession and site specific, and the ways that forms encoded privilege or disadvantage – for instance, being thought of as an engineer might be harder for women. Other strands of research have considered the workplace identities of engineers. McNair and Paretto (2012) investigated the ways that engineering identity at a consulting firm was negotiated not only between engineers, but also with other disciplines that engineers needed to interact with as part of their practice. The work of Anderson et al. (2010) showed, in a study of 6 engineering firms, that most engineers did not see themselves as contributing to the public good, rather they saw themselves as solving problems well. Engineers' practices, as students or as employees, are thus determined by their identities in addition to their skills, knowledge and abilities. Newcomers' integrations into work, and their abilities to perform engineering in their workplaces, can be understood in terms of identity – even if this dimension is missing from traditional preparation narratives.

2.4.2. Identity, Agency and Figured Worlds

As the preceding section suggests, there are multiple ways to understand engineering identity. For this study I use the work of Holland et al. (1998), which expands upon general socio-cultural learning theories to discuss social practice theories. Social practice theories, such as those developed by Vygotsky, Foucault, and Bhaktin, describe the relationships between practices and the social actors that perform them (Holland & Lave, 2009; Reckwitz, 2002). Holland et al. synthesize ideas from these theorists to form a practice theory of identity and highlight the “self in practice.” They frame identity as an interaction between an individual's agency and the cultural structures that surround them. Adopting a social constructionist perspective, they define these cultural structures as figured worlds, which are the ‘socially produced, culturally constructed activities’ (p .41) within which individuals continually exercise agency to negotiate their identities.

Holland et al. ascribe four attributes to figured worlds: *history*, *social positioning*, *social organization*, and *distribution*. First, the historical nature of figured worlds refers to the structures that precede the individual doing their identity negotiation, and the ongoing projects and existing identities that exist before any newcomer enters. This has multiple implications. For one, figured worlds exist beyond the actor's (the newcomers') imagination. Although the figured world is defined by the actor's own understanding of it, the figured world doesn't owe its existence solely to the actor; events have happened within the figured world before the actor ever entered it – mirroring Archer's definition of “structure” (2014). Given the history of the figured world, there must be an induction process as the actor learns how things are done, “gets up to speed,” and understands themselves in relation to it.

Second, drawing on Bourdieu, Holland et al. describe figured worlds as “organized around positions of status and influence” (p. 59, 1998). The activities and goings on of a figured world do not happen in a vacuum, or even according to delegation schemes that are objectively efficient. Instead, the practices happen through people, through their relating with each other, and through their evaluation of each other's positions and their own positions, and those positions come with more or less power. Power influences the identities and practices that are available to individuals improvising their identities within a figured world.

Third, the activities of figured worlds are also socially organized. The social aspects of engineering in figured worlds are not just side effects that influence the work newcomers do, socialization is how they happen. Other scholars have noted this same principle, that engineering activity is socio-technical. Trevelyan has shown how coordination and collaboration occupies a significant portion of engineers' time, and often determines the success of engineering projects (2019). Buch showed with his study of a practice landscape of an engineering firm how social practices gave way to technical practices (2016). Faulkner showed with her studies of engineering firms how the social and technical work of engineering was divided and gendered (2007). At any engineering firm,

engineers should be expected to be working as part of a group, which might range from a supervisor/supervisee duo to a multi-company, multi-disciplinary team. Engineering (of whatever variety) does not exist without organization.

Finally, figured worlds are landscapes of activity, with multiple ways of ways of participating, most which are pre-established, but some which can emerge from innovation of identities – bringing into existence new possibilities for identities, and potentially changing the overall structure of the figured world. Establishing oneself within a figured world is not as simple as picking a single identity, or even having one assigned. By distribution across landscapes of activity, Holland et al. mean that figured worlds give actors the chance to interact with multiple activities, to develop personal understandings of them. And, connecting to Bakhtin, identities are the results of negotiations between multiple voices, which emerge after participation (or hindrance to participation) in the landscape of activity.

Holland et al. (1998) note that identities and their subsequent practices are always forming and re-forming in relation to historically specific contexts. Thus, it is important not to think of identities as they pertain to work in general, but, for example, to think of the historical and political connections between engineering organizations, the U.S. education system, and other organizations such as professional societies. This history is elaborated upon by Noble's description of the relationship between engineering education and corporations: "education was [and is] the critical process through which the human parts of the industrial apparatus could be fashioned to specifications" (1977, p. 168). Holland et al. go further still, and show how identities are constructed in local instances of context. A "self-in-practice" is an improvisation that operates within a highly specific context influenced (but not entirely determined) by historical trends and the agency of individuals. From this perspective, student preparation for work involves the development of an engineering identity that is deemed appropriate by specific workplaces at a given time and in a given place.

The figured worlds structure/agency model describes the identities that individuals achieve as a result of improvisation, as a tension between existing structures and individual agency (Holland et al., 1998). Once at work, newcomers will experience structures that influence their engineering identities. Corporations place certain responsibilities on engineers at work (Flumerfelt et al. 2015; Huff, 2015), and will espouse a set of values that engineers should take on, as most organizations do (Haslam & Ellemmer, 2008). These structures provide resources for recent graduates to improvise their engineering identities (Tonso, 2006). From this perspective, some aspects of engineers' identities are an internalization of overarching cultural structures. For instance, an engineer's personal belief in the beneficence of their work might reflect a larger narrative that conflates societal and corporate benefit.

At the same time, engineers do have agency in improvising their identity. Drawing on Bakhtin's notions of authoritative and internally persuasive discourse, Holland et al. define agency as the ability to negotiate an identity or "voice" within figured worlds of multiple identities/voices. With authoritative discourse, one voice from the figured world is dominating and is reproduced by an individual without much negotiation, that is, with little agency. On the other hand, agency is more evident in the context of internally persuasive discourse, which is characterized by negotiation between multiple voices, each of which may be more or less persuasive, as part of an individual's self-authoring (Holland et al., 1998). Agency, in short, is an individual's ability to decide who they are, in consideration of what they want or value. Because no person is completely externally defined, it can be said that all individuals have agency, rather than some having more or less agency. Improvising an identity with agency does not necessarily position the individual against their social context, nor does it mean that the individual's interests are misaligned with their context. Instead it means that the individual's interests could ostensibly be separated from the interests of their social context, that the interests, recommendations or demands of the social context on the individual could be questioned (Matusov and Duyke, 2010).

A focus on agency avoids what Archer calls the “downwards conflation,” (1996) where the behavior of individuals is explained (or predicted) in terms of deterministic, overarching structures. They can choose to resist or acquiesce to the demands of the surrounding structure. From a figured worlds perspective, agency is defined as “the realized capacity of people to act upon their world and not only to know about or give personal or intersubjective significance to it” (Holland et al. citing Inden, 1998, p. 42). Individuals generally make choices to develop an identity that is tenable, acceptable to themselves. As Wenger (1998) says, employees constrained by the structures of work still “learn to create space for themselves...they do manage to have fun, to feel hopeless...to share their boredom” (p. 80). Because identities are lived, no identity is completely controlled, and there is always an element of agency (Wenger, 1998). As Tonso acknowledges, any one cultural discourse or grand narrative is not equally compelling for all members of a culture (2006). There are multiple ways for a newcomer engineer to interact with their community, multiple choices they can make with regards to the values, practices and problems already in place, some of which could involve rejection or resistance of the practices or values of work (Holland et al., 1998; Tonso, 2006).

While the structural influences of corporations are far reaching, and while they interact with agency and can re-construe it for corporate benefit, there is still the potential for identities and agency outside of corporate influence. For instance, even with his harsh criticism of corporate influence on engineers, in his epilogue, Noble (1977), points out the fly in the corporation’s ointment:

however impersonally the ‘problems’ might be formulated, the main challenge has always been people, people with a different vision perhaps, with equally rational but nevertheless conflicting aims. Thus, no matter how sophisticated their approach, how flexible their methods, how pure their intent, the corporate engineers have consistently encountered considerable difficulties in trying to implement their designs ‘in the field,’ opposition which they disparaged as ‘labor trouble,’ ‘personnel problems,’ or simply ‘politics’ (p. 323-324)

Engineers' agency is rooted in who they are beyond their identity as an employee. Their agency is part of what makes them irreducibly human, and also motivates their resistance against the structures that surround them.

2.5. Summary

As this chapter has demonstrated, traditional narratives about the aims and directions of engineering education are framed with two threads that describe the societal problems that undergraduate engineers will solve through their work in industry, and the skills that engineers need for work in industry, which the narratives claim that engineering education fails to provide. The focus on accumulation of skills, rather engineering identity development, gives a limited and potentially inaccurate view of students' transitions to work, which is necessarily a socio-cultural transition (Johri and Olds, 2011; Korte, 2008). The focus on skills also aligns with a human capital purpose of education, which positions students as objects to be specified for a role in industry, as opposed to liberal education which has the purpose of developing students' as whole persons, or liberatory education which has the purpose of developing students' resistance to harmful status quo. To both critique and counter these narratives, this study turns away from skills and toward identity. This study, using the identity framework developed by Holland et al., expands on prior research in engineering identity by focusing on the relationship between structure and agency in identity development, as Tonso did in her 2006 study, at the workplace, to be able to make empirical claims about engineers' relationships with their workplaces in place of the assumptions embedded in traditional preparation narratives. By accounting for agency, this framework helps humanize the participants of this study and provides insight into more realistic opportunities for change in engineering education and socio-technical practice. To achieve these goals, as the next chapter explains, I employ narrative analysis to provide holistic accounts of

participants' transition and identify emerging themes that suggest alternate narratives of both work and preparation for work.

CHAPTER 3: METHODS

3.1. Introduction

This study expands on existing critiques of traditional preparation narratives, suggests alternative conceptions of engineering preparation and humanizes engineering students and engineering newcomers. It accomplishes these goals through a narrative analysis of 12 newcomer engineers' experiences guided by two research questions:

1. *Who are new engineers asked to be at work?*
2. *Who do new engineers choose to be in response?*

The narratives constructed in this study represent newcomers' experiences and identity developments in their first one to two years of work, with the lens of the figured worlds framework (Holland et al., 1998), which focuses on both structure and agency. Accounting for agency in participants' identity development highlights their goals and intentions in a humanizing way, and accounting for structures of work highlights the identity and practice constraints that newcomers face at work. The results of this study highlight the ways that narratives of competency gaps and automatic beneficence are problematic (in the sense that they are at odds with human flourishing as a goal) and are potentially inaccurate.

The 12 participants in this study represent a purposive sample drawn from the larger NSF-funded multi-case Capstone to Work (C2W) project, as described in Sections 3.3.1 and 3.3.2. Data were in the form of multiple interviews done at graduation and 3, 6, 12, and 24 months of work. Guided by the figured worlds framework, participants' interviews were analyzed in a process of listening, narrative coding and memoing, and from that analysis their narratives were constructed. For the benefit of the reader, the narratives were then reduced to the summaries presented in Chapter 4; the

full narratives are available in Appendix C. Finally, thematic analysis within and across the narratives formed the basis for an explanatory critique of the existing preparation narratives. Understanding identity improvisations across 12 participants highlighted the contrasts between their identity improvisations and the typical assumptions of engineers' transitions to work that dominate the engineering education literature. Walther et al.'s framework of qualitative research quality (2017) informed multiple phases of methods ("making the data," "handling the data") in order to ensure trustworthiness of the findings. Steps taken to ensure quality are described within the relevant sections and summarized in Section 3.5.

3.2. Positionality Statement

A researcher positionality statement is an important part of qualitative research, as it involves disclosing the researcher's worldview, biases and positions, which characterize the research endeavor and influence both the making of and handling of the data (Walther et al., 2017). To use Creswell's framing, for qualitative research like this study, the researcher is the research instrument (2014).

3.2.1. My Worldview

To start, I will discuss my ontology, which informs my epistemology, as both are core aspects of research (Walther et al., 2017). Ontology refers to one's perspective about reality, and epistemology refers to one's perspective about what can be known about reality. The two are important to differentiate in order to avoid the epistemic fallacy: the idea that knowledge of the world is the same as what happens in the world (Decoteau, 2017; Fletcher, 2017).

The ontology that informs this study is critical realism, which is an effort to describe the interaction between realism and social constructivism. It is an ontology that attempts to accommodate

both physical, cause→ effect realities (realism), as well as realities that are constructed socially. One of the key tenants of critical realism is a stratified ontology, which accounts for each of these realities and relates them to each other, often described with the metaphor of an iceberg (Archer et al., 2016; Fletcher, 2017). Figure 1 illustrates this stratified ontology, and will be used to guide the reader through each level and how it applies to the study.

At the bottom, basic level, is the *real*, happenings that are governed by cause→ effect relationships, but are never observed directly. As an example, if a participant must practice safety at work, it may be because something sharp or electrified could cause them harm, or if a participant is working on a project involving energy production, those technologies are governed by *real* mechanisms, though they are understood on other ontological levels with equations and variables. The *real* level is present throughout and underlying the social realities that participants construct.

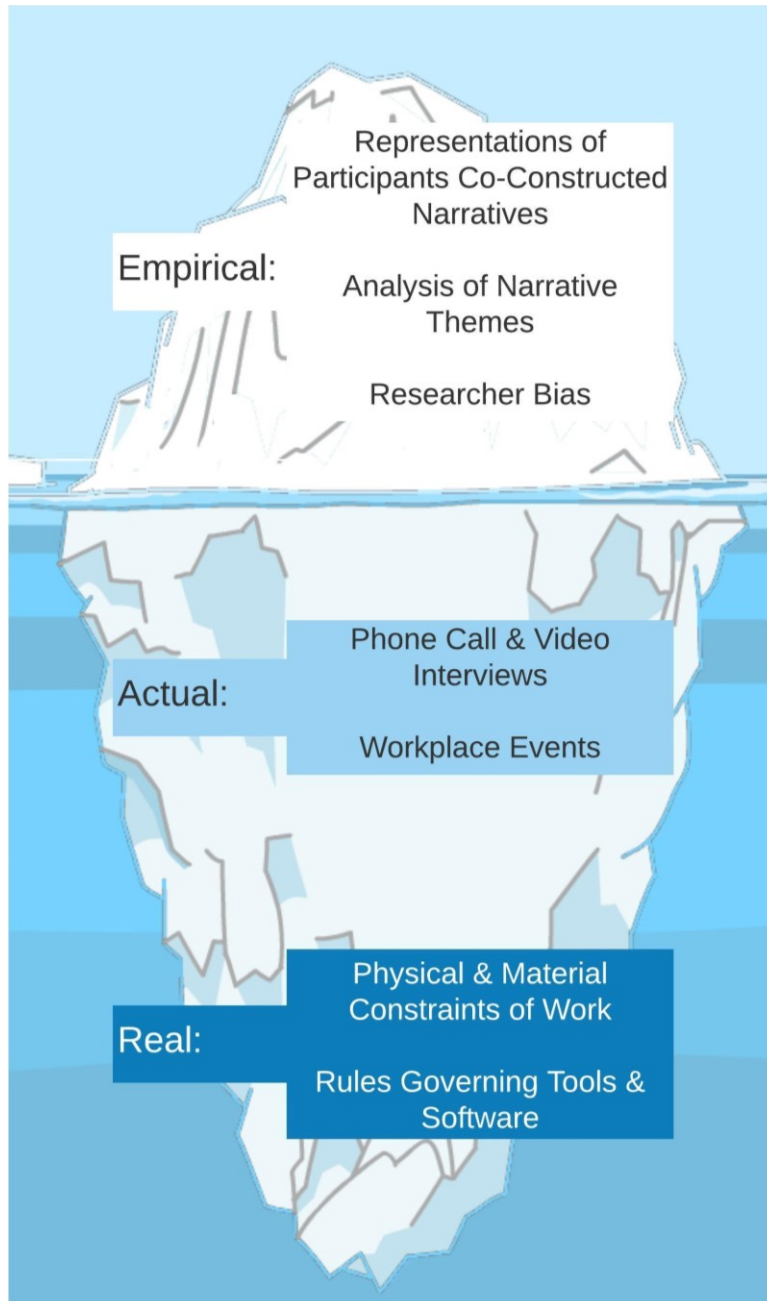
The next level, in the middle, is the *actual*, where events can generate social constructions on the top level if they are subject to human interpretation, but these events occur whether or not they are observed or interpreted by people. As people with biases and limits to perception, neither myself nor my participants have access to the *actual* events as they happen; however, we can still formulate an understanding of these events. When a participant says that they have gone to work, talked to a co-worker, or been through an annual review, it is reasonable to assume that these events have *actually* happened, and are not only constructions on part of the participant. These are what I will refer to as the “objective” parts of interviews (Smith & Elger, 2014; Wells, 2017)

While the first two ontological levels are associated with realism, at the top level is the *empirical*, which is more closely associated with social constructionism. The *empirical* is where events are experienced and interpreted by researchers, participants, interviewers, and interviewees. As Bruner asserts, narratives are one of the primary means for people to make sense of the world (1996). From any actual event that a participant might experience, the narratives about that event are co-constructed

(between interviewer and interviewee) on the level of the *empirical*. No narrative is without interpretation, thus, the empirical accounts that participants co-construct with the interviewer involve their interpretation of events, at one given time, in the context of the interview (Smith & Elger, 2014).

Figure 1

Iceberg Metaphor for CR Ontology (based on Fletcher, 2017, p. 183)



Delving deeper than the typical ontology of constructivism (the *empirical* level) to recognize the *actual* and *real* elements of work is important for two reasons. First, the causes for participant's circumstances may lie outside of social construction. As an example, if a participant takes 10 hours to complete a task, this calls into question the *actual* and *real* demands of their work. It may be social constructions (e.g. a lack of motivation, a desire to appear careful to colleagues or themselves, a lack of urgency, etc.) that cause the task to take that amount of time. Or it may be that the task requires a longer amount of time for reasons rooted in *actual* relationships (e.g. needing to coordinate with other colleagues, waiting on paperwork) or reasons rooted in *real* relationships (e.g. the centrifuge must be spun for 10 hours to produce a desired degree of accuracy). Or it may be a combination of multiple reasons. Understanding objective and subjective elements of participants identity construction is a more holistic approach to understanding their experiences of work. *Actual* events are part of what limits the complete autonomy of participants, because, according to Holland et al. (1998), identities are constrained by material conditions. Engineering, and identifying as an engineer, involves working with actual materials and tools, not only the social construction of problems. The realism of the bottom two levels allows me, as the researcher, to take seriously the events that happen to/because-of participants at work.

The second reason for incorporating realism into the ontology of the study is that it specifically has relevance for discussing justice. The ontology of critical realism has a commitment to human flourishing embedded in its realist perspective, and research with the ontology is sensitive to the issue of human flourishing (Braa, 2016; Delgado & Stefancic, 2016; Kahn, 2017). In forming an explanatory critique using participant narratives, critical realism will allow that critique to address injustice of multiple kinds. For example, the injustice of being overworked lies not only in being identified (misrecognized, to use Fraser's term (1997)) as "expendable" or as a resource, but also lies in suffering *real* and *actual* pains and stresses of overwork, before any interpretation is required.

3.2.2. *My Biases*

Acknowledging (and reporting on) my biases and preconceptions helps support trustworthiness and ethical validation, as it helps the reader understand and critique how I may have come to certain interpretations, and also helps me reflect on how these preconceptions may unduly inform the study. To summarize, I have a personal inclination towards thinking of engineering as corporate and militaristic, and this bias may conflict with participants' conceptions of themselves and engineering. Additionally, I also have the biases formed by my own experience of an engineering-physics undergraduate degree, which finished in 2015, and again may conflict with participants' own experiences of engineering. This conflict is where the critical realist concept of judgmental rationality comes into effect. Judgmental rationality is an approach that allows the researcher to determine a socially bound belief to be "false" in the sense that it contradicts other beliefs that an individual holds (Bhaskar, 2016). Under this approach, it is inconsistency within the participant's own beliefs, rather than inconsistency against my beliefs, that forms grounds for a belief to be considered "false." Representing participants experiences accurately, and doing justice to their narratives, even if they conflict with my preconceptions and personal experiences, does not conflict with my ultimate commitments and motivations, which are to find out and represent what how participants make meaning at work, to ultimately make engineering education and work more just for students and the public.

3.3. Data Collection (Making the Data)

3.3.1. *The Capstone to Work Study*

This study used data collected as part of the NSF Grant Number 1607811, "Collaborative Research: From School to Work: Understanding the Transition from Capstone Design to Industry," referred to as the Capstone to Work or C2W study. The purpose of the C2W study was "to understand how and to what extent capstone design courses prepare students to effectively enter communities of

practice in engineering workplaces,” (Paretti, Howe, Kotys-Schwartz, & Ford, 2016, p 1) by investigating the experiences that newcomers face once they enter work. The C2W study relied on a situated learning framework (Communities of Practice), and attempted to understand learning (competencies and skills, but also attitudes and identities) that might better prepare students for work. The data collected as part of the Capstone-To-Work study included reflective journals, quantitative surveys, and semi-structured interviews with participants from four institutions recruited from two consecutive graduating years, as detailed in Section 3.3.2. These data sources gave multiple perspectives on the activities that engineers engaged in at work, how prepared they were for those activities, and the challenges and accomplishments they experienced as they engaged in those activities.

This study relied on the semi-structured interview data to construct narratives of participants’ identity negotiations at work. While this study employed methods and frameworks not described in the original framing of the C2W project, the goals of understanding the preparation of engineering newcomers and critiquing traditional narratives were in alignment with the original purpose of the C2W project. Also, as is discussed in 3.3.5 Interviewing Approach, the interview data were collected with some focus on identity development and was collected in a way that allowed participants to share narratives of their experiences of work. Choosing this dataset was an early step in “making the data,” and these qualities made the C2W dataset an appropriate choice for investigating the social reality of interest using narrative analysis. More information about how the data for the entire study were collected can be found at <http://hdl.handle.net/10919/102437> (Paretti et al., 2021).

3.3.2. Defining the C2W Sample Pool

The 12 participants in this study represent a purposive sample from the full C2W data set. In this section, I provide a brief overview of the data set; a complete discussion of that data set is available in Paretti et al. (2021). For the C2W study, interview data were collected from students who graduated

from 4 different engineering programs (one engineering science program and three mechanical engineering programs) in two consecutive years in the late 2010s. The 4 programs were in universities from southwest, southeast, mountain and northeastern states. The research sites are summarized in Table 1. Mechanical engineering was selected as the primary focus of the C2W study because it is one of the largest engineering disciplines, often focused on industry participation, while the engineering science program presented a contrasting case. The focus on mostly mechanical engineering students may serve as a limitation to the transferability of this study, although though this study found no significant qualitative differences between universities and programs, and other studies of the full C2W data set found no quantitative difference between programs (Deters, Paretti and Ott, 2020). The sites ranged in size from a small program graduating 35-45 students annually, to larger programs with over 400 graduates per year, but all were focused on providing students with authentic projects, simulating industry expectations, practices, and environments. All programs included at least a full-year of senior design; one had a 4-semester sequence that began in students’ junior year. All included industry-sponsored projects, and most included faculty-sponsored and competition projects as well. Finally, all used a course coordinator coupled with individual faculty and/or industry mentors assigned to each team. Team sizes ranged, but the average across institutions was 4-7 students per team.

Table 1

Summary of the Capstone Course Logistics (from Paretti et al., 2021)

University	A	B	C	D
Location	Southeast	Southwest	Northeast	Mountain
Engineering Sub-Discipline	Mechanical Engineering	Mechanical Engineering	Engineering Science	Mechanical Engineering
Size of Program	~400 Students	~100 Students	~25 Students	~200 Students

Duration of Capstone	2 Semesters	4 Semesters	2 Semesters	2 Semesters
----------------------	-------------	-------------	-------------	-------------

Data were collected from two consecutive graduation classes in the late 2010s. Each participant was invited to four interviews: one interview before graduation (all participants completed this interview), followed by twice-weekly surveys during their first twelve weeks of work, and then three more interviews at approximately 3, 6 and 12 months of work. In addition, based on preliminary analysis of the data from the first cohort, C2W data collection was extended to include 24-month interviews for female participants for the first cohort. However, to maximize retention across the study period, participants were allowed to continue in the study even if they missed a data collection point; that is, if a participant was unable to participate in their 6-month interview, they were still invited to the 12-month interview. Thus, not all participants in the study have complete data sets. In total 140 participants (including pilot participants) agreed to participate in the study. Of those recruited, 119 completed at least one survey, reflective journal, or additional interview after starting industry work, the other 21 either entered graduate school or were considered “discontinued.” Of those 119 participants, 65 completed all four interviews (up to the 12th month), and 10 of those 65 completed a 24-month interview. This set of 65 participants were the pool from which participants for this dissertation study could be purposefully selected (see Section 3.3.4).

Demographic data indicated that, in total, the sample pool comprised 26 (40%) women and 39 (60%) men (0 transgender participants), 21 (32%) non-white participants and 42 (65%) white participants (2 not answered). Gender and race were both self-reported through an initial screening survey of participants; gender choices included non-binary options, while race was posed as an open-ended question. Where possible, C2W participants were also recruited to maximize variation of size and industry sector of companies where participants found work. The industry sector of the sampling

pool ranged from automotive and defense companies to energy and software companies. Of the 65 participants, 35 (54%) reported working at large companies, 16 (25%) at medium sized companies, and 6 (9%) at small companies (8 did not report).

3.3.3. My Involvement in the C2W Project

As the lead graduate researcher on the C2W research team, I was involved in instrument design, data collection, and data analysis for multiple papers (Gewirtz et al., 2020; Gewirtz et al., 2018; Howe et al., 2018; Howe et al., 2019; Knight, Gewirtz and Chowdhury, 2019), and I have participated significantly in many of the structures and protocols that governed data collection of the C2W study. I helped develop the first interview protocol, and after receiving responses from the first cohort, I made suggestions to include new interview questions, including questions regarding participants definition of engineering, conceptions of social factors in engineering, and company culture. I was also heavily involved in data collection and designed a data management system used for the whole project. Of the 181 interviews from the first cohort, I performed 127 of them, and was the main point of contact and interviewer for 48 of the 66 participants. My involvement with the second cohort is similar, as I was the main point of contact and interviewer for 42 of 75 participants and conducted 95 of the 191 interviews. The self-collected nature of the data means that I have formed the necessary “reflexive relationship between researcher and researched” and can recognize the motives and perspectives that informed much of the data collection (Long-Sutethall, Sque & Addington-Hall, 2010). However, I also used interviews that I did not conduct, as other researchers were responsible for most of the interviews conducted with graduates from site 2. Coding and listening to interviews ensured that the interviews where I was not the interviewer could still be used to construct faithful narratives. Coding allowed me to check for the presence of necessary information, such as aspects of their identity, and a personally meaningful account of the events of their work. Listening allowed me to hear more of the emotions

inspired by those events, and to understand the social contexts between interviews where I was not the interviewer.

3.3.4. Selecting from the Sample Pool

For the present study, selecting a purposive sample of participants from this pool was a significant step in making the data. A total of 12 participants, and 52 interviews (4 per participant adding up to 48, plus 24-month interviews for 4 of the selected participants), were selected, which was meant to provide a thorough understanding of newcomers' experiences with qualitative analysis. As with most qualitative methods, there is no formal "rule" for sample size in a narrative study (Patton, 2002); instead, as appropriate to purposeful sampling, the number of participants reflects the overall goals of and rationale for the study (Patton, 2002). The sample size was selected to provide a sufficiently large data set to provide meaningful variation across key variables (research site, participant demographics, employment characteristics) but small enough to allow for deep narrative analysis of each participants' full set of interviews. The deep understanding of a small n of participants helps prioritize their individual voices, rather than crowding them out, or reducing them to categories that might erase individuality and humanity (Lyons & Labosky, 2002). A deep analysis of a high number of interviews for a low number of participants means the narratives effectively represent the messiness and open-endedness of human experience, rather than easily knowable and often reductionist categories and concepts (Archer et al., 2018; Barrera, 2014; Kim, 2016; Slaton & Pawley 2018; Tyson, 2016).

To support process reliability (Walther, Sochacka and Kellam, 2013), I purposefully selected participants to cover a wide range of newcomer experiences, considering factors that affect individual agency and surrounding structure. Specifically, I was interested in selecting a range of company sizes that were present in the data (from start-up to multinational company) as this affects aspects of identity

formation, such as diffusion of responsibility (Jasanoff, 2015), opportunities for innovation (Wenger, 1998), and the kinds of missions that companies can take on and engender their employees with (Haslam & Ellemer, 2008). Additionally, given the multi-case design of the C2W setting, it was possible that university setting could influence the identities that participants enter work with, given that universities provide identity constraints for participants before entering work (Goncher & Johri, 2015).

Given these interests, two primary selection criteria were identified to ensure the overall quality of the data set:

- Participants must have completed all 4 interviews from graduation through twelve months of work.
- All interviews were of sufficient quality to support narrative analysis (see Section 3.3.5 for details about interviews quality).

From this pool, additional criteria were applied to maximize variation across key demographic variables, as follows:

- 3 participants from each site.
- Variation in company size within each site; company size was defined in the C2W study as “Small” (less than 100 employees), “Medium” (between 100 and 1000 employees), and “Large” (greater than 1000 employees).
- Diversity in terms of gender and race, with a target of 50% men and 50% women (no participants identified as non-binary), as well as having 50% white and 50% non-white participants.

In reviewing the interviews, it was not possible to meet all constraints. Many interviews not conducted by me were not of high enough quality because of the interviewer’s style, which often interrupted participants in the middle of storytelling. Again, this is discussed in the next section (section 3.3.5). The presence of lower quality interviews particularly limited the selection of

participants for site B, where I was not the primary interviewer. After narrowing down to participants with interviews of sufficient quality, the criteria to represent all 12 combinations of university and company size was almost met. However, no participants from University B or University D who met the initial criteria also went to a small company after graduation, though one participant from this pool switched to a small company during their first year of work. The sample does represent gender diversity (7 women, 5 men), which also improves pragmatic validation (Walther et al., 2013). With only 4 non-white participants there was not enough representation to thoroughly discuss themes of race. When participants brought up race in their interviews, that was included in their narratives; however, there were not enough participants to discuss themes of race in a trustworthy way, so race was not focused on in the analysis. To summarize, the sample met the following selection criteria:

- Participants all completed the first 4 interviews, and 4 completed an additional 5th interview.
- Participants' interviews were all of high enough quality to faithfully represent participants' experiences in narratives.
- Participants represent variation in university (3 from each university)
- Participants represent variation in company size.
- Participants represent diversity in gender.
- Participants do not represent diversity in Race.

Table 3 details the demographics for the selected participants and is shown below. In order to protect the participants' anonymity, cohort, race/ethnicity, and site were omitted at the individual level. Across the sample, nine participants came from the first cohort, 2 came from the second cohort, and 1 came from the pilot study. Eight participants were white; the 4 non-white participants self-identified as Malaysian-Chinese, Pakistani-American, Asian, and Latinx. Finally, although the sample includes 3 participants from each of the 4 universities, the analysis did not reveal significant differences between universities of origin, which is consistent with prior analysis of the quantitative C2W data (Deters et al.

2020). Ideally, participants would have been given the chance to choose their own pseudonyms (Allen and Wiles, 2015), but the C2W study did not offer participants that choice, and assigning pseudonyms can imply identity characteristics, such as Whiteness, that participants would not choose to represent themselves.

Table 2

Participants Selected for this Study

Participant ID Letter	Company Size	Gender
A	Large	Male
B	Medium	Female
C	Small	Male
D	Large	Female
E	Med → Med	Male
F	Large	Female
G	Large	Female
H	Medium	Female
J	Small	Female
K	Large	Male
L	Med → Small	Female
M	Large → Med	Male

Table 3 describes the scheduled interviews in more detail. Not all interviews were conducted at exactly 3, 6, 12, and 24 months, so the actual time of collection is shown. Table 3 also shows whether the interview was conducted with me, Chris (represented with a “C”), or not with me (represented with an “N”).

Table 3*Interview Scheduling with Interviewers Indicated*

Participant	Exit Interview	Second Interview (months after start)		Third Interview (months after start)		Fourth Interview (months after start)		Fifth Interview (months after start)		
A	1-2 Weeks Within Grad Date	C	4	C	7	C	13	C	NA	NA
B		C	4	C	7	C	14	C	NA	NA
C		C	5	C	8	C	12	C	NA	NA
D		N	5	C	9	C	13	C	NA	NA
E		N	3	N	7	C	14	C	NA	NA
F		N	4	N	11	N	16	N	27	C
G		C	4	C	7	C	13	C	25	C
H		C	4	C	8	C	13	C	NA	NA
J		C	4	C	7	C	12	C	21	C
K		N	3	C	7	C	13	C	NA	NA
L		N	3	C	7	C	13	C	25	C
M		N	3	C	8	C	14	C	NA	NA

Finally, while it would be difficult to define any participant as “representative” of the full C2W data set given the range of workplaces and experiences embedded in this rich data set, these 12 newcomers faced challenges, accomplishments, and experiences that were typical for participants of the larger study, based on comparisons between participants using other qualitative coding schemes (Gewirtz et al., 2018). These were not the only participants to change jobs, to experience sexism, or to demonstrate the themes that form the results of this study. So, while each participant had a unique story, these stories were representative in that they contained experiences shared with the larger data and can be considered paradigmatic cases (Marshall & Case, 2010).

3.3.5. *Interviewing Approach*

The way these 52 interviews were conducted was a significant aspect of making the data, and provided multiple sources of trustworthiness for this study, including theoretical validity, procedural validity, communicative validity, pragmatic validation, ethical validity and process reliability (Walther et al., 2017). The qualities of the interviews that will be discussed are the *ethnographic nature of the interviews, a focus on agency/structure, multiple interviews over time, and possibilities for co-construction*. *Possibilities for co-construction* were the deciding factor for whether interviews were considered to be of high enough quality for a participant to be included in the study.

Overall, although the interview protocols differed at each point in time (3 months, 6 months, etc.), in general, the interview questions addressed the challenges and accomplishments that participants experience at work, the differences between work and capstone (on a competency level as well as a cultural level), participants' definition of engineering, and the recommendations that newcomers would make to better prepare capstone students for work. In addition, based on preliminary analysis of the first cohort, we revised the protocol for the second cohort to explicitly investigate engineering culture, asking whether participants felt like an engineer and what the culture of their workplace was like. The 24-month interviews with the female participants in the first cohort also focused on the role of multiple identities in engineering. The full protocols for both cohorts are included in Appendix A, but the most salient questions relevant to this dissertation are as follows:

- ...Tell me a little bit about your job. What are your typical responsibilities?
- ...how would you now describe what it means to be an engineer and what engineers do?
- ...to what extent do you see yourself as an engineer at this time?
- ...social, economic, political, or cultural issues. Do you see any factors like these impacting your engineering work?

- ...what has been most challenging about your job over the past 3 months?
 - What do you think made that so challenging?
 - And How have you dealt/are you dealing with that challenge?
- If you could give advice to the next class of graduating seniors about what to expect when they enter their jobs, what would that be?
- How would you describe the culture of your organization?
- How did your understanding of the broader context of your work/your company evolve over the past year?

The first quality of the interviews that improved their trustworthiness was that the interviews were done in a way that mirrored the style and motivation of the interviews used by Holland et al. in the figured worlds framework, which drew significantly on ethnography to understand the narratives of specific cultures (1998). While all interviews after the first were conducted over either phone and video chat, and were not paired with observation (disqualifying the interviews from most definitions of “ethnographic”) each interview involved a “grand tour,” questions commonly used in ethnographic interviews where participants explain their daily activities in a detailed way, as a jumping off point for talking about meaningful objects and situations (Spradley, 1979). Additionally, specific questions asked about the culture of their workplace, and illuminated aspects of each participant’s community of practice: the kinds of knowledge that matter at work, the relationships between the participant and people in other positions, the bottom line of the community (Wenger, 1998). This quality helped secure theoretical validity, making sure that the framework of figured worlds could be applied to the interviews (Walther et al., 2013).

Second, the interview questions specifically asked about participants choices in response to their surroundings. For example, their strategies for dealing with challenges at work, and their advice for newcomers both indicate choices that they made, or would make given the chance, and thus also

demonstrate how participants conceive of themselves within the engineering culture around them.

Beyond those specific questions, participants' positions as the main character of their narratives often naturally illustrated their agency: the goals they had, the obstacles they faced, and the way they navigated those obstacles. These kinds of questions, again, helped secure theoretical validity (because the theory concerns agency, structure and identity), but also procedural validation. Procedural validation concerns the aspects of the procedures that improve or hinder the fit between the theory and the social reality being studied (Walther et al., 2013). Asking questions that resulted in the discussion of choices within restrictions made the narratives of the data appropriate for this study.

Third, the use of multiple interviews over time improved the process reliability, procedural validation and pragmatic validation of the data (Walther et al., 2013). Process reliability, again, concerns the mitigation of the effects of randomness on the research. Multiple interviews allowed for participants to comment on their prior responses, as shown in the example below:

Chris: ...we were talking about a project that, as a result of that senior engineer, was approved before it was ready and had been built and people were trying to make changes after the fact and you called it a "money pit," I remember. I was listening to it not long ago so..

[Participant]: Yeah. Oh man, I remember this. I think probably that was, you also caught me on a pretty bad day for that particular project, so-

Chris: Yeah.

[Participant]: I might have treated it as a bit of a venting session.

Chris: That's okay.

[Participant]: But that project still sucks, I'm just not doing as much work on it.

Participants' comments on their prior responses served as a kind of initial member check, allowing for some of the random effects, or semi-random effects, such as a participant having a bad day, to be mitigated. Multiple interviews also provided procedural validation (procedures that ensure fit between studied realities and theory) because it allowed for continuity of topics over interviews, and revealed how participants' identities, reactions and beliefs about their choices changed over time (Walther et al.,

2013). Multiple interviews also improved pragmatic validation (testing of assumptions) because responses to earlier interviews were used to inform later questions (Eliot, 2005), which allowed interviewer misconceptions to be corrected (Walther et al., 2013).

Finally, the interviews selected for the study contained co-produced narratives, and participants who did not have co-produced narratives were not included in the study. Co-production meant that participants could guide the meaning of narratives, and the interviewer “follow[ed] participants down their associative trails” (Riessman, 2005, p. 3). While the interviews were not explicitly conducted with the intention of being used for narrative research, Mishler (1986), Riessman (2002) and Polkinghorne (1998) all claim that participants tend to naturally share stories when being asked about their experiences, so long as they are not discouraged by an interviewer who interrupts them. It was a rare occasion for me (the interviewer) to interrupt participants during their sharing of a narrative. Many of the questions were open ended and asked in everyday language, as recommended by Bamberg (Bamberg & Demuth, 2016) and Hollway & Jefferson (cited in Elliot, 2005). Even questions that were more closed would occasionally produce spontaneous narratives. The semi-structured nature of the protocol left room for exploring participants narratives further with follow-up questions, and participants could guide the direction of the narrative at some points during the interview. An excerpt of a participant guided narrative is below, where I started the narrative on a discussion of a challenge, but it moved to a place where the usefulness of courses could be called into question. Questions given by the protocol are underlined.

Chris: What was your biggest challenge on the project?

[Participant]: Probably the fuel thing, given that I got it last minute, and all the manufacturing that goes in with it. I think manufacturing's probably the hardest. From a cooling and oil perspective, we get that subcontracted out. We have a [European] company who sponsors us. So all we do is send them specs, and they send it right back to us. That's pretty easy as far as making that and just hooking it up, 'cause all you do is send your specs to them, they send your radiator back, you hook it up, and you put your tubing to it. So that's pretty simple

Our fuel tank is a clam shell design, so we have two pieces of sheet metal, bend it up, go over the top, and then you weld the edges. So if your tolerances aren't right, and the gaps too big, it's really hard to weld. I don't know if you've ever welded before ...

Chris: Yeah. A couple of times.

[Participant]: ... but, welding a gap is hard-

Chris: Impossible. Yeah.

[Participant]: Just welding in general, I'd practice welding for two, three weeks, even after the class. And I still wasn't good enough to do it. So just manufacturing in general. Learning plasma cutter, how to weld, how to use a machine shop with a lathe and mill, and all that kind of stuff. There's a big learning curve for that kind of stuff. Which also, is never taught academically. That's something you're only gonna get in the [Company]...

My interviewing allowed for the co-construction of narratives that were unique to each participant and detailed enough to draw conclusions about their experiences. Participants often described events as well as their responses or interpretations of events. Interviewing for co-construction, rather than accepting fragmented responses to highly standardized questions, made the narratives more accurate and trustworthy representations of participants experiences (Eliot, 2005; Wells, 2017), but also gave them a liberatory quality, allowing participants to share their definitions of themselves instead of needing to accept and reproduce external definitions (Secules et al., 2018). This quality of co-construction primarily improved the communicative validity of the data, ensuring that the information communicated was representative of the meanings that participants were making of their social realities. The liberatory quality of co-construction also improved the ethical validity of the interviews, ensuring that participants' social realities could be included and represented in the study, even if they weren't initially conceived by the researchers.

Co-construction of interviews and narratives allows me to answer "yes" to one of the primary questions for ethical validation (Sochacka et al., 2018):

With the intended research focus, do processes of making data empower research participants to construct their lived experiences in a way and with a focus that is significant for them?

When I was the interviewer, I was able to give participants some control over the co-construction of narratives. With multiple interviews, participants were able to reflect on previous events they had shared, and some reported the interviews as “cathartic,” or “therapeutic” because they were able to talk about what was on their minds. As one participant put it,

Chris: Is there anything else that you'd like to add, talking about Capstone or work or transitioning from one to the other?

[Participant]: No, I feel like I vented my whole soul.

However, even if I was able to co-construct narratives with participants with communicative and ethical validity, this co-construction was not representative of all the C2W interviews. Reviewing interviews conducted by other researchers showed that some other interviewers focused more narrowly on the protocol and did not give participants as much control or ownership over co-construction of the narrative, as in the following excerpt:

Interviewer: Okay, so you would say, do you feel more prepared for certain things, than you would for, say for HVAC design type?

[Participant]: Yes.

Interviewer: What would you say you're most prepared for? I'm kinda trying to tie this in with your Capstone. What would you say that you actually came into the job prepared for that you are actually doing?

[Participant]: I would say I'm prepared... let me think...I guess basics of SolidWorks definitely helped when I view in Revit which is a 3D modeling program.

Deadlines, that's definitely a big one, cause my job is basically projects based, so that's a big one. And also, I'd say probably that those are the biggest two.

Interviewer: Okay. Those are the biggest two. So pretty much almost being able to work under the deadline; the stress of the deadline, I guess, is really what you got out of Capstone.

[Participant]: Yeah, well. I feel like this job is a very specific field and I'm not going to continue this, like after my internship I'm going to look for other jobs,

Interviewer: Interesting.

The excerpt is an example of more frequent interruptions to take control of the co-construction and return to the protocol, as well as more frequent instances where the interviewer interprets experiences on behalf of the participant. Additionally, both questions asked in the above example were not open-ended, instead suggesting some of the form or content that the participant should respond with. In the above example the interviewer did allow for narratives to develop at much later in the interview (30 minutes later) but overall an interview conducted in this style would not allow for a faithful narrative to be constructed. In searching for quality interviews, interviews of this kind were rejected, and it was necessary to choose different participants who were interviewed in a way that allowed for participants to claim narrative control.

3.4. Data Analysis (Handling the Data)

As Walther et al. discuss, after making the data, it is up to the researcher (and their research teammates, to some degree) to handle the data and represent findings to the wider research community in a trustworthy, impactful, and ethical way. In this case, narrative methods were used to analyze the selected data set. As a general overview, narrative methods are based on the concept that narrative is a natural structure by which people create and represent meaning (Bruner, 1996). Narrative is also a significant aspect of the identity framework of Holland et al., as narratives contain meaning about the individual, their surroundings, and how they relate to their surroundings (1998). Additionally, the choice of narrative methods also fits alongside prior research in engineering education, using narrative methods to understand the meanings that faculty make of engineering (Pawley, 2009), to understand how narrative identity generates agency (Secules et al., 2018), and to understand how narrative demonstrates construction of professional identity (Hatmaker, 2012). Finally, narrative methods were an appropriate choice given the goals of this study – to interrogate existing narratives, and critique them in relation to lived experiences (Aguirre, 2000; Brescia, 2018; Ottinger, 2017). Ultimately, these

factors motivated the choice of narrative methods for this study. The narratives present in interviews were used to determine what meaning participants made of their own identities and the structures that constrained or enabled those identities.

While narratives were present in the interview data, there was a need reduce and analyze them. Reducing the data is often part of qualitative analysis and involves transforming the data such that it can further lead to interpretations and can be represented by whichever research medium is appropriate (Riessman, 2002). It is the process of turning parts of a transcription into something that might be represented in research form. After the data were collected and narrowed down to the 52 interviews being used for this study, those interviews were analyzed in multiple stages, which were as follows:

- Listening, Reviewing transcripts and Emotion Coding
- Narrative Coding, Structure/Agency Coding, and Memoing
- Constructing Narratives and Narrative summaries
- Analysis with Narratives

The process was guided primarily by Kellam et al.'s explanation of thematic analysis of narrative, but I also drew on the work of Saldaña (2015), Elliott (2005), and Riessman (2001). The following sections describe these phases in detail.

3.4.1. Listening, Reviewing transcripts and Emotion Coding

The first stage of analysis involved simultaneously listening to recorded audio, reviewing the transcripts of recorded interviews, and coding participants' interviews for emotions. This first pass through the data was meant to improve the trustworthiness, and especially the ethical validity (Sochacka, Walther & Pawley, 2018), of the results.

Listening to all recordings of interviews provided multiple benefits. First, it allowed me to review them for accuracy. I listened to each interview, corrected inaccuracies in the transcript, and included social cues, such as laughter, which were left out of the original transcript. The interviews were originally transcribed by an external service, and, because no transcription is free from interpretation (Riessman, 2005; Wells, 2017), listening to and reviewing the data allowed more of the interpretation of transcription to be mine. This improved the trustworthiness and ethical validation of the analysis, as my biases and motivations have been made clear to the reader, whereas for the original transcriber they are not available. Additionally, reviewing to correct inaccuracies gave a more accurate representation of the interviews. I had extra insight into what had been said, which came from having done many of the same kind of workplace interviews, from having an engineering background, and from usually being the interviewer speaking during the recording. Finally, re-introducing social cues like laughter was meant provide new insights into the social reality being studied (Riessman, 2002).

Listening to interviews also allowed for emotion coding that could not be done with only the transcribed texts. Emotion coding involved interpreting participants' speech for the emotions suggested by participants; discussion of various events throughout the interview (Saldaña, 2015). Emotion codes were entirely inductive, with new codes being developed by attempting to describe the recording. Inductive coding produced 15 emotion codes, which can be found as part of the larger codebook in appendix B.

The inclusion of emotion codes was based on the recommendation of Sochacka et al. (2018), to improve ethical validity by ensuring participants' social realities, and their humanity, were preserved even after transcription. As Sochacka et al. (2018) assert, awareness of participants' emotions is an important aspect of doing justice to their stories, and is one of the primary requirements of research to ensure it has ethical validation. Additionally, Saldaña specifically recommends emotion coding for narrative inquiry (2015). Emotions are part of what makes narratives coherent, so representing

participants' narratives requires representing their emotions (Riessman, 2002). Overall, this stage of the analytic process (Listening, Reviewing and Emotion Coding) was intended to preserve the emotional richness and wholeness of the narratives shared by participants.

3.4.2. Narrative Coding, Structure/Agency Coding, and Memoing

For the second stage of analysis, the transcripts were coded a second time using multiple codebooks, which can be found in the appendix. Besides the emotion codes, the codebook had two major sections: narrative codes, and structure/agency codes. While coding, I also wrote memos to pay attention to what themes and categories seemed to be emerging from the data and to practice *abduction*.

Narrative codes were used to indicate aspects of the transcripts that had narrative import.

Saldaña (2015) recommends an approach to narrative coding that was particularly resonant with my aims and the social reality to be represented.

To most narrative inquirers, insight into the meanings of participant stories depends on deep researcher reflection through careful reading of the transcripts and extensive journaling...The write-up requires rich descriptive detail and a three-dimensional rendering of the participant's life. The ultimate goal is to create a stand-alone story as research representation that may [...] deliberately stress open-ended structures to the researcher's recrafted narratives, structures that leave the reader with evocative closure and provocative questions rather than fixed answers (Barone, 2000) (p. 111)

Narrative codes included narrative, purpose of narrative, character, setting and plot (Saldaña, 2015).

Once the interviews have been coded with narrative concepts, the next stage of narrative analysis can show how individuals put their selves into practice and develop an understanding of themselves in relation to the figured worlds around them.

Interview transcripts were also coded for structure and agency, following the theoretical framework that guided the overall study. A participant's narrative showed how they placed themselves in relation to the larger structural narratives (Holland et al., 1998). Participants' personal narratives demonstrate their agency in two ways. First, through the extent that participants' narratives are

modeled after the expected experiences of engineers in that context (e.g. are participants striving to occupy an identity that was outlined for them by work, or is their narrative of work different? Do the settings, motifs, motivations, etc. of their narrative match up with the narrative of a typical engineer in that local context, or not?). Second, narratives, if participants have the ability to guide their construction, illustrate their own character, motivations, struggles, and agency (Holland et al., 1998; Secules et al., 2018). Even if participants' identity, goals, and the strategies for attaining those goals, were all prescribed by their workplace, it was still because of an individual's improvisation, their choice to adopt those prescriptions. The codes for identifying the relevant excerpts of interview transcripts were developed a priori, based on my prior knowledge of the narratives, and on Holland et al.'s framework. They focused on participants' agency in how different their narratives were from the local norms, and also in their choices as a character in their narrative. Additional structure and agency codes emerged from the data during the process of coding, in order to capture the full extent of structure vs agency negotiations that occurred in the interviews.

The codebook underwent multiple rounds of peer review, at multiple points presenting coded transcripts to peer researchers for feedback on whether participants social realities could be represented through codes. The codebook was finalized after 2 researchers reviewed an entire coded interview transcript for participant M. Involving other IRB trained researchers improved the ethical validity of the analysis by cross-checking their interpretations of participants' narratives against mine, seeking a kind of "inter-rater reliability" and highlighting the areas where my interpretations were rooted in my own bias, or are otherwise unmerited (Walther et al., 2013).

Memoing was done throughout the coding process to improve validity, especially by allowing me to attend to the logical process of *abduction*. Abduction involves constructing a causal explanation for surprises found in the data (Charmaz, 2006; Decoteau, 2017), and memos help by making assumptions and predictions explicit, so they can be tested against the data. Rather than ignoring the

incongruent or unexpected aspects of participants narratives, instead I worked to preserve them and change my explanations of the data. This process improved ethical validation because it lessened the effect of my preconceptions and stereotypes on the interpretations of the narratives. Riessman (2002), also seems to recommend abduction to improve trustworthiness in the analytical process of narrative inquiry.

Investigators must continuously modify initial hypotheses about speakers' beliefs and goals (global coherence) in light of the structure of particular narratives (local coherence) and recurrent themes that unify the text (thematic coherence). Interpretation of meaning is constrained by the text in important ways, offering a check on ad hoc theorizing. (p.86)

Employing abduction preserved the surprising aspects of participants narratives in a way that might be erased by deduction or inferential/comparative processes. Abduction also made visible the process of forming interpretations and analyzing the data, including these instances of surprise.

The codes and memos helped decide what to include in narrative representations (the third stage), supported the analysis of narratives and identification of themes across multiple narratives (the fourth stage), and also aided in writing the discussion and conclusion sections. Codes helped by allowing patterns to be seen (and themes to emerge) within and across participants, as will be discussed in the next section. The memos helped by fostering the development of themes and the testing of assumptions, through the process of abduction.

3.4.3. Constructing Narratives and Narrative Summaries

After coding and memoing, the third stage of the analysis was to represent the meanings and experiences of participants in narrative form. Coded transcripts were used to create a narrative for each participant. Afterwards, codes were again used to reduce those narratives to shorter narrative summaries that capture the aspects of each participants narrative most salient to both the figured worlds framework and the emergent themes, both for the benefit of readers and to aid in cross case analysis.

The reduction method used for this study is one described by Kellam et al. (2013), which involves thematic coding of narratives. Following the coding described in the previous section, the coded transcripts were reduced by removing irrelevant, uncoded data and rearranging the remaining text into a rough narrative. Finally transformations were made to the rearranged transcripts to form a more coherent narrative. Researcher and participant text was differentiated by using italics to indicate participants' own phrasing (and the core of the narrative). This method was appropriate for the study, primarily because it prioritized the words (and worlds) of the participants and matched a style of interviewing that refrained from interruptions (Kellam et al., 2013). The final transformation of the data allowed for a more readable and understandable account of participants experiences, which contributes to the ethical validity of the study by allowing for "productive engagement with diverse audiences" (Sochacka et al., 2018).

After removing all uncoded text, the remaining sections were rearranged to better tell participants stories. Often participants shared the events of their workplace out of order, and for the representative narratives the transcript was arranged in a way that more intuitively introduced concepts, settings, goals, and characters that participants talked about. Participants also reflected "out of order" due to the nature of the interviews. Participants' own thoughts about their experiences were not always grouped with their initial discussion of that experience, and interviews often involved doubling back as the participant remembered a key detail or the interviewer broached a question they had been waiting to ask. This doubling back was also minimized by rearranging the coded sections of transcript so that participants' reflections were positioned alongside events.

After rearranging transcript sections, the sections themselves underwent multiple kinds of transformation to reach a final representational narrative. First, to preserve the flow of the story, within participant quotations, pronouns were changed from first to third person (e.g., "I" to "she" or "he") and

verb tenses were changed from present to past. The additional transformations are summarized in Table 4 and discussed below:

Table 4

Transformations of Excerpts into Narrative Representations

Excerpt as Transcribed	Excerpt as Represented
Removing Wordiness	
but I also feel like I'm one of those people who would enjoy most anything.	but she also <i>felt like she would enjoy most anything.</i>
Combining Quotes of Similar Meaning	
<p>We were honestly just doing testing improvement concept to try to get it to work, which we couldn't do, so.</p> <p>...</p> <p>[Participant]:As well as a range of internal pressures. So, that was going to be what we were doing, but we had to start from the design phase. So, they gave us, this is what we need, and starting from there. We didn't actually get to realize our prototype this semester, so it was kind of a bummer.</p> <p>...</p> <p>I think the reason our project was not successful was because we didn't understand what needed to happen from it on the science side. We understood the engineering and we understood what had to go into design, but we didn't realize that they physics we were working with were so complicated.</p>	<p><i>They couldn't get it to work, and they didn't realize their prototype, which was a bummer. The team understood the engineering, but they didn't realize that the physics they were working with were so complicated.</i></p>
Adding Transitional Wording	
I think just showing up on time with a lot of energy is the biggest ... especially mid-semester when everybody is just tired.	<i>The biggest part of that was showing up on time with a lot of energy, especially mid-semester when everybody was tired</i>
Making the Implicit Explicit	
Like I've literally just typed in engineer and found jobs that seemed interesting. Some are in the food	<i>In searching for jobs, she just typed in "engineer" and found jobs that seemed interesting, some were</i>

industry, some are in green energy.	<i>in the food industry, some in green energy.</i>
-------------------------------------	--

These methods of transformation were meant to balance a preservation of the participant’s verbatim wording with their meaning as reflected by the codes, while still constructing a narrative that clearly outlined the events and identity developments that participants went through at work. Italicizing participants choice of words helped distinguish between my wording and theirs during transformation, not only to clearly differentiate researcher from participant, but also to encourage me to use as much of the participants’ words as possible.

To preserve the meaning of the transcribed interviews, during the transformations of the rearranged interview data, all codes were visible as comments in the Word® document. Keeping the codes for each participant quotation visible indicated all the layers of meaning that were present in the sections of transcript that also needed to be present after transformation. In some cases, it was necessary to “fill in the blanks” or use my own words in order to succinctly communicate the meaning as I had coded it (those instances are reflected with unitalicized font), but in those cases, the availability of codes ensured that the meaning was preserved even if the wording was not.

Once participants narratives were constructed, I reduced them to shorter narrative summaries to improve readability. This final reduction was done by selecting the aspects of each narrative most relevant to the research questions, structure and agency, and the emergent themes. The memos written during coding served as the inception for themes, proposing important relationships between the structures that a participant navigated, and the agency they used to navigate them - for instance one memo would note that a participant was being required to acclimate to the ongoing practices of work, but also that they seemed inclined to do so. In most cases a memo started with an idea or situation that a single participant’s narrative consistently returned to; or they returned to it once or twice but in a way

that demonstrated significant identity development. Employing abductive reasoning, I would search a given participants narrative for data that would disconfirm the presence of a theme. This was aided by the structure/agency codes – if the theme involved a participant’s resistance or positioning against structure, I would also search for instances within that participant’s narrative of positioning aligned with structure. In this way, I would generally try to account for the range of a participant’s structure/agency relationships in their narratives. Once I had established a theme that applied to one participant’s narrative, I would compare each participants structure/agency relationships to that theme. For instance, if one participant was more interested in the variety and design work a job could provide them than they were interested in the impacts of their work, I would investigate whether that was the case for all participants. To finalize the themes used for construction, I narrowed down the themes to the ones that were touched on in each of the 12 narratives.

To construct narrative summaries, I removed choices, events, or identities from the narratives that didn’t significantly contribute to the overall narrative and themes I had decided to focus on, but also those that I did not interpret as significant to the participant. In the narrative summaries there was an additional interpretation and reduction of the data, although a reader could avoid that extra interpretation by reading the full narratives (which themselves were a reduction of interview transcripts).

3.4.4. *Research with Narratives*

Bamberg draws a distinction between research *on* narratives, where narrative analysis is used to understand narratives in a mechanical sense (the parts of a narrative, the ways that narratives differ by place or time or context), and research *with* narratives, where “narratives are the tools to explore something else” (2002, p. 2). This section will discuss how research findings emerged from the narratives constructed for this study.

Reading through each interview and narrative, with codes highlighting their goals, emotions, areas of resistance, and the structures that surrounded them, gave me a sense of the ways to best describe the identity developments happening in each narrative. As mentioned earlier, memoing helped develop the themes, because during memoing I highlighted the aspects of participants narratives that I thought addressed the research questions; represented aspects of participants' figured worlds, agency, and identity negotiations; or could be compared alongside other narratives. Beyond the identification of themes, with memos I also tried to understand why participants made the choices they did, what identities informed their decisions, or places where it seemed that a decision was not being made - that they were engaging in default behavior (either enthusiastically, or begrudgingly). In part, this understanding of choices and identities came from comparing participants to each other within memos, identifying the places where participants choices, circumstances or identities seemed similar to each other or different.

Once the major themes had been established, I began to identify each participant's relationship to the themes as I constructed their narrative summaries. For each participant, I wrote a short paragraph explaining how I thought the participant fit into the theme, whether their narrative supported the theme as a theoretical description of participants' social reality, or whether their narrative subverted it (and why they may have subverted it). These paragraphs formed the foundation for my theoretical discussion in Chapter 6. In discussing the themes and their theoretical import, I returned to participants narratives summaries and narratives to support those ideas. But I also used their narratives to practice abduction, trying to see whether my idea stood up to their narrative, and if not, the explanation needed to be shifted to account for that discrepancy. In that way, I was also practicing judgmental rationality – I made interpretations of participants' identity developments, but none of their choices or developments were inconsistent unless they were inconsistent with ideas the participant had already affirmed.

The product of this analysis were theoretical explanations for participants agentic inclinations, and the structures they faced – detailing what participants’ narratives were, giving likely explanations for why they were that way. From that explanation, an explanatory critique could be levied against the grand narratives and pedagogical approaches that contributed to participants’ circumstances, in terms of whether participants’ circumstances represented flourishing or not. The explanatory critique was meant to spur questioning in the research community, and to sensitize researchers (or any readers) to the possibility that these themes may exist for other newcomer engineers – not proof that the themes do exist for other newcomers, but an indication of why they might.

3.5. Summary of Quality Measures

Measures of quality to ensure trustworthiness of the results were described throughout the preceding sections, but are also summarized in Table 5 below for clarity:

Table 5

Measures of Quality for this Study

Quality Measure	Definition	Measure Taken in the Study
Theoretical Validation	The degree to which the social reality being studied fit with the theory being produced (Walther et al., 2013).	<ul style="list-style-type: none"> - The culture-interested nature of interview questions (fits with) the ethnographic nature of figured worlds. - Interview questions about obstacles and strategies (fits with) the structure/agency aspect of figured worlds.
Procedural Validation	Concerns the inclusion of procedures to ensure theoretical validation (Walther et al., 2013).	<ul style="list-style-type: none"> - Inclusion of “ethnographic” interview questions, and questions about obstacles and strategies allowed for discussion of structure/agency in figured worlds. - Visiting topics over multiple interviews allowed for discussion of themes and identity development over time.
Pragmatic Validation	Concerns the degree to which the claims match the empirical results (Walther et al.,	<ul style="list-style-type: none"> - Using later interviews to test interviewer assumptions formed in earlier interviews. - Selecting a diverse pool of participants to reduce the hidden influence of demographics.

	2013)	
Communicative Validity	Concerns the degree to which the information recorded was representative of the meaning participants made of their social realities. (Walther et al., 2013)	<ul style="list-style-type: none"> - Co-construction of narratives on participants' terms and allowing them to direct the topics and nature of the narratives meant that narratives were not restricted to the meaning making desired or expected by the interviewer.
Ethical Validity	"Do the findings appropriately capture and represent relevant aspects of the social reality observed?" (Sochacka et al., 2018, p. 375)	<ul style="list-style-type: none"> - Co-construction allows for participants to talk about what was important to them. - Check ins with participants during interviews allows them to give feedback about research procedures. - Positionality statement gives readers context for my interpretations. - Re-transcription re-contextualizes interview data, and accounts for more aspects of participants' experiences. - Improvement of readability widens the purposes of the research beyond my academic benefit. - Use of abductive reasoning lessens the effects of preconceptions. - Emotion coding includes important aspects of participants experiences.
Process Reliability	Mitigation of the effects of randomness on the research (Walther et al., 2013)	<ul style="list-style-type: none"> - Purposeful sampling reduces the effects of demographics or any one structural context. - Use of multiple interviews per participant reduces the semi-random effects of mood or recency bias.

3.6. Limitations

While this study is meant to have intellectual merits and broader impacts, there are also features of the study that provide limitations to its impacts, and limitations to how transferable the conclusions are. There were some limitations on co-construction of narratives, and other limitations concerned the lack of a full exploration of all participants' relevant identities, and limitations associated with the small, self-selected sample of mostly mechanical engineers.

One primary limitation to consider is that the interview protocols were not explicitly designed to co-construct narratives for the purposes of the research questions guiding this dissertation. When interviewing, I had to be conscious of how “far away” from the protocol I was, and I was constantly compromising between allowing a participant to continue constructing a narrative and interrupting them to ask the next question, as the example below shows:

[Participant 1]: ...That's something you're only gonna get in the [Company]. Well, that's not true, you do have your, what's it called, industrial manufacturing course, or something...

Chris: A lab course?

[Participant 1]: Yeah, but you don't learn jack squat in there, man.

Chris: No?

[Participant 1]: No. I mean, you learn the basics to not get yourself killed. But actual, practical, "Can I go make something?" No. So in summary, manufacturing was the hardest.

Chris: Okay. So, stepping back, and talking about what you've learned from this project to bring into work that might be useful later, what do you think is the most valuable thing that you've learned from this project?

This interruption, not continuing to follow down the path of “manufacturing was the hardest,” reduced communicative validity, which (for the making of the data) involves “authentically co-construct[ing] meanings of participants’ social reality on their own terms” (Walther et al., 2017, p. 401). At that point in the interview, the narrative was co-constructed on my terms, and I referred back to a question in the protocol; I decided what was important for the participant to share, although later I would give control back.

Another one of the consequences of this aspect of the interviewing is that the narratives that we co-constructed did not explore other influential dimensions of identity as deeply. I did have sensitivity to gender as a personal identity that affects engineering identity, because this had been discussed by the research team, and it is an identity that a few participants were directly asked about in the 24-month interviews (of which there are 4 in this study). However, no interview prompt explicitly directed the conversation to other dimensions of identity such as race, religion, socio-economic class, or other

identities that might have been relevant to the participant. Still, because the participants were given the opportunity to direct and guide the topic of the co-constructed narratives, in some cases participants directed the narratives to these other identities. Two examples are shown below:

Chris: ...where have you gotten preparation for this kind of management and a lot of work that you're doing? Where have you gotten preparation for that?

[Participant 2]: I think my internships and just ... I think a lot of it is just like, as weird as it is to say, just how you're raised in your family culture.

Chris: Mm-hmm (affirmative) Could you talk more about family culture?

[Participant 2]: So, I guess like, my dad has a really good work ethic, and he always taught us that that's really important, and the most important thing in your job is working hard even if you don't fully understand it, or if you don't feel fully equipped. But just give them your best and showing up every day, having a good attitude, and just working hard, because it's hard to come by...So I think that had a lot to do with it. And basically just my background and the example that he set for us in just doing what you have to do in order to provide for yourself, and to be the best employee that you can be, even if you don't love everything about your job.

Chris: Okay. Can you give me an example of what a good attitude would be while you're working?

[Participant 2]: Not expressing your frustration openly when you've been here for 12 hours, but instead, looking at it as an opportunity that you've had 12 hours to learn...

[Participant 3]: I don't think it's anything related to school or [anything like that], I think it's more part of my upbringing, because I grew up in [Region], I came here as a refugee, I saw my mom work really hard, I saw my dad not work hard when he got here, and it just instilled this idea in my head that I don't want to be lazy. I want to be consistently motivated by something, and I know that my faith is a good driver of that and just my upbringing, and I think those two are the two major components that make me who I am and give me these qualities which can be good or bad, depending on the day and the application.

My methods of narrative construction attempted to preserve whatever aspects of identity participants discussed in the interviews. With the analysis, I may not be able to answer any questions with regard to these identities, because they are not particularly frequent, however, the narratives can still present opportunities “that leave the reader with evocative closure and provocative questions rather

than fixed answers” (Saldaña, 2015, p. 11). Including and preserving these aspects of participants’ identities in the narratives, however infrequent they may be, is an important part of the ethical validation of this study, as it is important to do justice to the participants by representing their identities. But it should be noted that aspects of identity that extend beyond work and education are somewhat muted in the co-constructed narratives, because of the interview protocols used.

There were also limitations associated with the sample. Although the sample was selected purposefully, to capture a range of possible influences on participants experiences of work, to capture diversity in participants demographics (at least in terms of gender), and in a way that was representative of the larger sample, there are aspects of the sample that make it not representative of all engineers, and not as transferable. While mechanical engineering is a broad discipline, and mechanical engineering graduates find a wider range of jobs, they are not representative of all engineers. And the engineering science graduates of the sample are less representative of engineering graduates as a whole, because it is a more rarely conferred degree. Additionally, the sample of 12 is surely not representative, even of all mechanical or engineering science graduates, no matter how diverse it is. The narratives resulting from the study should be taken as possibilities of the experiences graduates will face, rather than guarantees. Finally, the larger C2W sample was self-selected, rather than randomly sampled, so there may be a self-selection bias. The kinds of graduates inclined to participate in a study of the transition from school to work may not be representative of all graduates – most participants in the C2W study discussed their capstone experiences favorably.

CHAPTER 4: NARRATIVE SUMMARIES

The results of this study are the 12 narratives representing participants identity negotiations and improvisations in their first 1-2 years of work; the full narratives for each participant can be found in Appendix C . For ease of reading, this chapter reduces the data further to two-page narrative summaries of critical information. These summaries do not use quotations to distinguish the voices of the participant from the researcher, but they rely heavily on participant words and seek to preserve the informal tone of the interviews (e.g. use of slang, use of second person). Readers are invited to refer to the full narratives for direct quotations as well as for more detail about each participant's story. Note that in addition to removing participant names, other identifiable details, especially about participant's area of work, are changed to preserve anonymity.

4.1. Participant A

A had interned at a defense manufacturing contractor for 2 summers prior to his senior design course. That was the company that was sponsoring his senior design project, and that was where he was going to start work after graduation. It was a classified facility, so he already had a security clearance. There was the prospect of staying at the company for a long time – there were a lot of people that had been there for 25, 30 years. That gave him confidence that it was a good place to work. He could see himself doing that - he liked the area, he had family in the area, the company could also help him pay for an MBA.

A had been hired to take over one of the 30-year-old processes of the company, maintaining it, rather than designing anything new. It wasn't much engineering: he probably would never use the thermodynamics or fluid mechanics he learned in school. But he still solved problems. Sometimes those were just helping his older colleagues with software and spreadsheets. He had an advantage in

being the youngest engineer at the company by at least 20 years, though that meant he also had some maturing to do.

For the first few months, A was more of a shadow, always following whoever was cognizant over the problem or process. But after 7 months, A didn't feel like a recent college graduate anymore, but more like a professional engineer. It was getting real. He had finished up his probationary period, and he was starting to take over the necessary duties. He really did do the same thing almost every day. Go to work, fix a cup of coffee. Get down and check in with the guys on the shop floor. Do some more work. Fix another cup of coffee. Work 7 to 4:30. No homework. It was wonderful.

When his official transition date came, when they would pass ownership of the process to the next generation, there would be an official ceremony. Somebody could bring donuts. It would be a good time, very informal. And afterwards he would be initiated into the role, keeping this process running. It was a very specific process, with very specific attributes that they needed to get right.

After a year, he had come to appreciate the purpose of the company, national defense. He could take pride in his work, because he knew he was doing a good job, and he knew he was helping out people who protected the country. He wasn't expecting that feeling, but now it felt very important. At another job, he might make several people's lives more convenient, but it wouldn't have a broad impact, and it probably wouldn't be as real to him.

He had also come to appreciate the knowledge held by the technicians and machinists he oversaw. He had talked to them - they felt that most engineers talked down to them. But oftentimes the machinist knew more than the engineer. It was important to keep an open mind, to not take anybody for granted.

Things had started to fit into place as he reflected on his life. He was trying to build stability at work, but also a life outside of it. Some of his colleagues liked working because it was the only thing

they knew; they didn't have any hobbies. A had heard stories of people that got burnt out, which made sense if they had been doing the exact same thing for 35 years. In some cases, people worked at the company until they were 80 or 85, and when they finally decide to retire, they died a week or two afterwards, because their whole life was working. You had to have something else to do, outside of work. He was trying to strike that balance, and he mostly kept to a 40-hour work week.

4.2. Participant B

B wasn't planning on doing engineering for her career. In her co-op experiences, she had seen senior engineers. They knew the codes, the standards. They were fast, efficient and hard-working. That was the picture of success presented to her, the pinnacle of an engineer. It wasn't something she was looking forward to, not what she had planned for her career. It didn't seem like many engineers were creative or discovering something new, or even using a new technology. To her, engineering was a lot of repeating processes. Engineering was just about saying that you knew what you were doing and putting your authoritative stamp on things.

But she had taken a job at an engineering firm after they had given her only a week to accept it. She was going to stick it out for a year or two; she didn't want to seem like she was using the company. Her plan was to branch out into an engineering-related area, but to eventually do something non-traditional. She did have a minor in industrial design – she cared about design, how pretty things looked, form as well as function.

Early on she had been trying to craft her job. She didn't want to sit behind a desk the whole time, so when the opportunity came up for her to transfer, she took it. In general it seemed like the typical structure of the company was self-paced – everyone was busy, so you had to find work when you didn't have work. When they planned well, you were given a lot of work. But at one point she needed to maintain boundaries with her boss, and she made him aware that she was only going to be able to get a

portion of a certain task done. She had set boundaries on what she could do – something she had struggled with, before.

She also knew she enjoyed coding, so whenever she had repetitive tasks, rather than doing it by hand, she had been writing codes to optimize that process. Some had been helpful; some had been a waste of time. On some tasks she had spent too much time coding, to the point where it would have been better to do it by hand. But she had enjoyed writing code. She also thought that it would be beneficial later on, although that could have been a way of rationalizing it to herself, since she liked what she was doing.

The other thing she was dealing with was communicating with older males from the South. It was different from what she was used to, culturally. Relating to them was sometimes easy, but they had a different way of speaking and joking around. She had some older guys who would say inappropriate things. Maybe not super inappropriate - just pet names - but that wasn't okay. It was part of the job, but it was something in the real world they didn't talk about in school. There was a certain lightness that you needed. Her boss had in spades. He was great at just diffusing situations and not being offended, even when contractors were not happy. She wished she had that.

Many things about the company were good. The employees were free to take time off when they need to, and there wasn't a culture of overworking, in contrast to what she had heard from some of her friends at other companies. She liked that the owners of the company wanted to treat their clients like family. It seemed like a comfy place to be. But the work itself just wasn't interesting. The main thing she struggled against was boredom. After her transition to a new department, things were occasionally fun when she got to walk around all day and address problems directly in real-time. But those opportunities were short-lived, and she found herself unmotivated. They never created anything new, and they worked for a purpose she didn't find compelling, but ultimately, she was content to work because she knew she was getting paid for it.

When she tried to do things differently, it didn't always work out. When she made one of their programs more efficient, a manager she was unfamiliar with had critiqued it. She took his feedback with a grain of salt. He didn't see how much time the program had saved her. When writing programs in the future she would be stealthier about it, wouldn't bother presenting the code to her superiors. She enjoyed writing programs, so she might continue writing them even if it wasn't the best thing.

The performance reviews seemed mostly positive, and her manager did value her coding to change the way that they did things, though it would be harder to get everyone else on board for doing things a new way. And regardless of her performance, she had heard that if you didn't negotiate and sell yourself, they wouldn't give you a raise, which was true with any company. She would try to negotiate a meaningful raise, more than just to keep up with inflation.

At a year into work, she was unhappy; she wasn't challenged but she also wasn't sure if it was a millennial thing, and it seemed wise not to change jobs after only a year. She didn't want to make a huge career mistake, she didn't want companies thinking she was going to use them. She just needed to man up and talk to her boss, and treat the company like a person. This company was a good company, and she didn't want to treat them poorly. They had invested a lot of money in her and they weren't going to make the money back unless she stayed.

Her advice to newcomers was "If you don't like it, stick it out. Try to change the way that you work. Try to be creative in your job. Don't be afraid to advocate for yourself and don't be afraid to make waves. Don't worry about if you don't like it, things will develop and you're not going to be stuck there forever."

4.3. Participant C

C's senior design project was great for him. He had worked directly with a single client, designing a device to help them with their disability. He felt proud when they saw the client's reaction

to their efforts. They were doing real world problems, as opposed to the typical undergrad approach of doing a bunch of problems millions of people had already solved, which was not as rewarding. It was nice to see an item that represented his work. Now C was off to a job consulting about a niche technical discipline. While he hadn't taken classes in the subject, it was something he felt passionate about.

The job was in a big city, and he was excited for a change of pace. It allowed him to explore the city, socialize with clients from all walks of life. He was desperate to prove his worth and achieve a promotion so that he could be taken seriously, both by his colleagues and his clients. He wanted to be an asset to the company, a good team member, and working towards that would also help his personal growth. A good way to measure his production would be with number of reports. If he was able to produce more, then the company could also make more money because it would mean more jobs. He was very concerned with being reliable, showing up on time, dressing properly. When he had free time he would take down notes in a digital format, until he was known in the office for taking notes.

At a midyear review, he got feedback that he might be trying to run before he could crawl because of his desire for a rapid promotion, but he just couldn't stand the "Junior" in his current job title: "Junior Associate." Sometimes, pushing for the promotion meant needing to work long days, where he could only hope to eat and fall asleep once he came home. But, importantly, his work was enjoyable – he didn't hate it and he was willing to stay late.

A year into work, he did get his promotion - in two-thirds the normal time. He had matured a lot and felt like a true professional, but at the same time his growth had slowed down a little. In the beginning he was learning new things every day; now he had to stick his neck out. He was still trying to read one textbook page per day. He missed coming up with new products and solving problems no one had seen before. He had found side projects helping friends in need of a private contractor. Maybe he could do that for work? He wasn't sure what his next goals should be now that he had gotten his promotion. Maybe he would switch to another branch? Another company? If this job didn't work out,

80

he could always do finance. Whatever it was, he didn't want to stagnate - as people got older, their dreams tended to fade away, and he didn't want to be like that.

4.4. Participant D

The goal of D's capstone project was to test a prototype at a range of environmental conditions and try to get it to work. They couldn't get it to work, and they didn't realize their prototype, which was a bummer. The team understood the engineering, but they didn't realize that the physics they were working with were so complicated.

But once capstone was over, D was looking for a job. She had done a prior internship that dealt with green energy, but she also felt like she would enjoy most anything. The only job she didn't want to do for her first job was weapons research, because she felt that it would limit what she could apply for afterwards. She had heard that once you do weapons research you might get blacklisted. Sometimes people didn't want to hire you because of the bad press. She wanted to keep her options open. She was excited to go apply everything she learned from school, whether that meant green energy, or making something 10% more efficient. With her level of education, she could play that role in almost any business. She was also excited to start paying off student loans.

The biggest thing she was unsure about was the ethics of work. How would you deal with a supervisor who pushes something that shouldn't be pushed? Ethics could get tangled so fast. She would like to say she would do the right thing in most situations. If her boss wasn't willing to work with her she would go to his supervisor and get it taken care of, especially if it's a big deal. But if it were something small, it would be tempting to let it slide, especially if it would hurt the company, or cost people their jobs.

A few months later she started work at a national lab in a one-year post-baccalaureate "student" position, researching and modeling green energies for government grants and industry clients. There

was a steep learning curve. At one point a manager came to her and asked her whether she could learn a particular programming language in a week, which she couldn't do. She has also needed to learn more technical details and vocabulary, sit down and read a textbook for a couple hours each day. On the other hand, she wasn't worried about ethics anymore. The lab wasn't worried about profits as much as about publication. She felt that things were pushed more in an industry setting where profit was important. Ethics didn't seem to have any bearing in her position, because they weren't doing the designing.

To her, an engineer was someone who found a problem and worked at solving it, whether that was making something 5% more efficient, 5% cheaper, or 5% longer lasting, or coming up with an entirely new idea. Engineers solved day-to-day life problems. Thirteen months in, D had gotten her first "actual" engineering problem, doing stress analysis of a component system. It let her crack open textbooks that she hadn't touched in a while. It was the first problem that wasn't just reading or data analysis. It was an actual sit-down, pull out equations and figure out what you're doing, problem. The equations were very familiar to her.

The work culture was very relaxed especially for her and her coworkers who were in student positions. As long as work got done, her supervisors didn't care when you showed up for work. Their purpose at the lab was to get research done, but also to learn to be young professionals. She was often asked about what kind of work she would like to be doing. Her final answer was, "Whatever I have the opportunity for I'm not going to say no to, because you never know what opportunities are going to pay off."

Her advice to newcomers would be not to enter a job thinking they know anything. Always be open to learning. In the beginning she hadn't expected to be as lost as she had been. Graduating with an engineering degree was a big accomplishment, but it would save people a lot of frustration (and hurt pride) if they accepted that any new job, and any new situation, was going to require a lot of learning.

She also heard the advice to think of your career in two to four year segments, and tell yourself that you're going to be doing something new every two to four years. If you did that, you would never go stagnant, and you would always want to learn the next new thing. In four years you might be applying to new jobs. The next big thing could be tomorrow, or five years from now, and either way you had to be competitive in the job market.

4.5. Participant E

E held leadership positions on both of his senior design teams. It wasn't a huge deal, more of a communication thing. Being lead just meant taking control of making sure that everything sticks, that everything follows the schedule they made at the start of the semester. It meant putting the responsibility for project completion on your shoulders, but also making sure that everyone was doing their part.

For work, E had secured a full time position at the energy company he had been interning for the past year and a half. During his internship they didn't expect too much because they knew he was busy with school. He knew that, going into work, he would be writing calculations and reports, somewhat related to what he had already been doing as an intern. He also knew he would be doing CAD modeling, which he regretted not learning more about. He expected to be teaching himself at work, which he didn't mind, though he did understand the company wouldn't have hours for him to be sitting around, working off overhead hours, trying to teach himself the software. He was also nervous about the responsibility of no longer being an intern. As a full time employee, he wouldn't always have someone checking his work. He was worried about making an early mistake and needing to re-do all of something.

In the beginning, E enjoyed his work, despite the fact that it was a lot of report writing, and despite questioning whether he wanted to do this work for the rest of his life. He got stuck pretty

frequently, not because he wasn't prepared for technical writing, but because each site had highly specific technical details to keep track of, and all the little technical details could add up. With these details, he didn't see a place in college for learning them because they were so company-specific. Anywhere you went, the challenges were going to be primarily technical details, getting acquainted to the job that you were doing specifically.

In his first few months, motivation was come-and-go, but he did get opportunities to work outside the office on interesting hands-on technical projects. Still, he wished he had been pushed more into graduate education, but at the time he had felt like he was stuck doing mechanical engineering. The longer he waited for grad school, the harder it would be for him to start.

By eight months into work, the company had lost a major client and things had slowed down significantly. E was one of the few people bringing money into the company with his outside projects. The company wasn't communicating it very well, but everyone was worried about job security, so they had started looking elsewhere, including him. Luckily, he had a lot of connections through work, so finding jobs wasn't so difficult. And the opportunity to leave his job had silver linings – it seemed most people found the field boring after a few years, and he had always had law school at the back of his mind. This could be his opportunity to apply.

After a year at the job, he left, and quickly went through another job which wasn't a great fit – no design creativity, and they didn't support his personal growth as much. Finally, he arrived at a position that felt more like engineering, more like capstone. He had applied and been accepted to law school, which was enough for him to cross it off his list. Now that he had an opportunity to do actual engineering, apply principles he learned in school, he wasn't looking to law school as much. Being accepted to a law program was as far as he went. He knew now that things didn't always meet your expectations. For example, he had expectations of staying at his first job for multiple years.

In this new job, his goals including getting an engineering masters while he worked and networking with everyone along the way. Making sure people knew you were a good worker was important because you never knew when you were going to need someone to vouch for you. Your reputation was going to follow you around. He still needed to learn about how to disagree with managers and hierarchy. Even if you got along with them most of the time, there were going to be disagreements, in which case it was up to you to make a strong enough case for why someone above you should listen. But if you disagreed with everything? Maybe that was a warning sign that you weren't fit for the organization, that you needed to get out.

4.6. Participant F

In school, throughout F's design projects, there was no challenge that she came across that she didn't overcome, nothing that she needed to understand that she didn't by the time she graduated. Capstone had helped her become more confident in her abilities to perform any sort of a task, helped her know where to start. Even her junior year project experiences helped her know how to work as a team effectively, if only by showing her what not to do.

She had landed a job at a national lab, and she considered herself lucky. She hadn't interned there before, so she wasn't sure why they had chosen her resume. She was a little nervous, hoping that she hadn't made it sound like she knew too much. Before starting work, she wasn't 100% sure what the job entailed, but she did know it was a hands-on position, and she was excited about not sitting in front of a computer all day. She had some sense that it would be very similar to capstone. She was planning on staying there a little while, for at least 5 years. Ideally by then she would be doing something different, would be smarter, and might even start a Master's degree.

At 4 months of work, F didn't yet have any highly specific responsibilities. She mostly did whatever anybody told her to do, which could range from working on image editing to testing

components. Most of her work was sitting in front of a computer, though. Boredom was a new challenge for her. There was a lot that she wanted to do, but she didn't have the experience to do it.

As things went on, she began to feel more comfortable, and more like an engineer. The company's design process was about the same as capstone. You had meetings, you came up with a design, you planned, you came up with a prototype, there were reports and presentations that needed to be done. From capstone, she learned produce something quick to get a better idea of the scope. The faster you produced something, the better your product was going to be. She also found that if there was a problem or concern, she was able to go through and explain, propose solutions. It seemed like going from zero to a hundred percent design was what it was going take to be an engineer.

After two years of work, things were good but busy. F felt fortunate that she got to travel. She got to travel and get paid for it, which she didn't think could happen. She had also learned how to say no to work, which helped. When she first started, she was overwhelmed and confused. Since then, she had learned when it was too much for her to handle, when she couldn't take on a project. It felt less like a big deal to deny a request, even when she knew it would make things difficult for her project lead.

She wasn't really doing engineering. Her position was responsible for getting things ordered, submitted for review, shipped and received. That didn't mean the position wasn't important or beneficial to her. She was learning how the world worked and gaining experience, either way. That said, it was a lot of the same thing over and over and over, so it wasn't something she would continue to do. She would do it here and there, but not for her career. She would tell anyone it wasn't her dream job, but she did enjoy it. The traveling made her feel fortunate. She got paid well. There was a lot of opportunity at work, so she wasn't pigeon-holed into a particular role - she could easily move on to something new if she got bored.

Sometimes she did occasionally have a challenge with the physical labor. They treated her differently as a woman, but it was for a good reason; she knew there were some things that were too heavy for her to lift. On the other hand, she felt she had to contain her emotions because if anything ever bothered her, people would treat her like their little sister, try to hug her and calm her down. She didn't understand why. She just wanted people to listen to her and work on what was frustrating her. Why couldn't we just have that conversation? she wondered.

On another level the company was never going to be her dream job because they were involved in defense projects, and that wasn't what she wanted to do with herself. Anything that had to do with weapons or military, she was not interested in, in the long run. She wanted to put her efforts into saving the planet, saving animals, and making sure there was enough food for all the people. She wanted to see things thrive, not see them be destroyed. She would like to do something more on the lines of sustainability. But she hesitated. It seemed like there was a lot of red tape, which could make progress in that area very difficult.

Fresh out of college, she had had no reason to turn the job down. She hadn't been expecting her dream job. She had heard it was a great place to work (and it was). She had figured the experience would help her find her dream job. Now, she felt very secure in her job. There was so much work in her department, they were overloaded. She could stay in this position for the rest of her career if she wanted.

4.7. Participant G²

G spent some time as project manager during capstone, but beyond setting schedules and managing, G also did the CAD modeling for the project, which was a killer. She was a perfectionist. She had to get all the dimensions correct. When she started the CAD modeling, she was doing it alone, and she ran into so many problems. But it ended up working out. Things actually fit together in the end.

At the end of the course, she felt much more prepared than she had been a year ago, and the project manager role she took on played a big role in that. She knew now not to have meetings for no reason, how to close meetings before she wasted people's time. Having the responsibility of setting up meetings with people outside the team was also good preparation.

For work, she was going into a consulting firm where she was going to be doing HVAC design as entry-level person. It was all very mysterious to her. She didn't know on a day-to-day basis what she was going to be doing or who she was going to be working with. It was kind of scary. She had been a student her whole life, had never really worked in a professional setting. She had previously worked at a summer camp for five years where she was basically paid to be a kid. She didn't want to lose her childness. She didn't have other companies to compare it to, but the first interview she did there, they gave presentations about the company that really sold her. The company was really sustainable, they worked on really cool projects, but they also had a philosophy she wanted in a company. They paid

² A version of G's narrative appears in an article forthcoming *Engineering Studies*: Gewirtz, C. & Paretti, M.C. Becoming after college: agency and structure in transitions to engineering work.

attention to work-life balance. The employees did activities together outside of work, like hiking trips and baseball. Everything they were doing, she would do.

What she did know was which CAD program her new company used. It wasn't one she'd learned in school, so she had been watching tutorials on it. She was trying to study up on what she should. She emailed her boss before she even graduated and asked, "Is there anything I should be knowing?" She just wanted to come in prepared. But everything they needed to know, the company would teach when they got there. She knew that.

When she started, she was glad to hear that she could take naps if she needed, and she had control of her hours. Some employees had other first priorities, like their families, and that was fine with everyone in charge. She was interested to learn as much as she could so that she could be an asset to the company, hopefully through tasks that also concerned sustainability. Most of her time was spent working on more mundane projects, though, where were not necessarily concerned with sustainability. But eventually, through a mentorship circle, she got the chance to work on a green energy project, which was exactly what she wanted to be doing. She did have to stick up for herself to her manager and argue to him that she had enough time to do both her main HVAC design work and the sustainability work. And she had to back up her arguments with impeccable time management.

Through the circle she got other sustainability projects too, and she learned on-the-job about the kind of coding and budget calculations that were necessary. In one case she learned about budgeting for sustainability only after she and her partner had submitted the documents. Although the project didn't turn out as well as she would have liked (their obsolete calculations supported Combined Heat and Power over green energy), it was still the kind of sustainability work that she was interested in. After a year of work, she had been getting a little "skyscraper-ed out," and she didn't want to be stuck as "the skyscraper person," which seemed to have happened to some of her colleagues. She was glad to balance out that CAD work with sustainability opportunities.

After two years of work, though, things had shifted. She found herself in a rivalry which had been making work suck: one of her colleagues made her seem incompetent and would communicate with her manager but leave her out of conversations. At the same time, the managers had assigned her projects which were good for beginners, but they required 80-hour work weeks, which she wasn't comfortable doing, but she also was a little afraid to work part-time. And no, it had turned out that the wellness room wasn't for napping in.

Her biggest challenge though, was balancing her time between environmental activism and work. In order to do both, she found herself taking activism calls at work, and bringing work home. Recently, a miscommunication with a senior engineer had put her abilities into question. She hadn't been able to deliver important results on time – but the senior engineer also hadn't communicated deadlines and expectations well to her. Was she just a slow worker, or were other people just rushing through the work they were doing? Every time she took her time to really understand the work she was doing, and do it well, she felt she was taking double the time people were expecting. It struck her that her that the ongoing miscommunication in her engineering job was so different from her activism work, where everything was about uplifting each other. Eventually she and the senior engineer did talk it out, and it was a jolt that reminded her to get her head in the game. Her plan was to turn off the podcasts and music while she was working, and try harder at work. Things would be better once she was fully focused all the time.

4.8. Participant H

H had been a Scrum master on her senior design team, so she was a little familiar with what the role was supposed to be. She had landed a project management job with the same company that sponsored their project, which was exciting. She was going to be the company's only project manager. She had taken many classes without a cohesive picture about herself and what she wanted to do. But

now she was confident that she wanted to work in healthcare tech and software, and that her skills were more in the area of management – not that she couldn't build software, but she knew her strengths. And she was excited to be part of this company, excited about its mission.

When she started, it was hard. She knew what she was supposed to be doing on paper, but senior employees had a hard time trusting someone so new. She was going to be managing a newly formed team with people from all different disciplines, and they weren't always clear on the difference between a Scrum master and a manager. She was supposed to be more of a facilitator, or a coach. It took a lot of her own initiative to define the role. At first, she would check in with her manager, but eventually she began to think on her feet, and became less afraid of making the wrong decision.

In her job, it was important to keep a clear head, look at things objectively, and try to understand another person's point of view. She was trying to practice active listening, encouraging her team members to speak up rather than vocalizing her own thoughts instantly, which she knew she was prone to doing. In part her desire to do better came from a common human need to feel liked. Of course she wanted to do well in the project, but she also wanted to be liked by her team members. She was also very invested in the team getting up to speed, so it could succeed and serve the company's needs. The biggest challenge would be unifying the team.

After a year, she and her team had seen a few successes, and she was proud of them, even if they had been a little dysfunctional to begin with. But her managers didn't seem to recognize those successes, and in their opinion, the team "sucked." She tried to convince them that the team just needed a little patience, as opposed to needing to be "whipped into shape." From her perspective, there were multiple problems with management, especially as they reorganized the company. They seemed attached to the Scrum framework, but every training she had been to told her that was only one way to do things. No-one was asking how people felt, and instead they were focusing on hiring more people, which would just scale the problems up. People over profit was an important philosophy, because it

gave teams the psychological safety they needed, but she wasn't sure if that's how management was thinking.

Eventually, as she was going to be added onto multiple new teams, she was given the choice to leave the old one, which she had been so invested in. It was a hard decision, but she chose to leave her team. She didn't want to share the team's bad reputation when they didn't seem able to shake it. Plus she had an opportunity to learn about new technologies that other teams were working on.

Still, by one year of work, she was at her lowest point. A friend of hers had recently decided to leave for another company, because she had had enough busywork, although it wasn't clear how well her friend had been communicating. Maybe it wasn't as bad as it seemed. Still, she was stressed. There were times where she didn't know why she was doing what she was doing. She didn't know if she was making impact now, of the kind she used to make. It seemed like she had less responsibility, but at the same time more. The things she liked doing, she was doing less of, and she was doing more of things she didn't want to do. But she didn't necessarily have a choice.

4.9. Participant J

J's capstone project involved a lot of CAD. When the project started out, only half of the four-person team knew CAD, including her, and it was up to them to teach the other half. J had survived college only by asking for help, she had needed to get over pride and doing things on her own. At the same time, she knew employers liked employees who were self-sufficient. She also knew she wouldn't always get help, that she might be isolated, especially as a woman of color. Finding relationships at work would be important. She had applied to a few engineering jobs looking variation, so that she wouldn't get bored.

Before landing her job, she had told herself that she didn't want to be a project manager, but that was the kind of position she found herself in at work. Her job was more of a process manager

position. She works very closely with the sales team. When they got a sales opportunity, her and her team designed and provided customers with prototypes based on whatever they wanted. The turnaround time was quick. She also needed to manage projects, making sure team members were doing things that progressed the projects, making sure that the team met deadlines, and making sure that everything was fully documented. More recently, her boss has been putting her in charge of scheduling projects and coordinating with other departments, making sure they were well-fed with information so they could do their jobs. It was difficult dealing with frustrated people when she didn't have much authority, but she found that a diplomatic and empathetic approach to communicating seemed to work. Most people she talked to didn't seem used to it.

As time went on, the work for her team kept increasing. Partly this was because people kept dumping work on them – they never seemed to remember what she nor her team did. Then one of her team members quit, which increased the workload more. She and her team members were starting to get a little burnt out. She was also exhausted because people didn't seem to take her seriously - perhaps because she was younger, perhaps because she was a woman. Regardless, her presence didn't seem to prevent any sexist or racist jokes from her colleagues. She wished she was a better advocate for herself, and knew that she should be prioritizing her own needs above the company's, in contrast to the blind loyalty she saw from some of her co-workers.

A year in, one of her supervisors quit – he was sacrificing his life for work, and the CEO kept making promises that weren't possible for the team to fulfill, which made them look bad. Her two supervisors had always challenged the CEO on his unrealistic promises, and if both of them left, they would have no way to resist. She also noted that with the unrealistic promises, the company seemed to be deviating from its proclaimed philanthropic and environmentally related mission. The company was starting to stretch itself thin, and dabble in projects outside of that bigger picture, and it made her uncomfortable. To her it was an issue of honesty. The company should be focusing on what they said

they were good at. On top of all these issues, some people weren't being paid fairly. Things had been frustrating. She herself was thinking of quitting, but her supervisor hadn't left yet. J had reassured herself that she deserved to be heard, and just because other people didn't listen didn't make her a less valuable person.

At almost two years into the company, an accident happened with the prototype her team was working on, and it was the last straw. Her team had warned the company about pushing the limits of the prototype, but those warnings were ignored. She had seen her co-workers get laid off a few months ago. Additionally, J had been motivated in her work by the company's environmentally related mission and its philanthropic work. She was committed to the bigger picture, but now she didn't know if that picture was true anymore, and she wasn't sure if the philanthropic work was still happening. And the confrontations and politics at the company were only getting worse. She was looking for other jobs.

People seemed to see her as a child and were surprised to find out she had technical ability. She felt alienated from her all male, usually white, older colleagues. In the lunchroom she would talk to the technicians, or the cleaning staff. They looked like her, and they understood her. They were proud of her for being a representative of their people in a higher position. With the other male engineers there were no commonalities. It was usually very short conversation. She missed her college, being surrounded by women, or at least a couple of women. She missed being around people that in some ways look like her.

4.10. Participant K

In picking his senior design project, K had wanted to work on something related to the automotive industry. Then he learned about the project he ended up picking. It was everything he wanted to do – mechatronics, autonomous systems. It was supposed to be a mechanical engineering project, but there was a heavy focus on software, as he found out. Being able to get the software to

work the way they wanted it to sometimes hindered the team. They ended up building software to be able to control their machines and came up with some hardware to support the project. Things didn't go exactly the way they wanted, but the clients were happy. They were a little bit disappointed when the team's demo didn't work, but they were satisfied with how far the team got with documentation, everything they had found, and all the information they had presented.

Now he was preparing for a job at a large automotive company. He was excited about the opportunities available to him in the job. It was a big company and he was going into software. It was exactly what he wanted to do, because he would get a lot of real world experience with software, coding. It would open up the whole career path of software development for him officially, so he could probably go the software development route. He could also move around in the company and go the mechanical engineering route. And of course, there was the business sector and management. Maybe in 10 years he might want to move into management. The company also did work with autonomous vehicles, which was appealing to him. There were a lot of opportunities, and he was ready.

He was nervous about workplace etiquette and fitting in, watching the way he spoke. He wanted to make sure he did it right. Communication with all kinds of people was useful both in your professional and in your personal life, and he thought it was one of the key elements to success in any industry.

After 3 months of work, he was finishing up training. His first two weeks he sat next to two new college hires on his team. They had slacked off. They would watch Bob Ross videos if they had nothing to do. K took more initiative than they did. He was more available, proactive and curious. He preferred to work with another college hire with a mindset like his own, who was also interested in increasing his visibility. He liked that there were young people who were laid back, but they were also focused on growth. Work wouldn't dial back their expectations for you to perform.

He thought newcomers should give their all and be available as much as they could. Going beyond what was expected of you would get you ahead and set you up for growth. People weren't there to help. The primary goal of people interacting with you in college was to help you grow, and the primary goal of people interacting with you in corporate America was to create value, generate revenue. Personal growth was second to creating value. People were invested in you because you had value to them, but you could grow by pushing yourself. It was also important to take care of yourself outside of work.

After 7 months, his main role has started, developing new software. There was no real blueprint for it. The goal was to do things the same as before, but from scratch. Much of his team was at another office, testing his code. Face to face would be easier. Virtual conferencing amplified the communication issues he was worried about. But things were going well. He was proactive and keeping a positive attitude. He was volunteering for more challenging tasks. He wanted to learn and impress his boss.

One challenge he encountered at work was disgruntled employees, people who were super negative all the time, who would say "Why are we working for corporate America? We're just a cog in the wheel." He wasn't prepared for the challenge of working with disillusioned people who didn't agree with the policy or didn't feel valued as employees. It was detrimental to new college grads if they didn't know the expectations around how much they should work. Then they wouldn't work enough, or wouldn't communicate their needs, or the work they had done well. Showing a positive attitude working, trying to go above and beyond, showing that you cared, being visible, that was all important.

At 13 months into work, it was going okay. It was slowing down a little, becoming repetitive. It was a lot of looking at code that others had written, figuring out what it did, making sure it worked, and passing it down the pipeline. It was code he didn't like looking at because it didn't work very well. It wasn't his, so he didn't take pride in it. He had learned a lot technically, and he had been able to

practice his skills, but not as much as he would have liked. He wasn't getting as many formal presentations, or decision-making opportunities. He was just in technical meetings.

He asked his manager a few weeks ago if there were more opportunities to learn, but it came off like he was asking for more advanced leadership position, which didn't fit into the timeline for the college hire programs he was a part of. His manager said that it might be a better idea for him to wait because once he was promoted, the raises wouldn't happen as often. A new position wasn't really what he was looking for.

What he wanted to do was write his own code. and come up with his own solutions. He'd also like to explain why his decisions worked. He had a very small sphere of control. At a team level, he had the ability to make decisions, or at least provide input on some of the things that they should focus on. But a while ago someone else made a bigger decision that he disagreed with. Ultimately, it would be more desirable for him to make some of those bigger decisions, guiding more people. Maybe he wasn't quite ready for that yet, but being a leader might be part of the direction he wanted to go.

Aside from that, there were also decisions he would like to make about what was worth the company's time to accomplish. He was practicing making those decisions with a separate company-sponsored organization that tackled innovation challenges. They would assess how viable different projects were and work on them. They had only just gotten started. He wanted to see results after working on a project, to see how successful it was, how it might be integrated with the tools the company was already using, and then how much it saved cost, how valuable it was to the company.

He was hopeful for the future. Now that he worked for a big company and his work was more monotonous, he was in the position to plan his next five or ten years. He had noticed that other people were similarly philosophical. Before, he didn't really get it, he thought, "Man, you are in such a great company and you just have to keep a positive attitude and always work as hard as you can, and you

will be rewarded." Now he was in their shoes after a year, and he thought it was okay to have a skeptical attitude as opposed to a I'll-do-it-no-matter-what attitude.

4.11. Participant L

L's senior design team didn't have the good cohesive teamwork that some other teams had. She was not too sure how they had handled the project. In the first semester, she was really stressed out, trying to fix her teammates' mistakes, trying to follow their tasks. Towards the end, she changed her approach to "I can't fix everything." She learned to either let it go, just let her teammate talk. She was the kind of person to say, "this is wrong but if you try to tell me it's not, well, okay, whatever."

Looking back on the experience, she now knew that you didn't have to be buddies with your teammates, but you still needed to be both respectful and professional with other people. It would be better if you were friends - you'd get better results. But if you just hated the guts out of them, you could still treat them professional and clock out and never talk to them again.

L was looking forward to work, which would be working for a construction consulting firm. She really liked the field. Working on buildings and getting to work with the architect themselves sounded exciting. It felt like the work actually made a difference. Creating energy audits could save the client thousands of dollars. She might be missing technical experience, especially regarding the CAD program she would use, but she really liked the theoretical stuff: heat transfer, fluids, and thermodynamics.

But, although she was looking forward to it, the job was more of a steppingstone to another company she had in mind, which dealt with more complex buildings where everything had to be creative. She didn't see herself at her dream company even in five years, but that is where she wanted to end up.

In the beginning, work had a steep learning curve. Whenever she had free time, she would go over CAD drawings with co-workers, and come away with terms to look up on her own. Everyone accommodated her learning, including her supervisor. He would tell her what to do, what to work on, and if she was confused with anything, they could take an hour or two to clear things up.

She didn't feel a time crunch like in capstone, but she did see her superiors occasionally pulling 70-hour work weeks to get something in. She valued her free time more than she valued money or a great position. If the company tried to pull 70-hour work weeks for her too often, she'd probably quit.

After a few months, work proved to be a lot more boring than L expected. While she had liked doing energy engineering at her previous internship, she figured out she liked design more. She had been doing auditing, fact-checking, making sure the client was satisfied. Now she was looking for new positions at the company, but none were open for a design engineer. When they transferred her to a new position, tracking people down and filling out paperwork, she wasn't too happy. They said working under a PE would help her become a design engineer, but that meant she had to work in that position for multiple years, which she hadn't committed to. She had thought the position would be more calculations and engineering, but it turned out to be about chasing down people, and bugging them for documentation, pictures, graphs, signatures.

After two months in the new position, L left for another job at a very small start-up company. She had been talking to the owner, who offered her a new position as a design engineer. L decided she would rather work there than try to back-door her way into a PE. And this way was more direct, since the owner was a PE as well. Maybe L was a little faster at switching jobs than her peers, but it wasn't too abnormal. She just happened to have an opportunity to do it now rather than in two or three years. She was excited. She would be working from home, so she didn't have to commute every day. She was also excited about getting into modeling, like she wanted from the very beginning. And she was going to talk to the architects themselves, to see what their thought process was.

A few months into her new job, it was a bit of a struggle. It felt like she was still in training, given how much she was learning. And they still were adjusting to each other, for L, adjusting to a new work environment, for her boss, adjusting to being a CEO.

Most of her significant contributions were fixing spreadsheets. She didn't know why she became the spreadsheet wizard, but she did. At least she felt more like an engineer. But she was a manager and a secretary at the same time. She was doing everything, and she was stressed out - small company blues. There were a lot of great parts, but the downside was that there wasn't a good backup plan. If two people were sick that was two thirds of your company.

After a year in the new company, she was even more tired and stressed out. She didn't know if it was just her, if she should be liking work more than she was. It wasn't a bad job, and she felt like she was doing something. But she couldn't turn her brain off when she was not working. And since she was working from home all the time it was even harder for her to not work. Maybe she felt she didn't have job security. She always felt she was going to get replaced by someone better. She wasn't a very negative person, before. Maybe she just had more confidence back then. And she couldn't be burning out yet; she was only 24. She was supposed to burn out when she was 50.

If the job wasn't so convenient, she would be thinking about switching to a larger company, where she might get more support or not feel as much pressure to do really well. She was missing a safety net. Though maybe big companies also had those issues and she didn't know it.

Something that had been annoying her was she had been getting more clients who were looking to do the bare minimum. Rather than maximizing energy savings, most clients wanted to get a minimum level of energy savings. That's why one of their projects didn't get the funding they needed: the political winds had been shifting away from energy conscious decisions.

4.12. Participant M

M was proud of his capstone project. The team was part of patenting a product and helped create something that had never been done before, improving upon a-hundred-year-old design. Reflecting on the past year, he realized that he had developed a broader understanding of what engineers could do. Sure, engineers did R&D, research, designing, and prototyping, but the defining characteristic of engineers might be a certain way of thinking. One of the main things he took away from his education was learning how to learn. Engineers could do anything from design work to business. They knew how to problem-solve, and they could be put in almost any situation and do well.

He originally wanted an aerospace job, working on satellites, like his first internship. But a later HVAC internship opened his eyes to other possibilities. He had applied to maybe 35 positions. One company he applied to was in telecom. He knew little about it, but he figured he could try it out. He interviewed with them and they impressed him. It was just an overall good feeling, and he was glad he accepted it.

For the job, he felt prepared, because he would be using CAD software at work – he had taken a CAD class in his last semester to prepare. He was excited to move beyond homework and tests – though those were things he was used to. On the other hand, he was nervous that he wasn't going to know anything specific. In the interview they used words like "operations" and "equipment," which he was not at all prepared to understand. But he got the impression that people don't really look at those specific skills and if he knew how to learn and how to apply himself, he would be fine.

M was enjoying work at 3 months in, but it was a little iffy at first. He was hired as part of a large group in a graphics technician role, and it sounded like they would only keep the people that they like on board. He was a little nervous. He didn't want to be cut for not doing good enough work.

His first month he didn't feel like an engineer at all but more like a technician who was doing dirty work for an engineer. It unsettled him. But it also was always his goal to start off in the weeds; that way he would be more well-versed in the subject and the components involved. He knew there were chances for design work, and management seemed to understand that was what he wanted.

After 8 months, he had met one of his goals: to get project management experience. It had opened his eyes to engineering that was not just numbers and math, but communicating what you were working on to someone so they could improve it. He supposed he was only able to become a lead because he was a technician and did enough in that role to impress the lead who recommended him. Now he wanted a design engineer position. He would advise any newcomer to try the same strategy: take opportunities and mold them in your favor, even if they were uncomfortable at first.

Recently, when he visited home for Christmas, an extended family member asked him a few questions about work. "What's the benefit of the work? What's the bigger picture? Can you use renewable energy to accomplish those tasks?" They were hard to answer, not just for him, but for anyone. He didn't think about those things unless asked. A lot of it was lost, because it was all about getting what the client wanted, and the client wanted the cheapest thing done in the quickest amount of time.

A little after 8 months into work, M was laid off. Although it seemed obvious to him that it was going to happen, it still didn't feel good. After quickly going through another job, he finally landed at his third company. Things were going well until about a week or two ago. He had been striving to be a yes man, picking up any order he could. He felt he was doing his job quickly and efficiently, and he could make the most profit margin if he spent the least amount of time per project. But he was getting a little overwhelmed.

He saw himself as an engineer in this position. Problems came to him and he was supposed to fix them. He might not come up with the solution - they usually subcontracted that out - but without him, they wouldn't know there was a problem or what its constraints were. He saw himself at the forefront, identifying the problem and the constraints, and laying information out for someone else to fix it.

He also felt like a good guy at his job. He was preventing environmentally hazardous situations. On the other hand, the systems he was maintaining were military technologies, used to kill people. So, there was a balance there. It wasn't easy to think about. He wouldn't quit his job because of his realizations. But he wouldn't know how to react if this country went into all-out war. Maybe his work would be more necessary then, but still he would be connected to military technology. Before, he never thought about those issues, because all he did all day was write or draw lines on a program. He didn't really think about environmental impacts. Before, that wouldn't have been a deciding factor in what kind of career he did, he would just do whatever work was assigned to him. But being in various industries over the year led him to makes decisions based on what kind of work he would be doing. He liked being in a company that was trying to help people. His final piece of advice for future engineers: There are so many things to do in this world – it was important to live a little. Go work for an environmental engineering company helping environmental situations when you're a mechanical engineer.

CHAPTER 5: CROSS-NARRATIVE ANALYSIS

This chapter presents an analysis across narratives. The first section identifies patterns of structure and agency aligned with the four components of figured worlds; the second section identifies patterns associated with key variables; and the final section presents four emergent themes: sexism, exploitation, alienation/engagement, and dissonance.

5.1. Structure and Agency in Figured Worlds in Participants' Narratives

As detailed in Chapter 2, Holland et al. discuss four attributes of figured worlds: History, Social Encounters and Positionality, Social Organization, and Distribution of Individuals Across Landscapes of Activity. This section explains how each attribute manifested for the participants (the structures) and how they enacted agency within or against those structures.

5.1.1. History

The historical nature of their figured worlds meant that newcomers encountered existing expectations, practices, values, and norms (rather than creating these from scratch), which they navigated as they became engineers at their workplaces. Table 6 provides an example for each participant, though of course each encountered multiple existing structures.

Table 6

Examples of Historical Structures Participants Encountered

Participant	Examples of Historical Structures that each Participant Encountered
A	A 30-year-old system with all the kinks worked out, which should be maintained.
B	Traditions that determine which code is useful and which code is not.
C	Templates for project reports that should be adhered to.
D	Ongoing research on a specific family of technical problems.
E	Technical report templates with a list of details to keep track of.

- F A design process that is particular to the company.
- G Trainings for a specific CAD program (and a lack of training for green energy analysis).
- H The practices and responsibilities expected of a Scrum master.
- J Damaged supplier relationships due to the CEO's unrealistic promises.
- K The expected promotion timeline for a "new-hire."
- L Documentation for existing processes that must be tracked down.
- M A process that experienced through the roles of technician and project manager.

Newcomers needed to acclimate to the historical practices, expectations, and knowledge of work, even when they were confident in the practices and knowledge that they had gained from their schooling. D explained,

I felt that there wouldn't be that steep learning curve and I could use knowledge I'd already gained, I wouldn't have to go through and still feel like I'm in school almost. The first day they handed me a textbook and said, yeah you need to read this...just feeling like I'm lost again. Just not expecting to feel that way after I got out of school. I was shocked to my system. - D, 3-Month

The one-directional nature of acclimation meant that engineers were mostly given opportunities to become the kind of engineer that could carry out ongoing practices, whether those ongoing practices were related to internal processes, saving money, or satisfying clients. Participant E saw this one-directional acclimation as resulting from the specific technical tasks of engineering in general,

I think anywhere you go the challenges are going to be primarily technical details, just getting acquainted to the job that you're doing specifically. -E, 3-Month

In addition, multiple participants felt pressure to assume identities they had seen in more longstanding employees that represented existing ways of working, such as someone who exclusively worked on skyscrapers (i.e., a "skyscraper person") (G), an uncreative kind of engineer (B), or someone no life outside of work (A).

One exception to this process of acclimation was where there was very little history, as in L's second job with a start-up. In that case, there was evidence of significant mutual acclimation, as she explained:

We're just kind of adjusting to each other[...]for me, adjusting to a work environment as an engineer, for her, trying to be an actual CEO.

- L, 12-Month

D's narrative also indicated exceptions to the rule since she regularly engaged in learning that was new to both her and the company, and part of her role was sharing that new knowledge with other teams.

But apart from those two cases, newcomers were deemed to be an asset or not based primarily on whether they could carry out ongoing practices, or embody long-standing philosophies. Some participants A, C, G, K, and M explicitly mentioned becoming that kind of asset as one of their desires, as C's comment illustrates:

I think a good way to measure production would be like number of reports...I think if I'm able to produce more then the company can also make more money because doing more reports means you're doing more jobs...turning from someone who, I wouldn't call myself a liability, but turning from someone who is doing a lot of learning to someone who is really an asset to the company, someone who is completing projects and helping the company earn more money.

- C, 3-Month

While participants' narratives generally involved one-directional acclimation to the history of work, there were exceptions where participants' agency made them deviate from that history. For example, A leveraged his computer knowledge (which he associated with being the youngest engineer at the company) to help his older colleagues. And although C was intent on being an asset through increasing his ability to carry out a historical practice, he also engaged in a new practice of notetaking that still reflected his desire to be an asset. He explained,

When I have free time, whether it be lunch or something, I go and I type it up[...]and it's pretty well organized to the point where anything I've ever done[...]I can go through and find it[...]I think it could be a possible change that would benefit people[...]I figured out that I'm known in the office. I don't think anyone takes as many notes as I do[...] "You've got a notebook. And you're gonna take notes. Aren't you?" Kind of laughed at it. I think he was gonna be more laid back than I had planned for it to be. - C, 6-Month

Although the practice suggested a new identity, it did not require much acclimation on the part of his colleagues, and he did not face any obvious obstacles to implementing it. More often, however, when these newcomers attempted to deviate from historical practices, it was not always simple or easy. H received negative feedback about her management practices when she deviated from a specific version of Scrum that her supervisors had in mind. She explained,

We do all these trainings, and at the end of the day, the takeaway message is[...]Scrum is an agile framework. This framework is just an example of a way you could do things. You could use a ticket, adapt and modify it, whatever[...]If the team doesn't want to meet every day, that's fine, because they're a small team...I don't see why we need to use these hard and fast rules about every team, every single team! - H, 12-month

In the same way, B worked on developing new programs to save her time, but her supervisor was resistant to a non-traditional way of doing things. In G's case, the obstacles came when she and her mentor were not prepared with the necessary knowledge to properly deviate in their pursuit of green energy projects, compared to the traditional financial calculation methods,

It must have been at least a month since we sent it in the final test reports. And then, he just sent me an email[...] "Look at this, this would've been a really cool way." [...] We had been using the simple payback method[...] a lot of times the best technology recommendation that we could make was CHP, which is not really green. - G, 12-Month

Still, even with obstacles, the history of these figured worlds did not completely constrain newcomers' identity-based practices. For instance, B was intent on continuing to code to save herself time, despite the negative feedback.

If I do continue to write a program I'm going to be more stealthy about it[...] if I'm sure it's the best thing for me, what I'll do in the future is I'll write the program and use it for my purposes, but when I present anything to my bosses I will just use the dump sheets that it produces and edit it from there, so they're not confused. - B, 12-Month

Similarly, in spite of her obstacles, G continued to hold multiple identities, of activist and engineer, which gave her tasks to juggle and motivated her pursuit of new green energy work until tensions

between those identities came to a head in her second year. J insisted on staying true to herself and practicing empathy for her colleagues, even if it was a foreign practice to them and the company.

Though some participants used their agency to push for change or persist in new practices, most, when they were dissatisfied with the call to acclimate to the history of work, began considering other positions or jobs rather than trying to change existing structures. As E put it,

If you know you're right, maybe you're not a good fit for that organization, and maybe that's a warning sign that you need to get out. - E, 12-Month

Many newcomers were dissatisfied with the lack of opportunities to create something new, and found their adherence to history boring. Nine participants (B, D, E, F, G, J, K, L, M) mentioned boredom or an adherence to historical practices as something they were struggling with or planned to avoid. Some (F, K, L, M) sought other positions within the company, trying to renegotiate their position rather than change the structures. Thus F noted,

There's a lot of opportunity at [Company 1], so I'm not pigeon-holed, as you would say, into a particular role. I can easily move on to something new if I get bored or if I'm interested in something else. - F, 24-Month

For others (B, E, K, L, M), their dissatisfaction with historical practices and/or the lack of opportunities for non-boring positions caused them to consider work at other companies (or other non-company organizations), as E's comment above suggests.

5.1.2. Social Encounters and Positionality

Figured worlds are also structured by social encounters among individuals and the positions those individuals occupy. Thus, these twelve participants improvised their own identities in relation to both the positions they occupied and those that were available, seeking out desirable positions, and trying to avoid undesirable ones. The table below gives some examples of the positions that were available to newcomers at work.

Table 7

Positions that were Available to Newcomers at Work

Participant	Examples of Positions Available to Newcomers
A	A position alongside his colleagues in order to replace a senior employee.
B	A position where her novel use of programming is critiqued, which in turn requires her to “hide” the programs she creates to support her work from superiors.
C	A promotion that allows him to drop the “junior” in front of Junior Associate.
D	A student position where she learns whatever she can.
E	A unique position that allows him to bring in more money for the company.
F	A higher position that means being independent and catching your own mistakes.
G	A junior engineer position which means she will be assigned 80 hr work weeks.
H	A position she was offered on a new team, because the old one supposedly “sucked.”
J	A degrading position of note-taker. Colleagues can’t fathom her having technical skills.
K	A leadership position within a company sponsored innovation group.
L	A position at her first company that implies a commitment she didn’t sign up for.
M	A non-engineering position, from which he will work his way to a design position.

For newcomer engineers, their interactions with positions in their figured worlds defined their activities and helped them more closely identify what the actual work of engineering might be.

Positions generally came with a certain set of tasks, although they were not what newcomers always expected, as happened with L’s transition to a new position around the 6-month mark:

The [position] I thought was more calculations and engineering, and things like that, but it turns out it was a lot more chasing down every single person, and keep bugging them asking for documentation, documentation, documentation, I need pictures, I need graphs. I need data. I need signatures, and things like that. - L, 6-Month

Unsurprisingly, all the newcomers entered work with positions of low influence on their workplaces. For instance, although he could occasionally take on greater challenges, K’s position defined his primary tasks as editing “someone else’s code” and gave him a small sphere of influence.

G's position defined her primary tasks as CAD. And A's newcomer position involved being a shadow, as he explained,

For the first few months...I was more of a shadow. I was always following whoever was cognizant over the problem or process. I was kind of following around just listening. Now, it's more of me doing the talking and then figuring and working stuff out as an independent thinker I guess.

- A, 6-Month

But most were given opportunities to adopt identities that involved more power, to develop influence approaching that of their colleagues. Often however, those opportunities were only available once they had proven they could be trusted to wield that power properly – essentially, to succeed in the historical practices. If newcomers wanted to secure a more advanced position at the company, the company would ask them to demonstrate they had internalized the philosophies and methods of the company. Rather than unconstrained autonomy, or the constant feedback that constrained newcomers in their first months of work, newcomers' attainment of higher positions meant they would be self-regulating and constraining their own activities. For instance, F found that in her higher positions, she wouldn't have people to check her work, so she had to employ proper practices unsupervised, explaining that

I can't expect anybody above me to catch my mistakes, 'cause it's just, there's just so much going on. People don't have the time or the resources to really fine comb what I've done, so you, as an individual, we have to kind of fine comb things ourself. - F, 12-Month

Participants improvisations at work generally involved this relationship with the positions at the company. Though they could eventually resist and experiment, their practices were primarily defined in terms of receiving feedback about how to perform the historically defined practices associated with a position, and then performing those practices with at least some of those constraints internalized.

As mentioned earlier, some participants entered work with the intention to align their identities with those historically outlined within the company, and that was often accompanied by a desire to occupy a promoted position within the workplace. A, C, K, and M, all mentioned their desires to be promoted within the company. C's felt that in order to be promoted beyond the level of "junior" he

would need to be reliable, not being a draw on resources like the attention of his colleagues. A's position meant taking over for a colleague and working independently so their system could keep running. M wanted to prove to his employers and to himself that he was fit for an engineering position through his work as a technician.

However, not all participants were offered positions they desired within their current companies. L. wanted a design engineer position at her first company, but left for another company when she was told she would have to wait. B was frustrated with her promotion-but-not-a-real-promotion, which didn't come with a significant pay raise. H could not prove the effectiveness of that the team she was invested in, and was not willing to "whip them into shape," so she was only offered the difficult choices of being a leader for other teams. And J was consistently misrecognized as someone without a degree – she didn't think that having a degree was relevant, more relevant was the knowledge to back up her claims, but being a woman of color made it difficult for J to achieve positions of influence at her workplace. She phrased it this way:

Just assuming I don't know anything[...]I was analyzing data, which is what I usually do for my team. And they were surprised that I did that[...]I was like, "Why would you be surprised? I've been doing this for like two years." [...]They would tell me, "Oh, can you write these notes on a company form or whatever?" [...]It became really frustrating and kind of degrading, because I wanted to do so much more. I wanted to learn so much more...but I wasn't given that opportunity because people didn't realize that I had a technical background. - J, 24-Month

Finally, some participants sought to create new positions within or outside of their companies. When K and C both found that they were not growing enough in the positions they had achieved, they worked to create positions outside of their primary work – K as a leader within a company sponsored innovation group, and C as a private contractor for his friend. E negotiated a position with a separate technical group in pursuit of something that felt more like engineering. And G negotiated opportunities to improvise an identity of commitment to green energy, either through her mentorship group or

through her activism group, until her position as a junior engineer forced her to work on more traditional projects in her second year. In her words,

I was doing like 40 hours a week on [my second Skyscraper project] for a few months, so I was really nothing else and I was like, "Wow, a new opportunity and something that I actually wanted to do and asked for." And I was not about to just give that up because someone older than me said I shouldn't. - G, 12-Month

They can put junior engineers on [those projects], and they can go through the entire design process from beginning to end through construction all in the matter of two months. So it's great to learn, but extremely stressful[...]I don't know how anybody's supposed to know how to balance the workload they have with that kind of timeline, with things going on outside of work. - G, 24-Month

Ultimately, the positions available at work specified the identities and activities that newcomers could improvise to be recognized at their companies. And within those positions, newcomers were constrained in terms of the practices they were expected to perform, and how they were expected to perform them – some of those constraints being self-imposed in order to secure the position. Power at newcomers' workplaces defined those positions, and meant that some positions and activities were not readily available to some newcomers, either because of their race/gender (J) or because of their current position or lack of seniority (K, L, M), rather than hinging exclusively on technical ability.

5.1.3. Social Organization

Within figured worlds, the identities and opportunities for identity improvisation are sustained by underlying social organization that govern how individuals relate to one another. In participants narratives, those social organization took many forms besides the exact form of each newcomer's office, or place of work. In the course of improvising an engineering identity, participants had a variety of kinds of interactions within the organizations that they were a part of, sometimes leveraging their identities within one social group to improvise an identity within another social group, or socializing outside their company to improvise or test an identity that was more aligned with their agency. In the

table below, an example of social organization structures that influenced identity improvisation is listed for each participant.

Table 8

Social Organization Structures that Influenced each Participants' Improvisation

Participant	Social Organization Structures that Influenced each Participants' Improvisation
A	His maintenance team, looking for someone who can continue the process
B	Her company, which she believes will define her reputation for other jobs in the engineering field.
C	The consulting team, which he is trying to be valuable for.
D	Her subteam, which has valuable knowledge to share with others at a lunchtime seminar.
E	The former-employee network, which helps him secure a new job.
F	Her current job, which she supposes has less red tape than sustainability jobs.
G	Her mentorship group, which connects her with opportunities for green energy work.
H	Her team, which needs psychological safety and a people-over-profit environment.
J	A group of cleaning staff that understands her better than the average engineering group.
K	An innovation group he started so he could code from scratch and improve his standing.
L	Her new job, which will help her get her PE faster.
M	The team he manages, which is outperforming other teams in terms of efficiency.

Participants' social organizations were characterized by, and were organized around, historical practices, and positions within those organizations determined participants' relationships to those practices and to each other. For instance, A was hired to fulfill a specific purpose within his organization, managing a 30-year-old process that was part of the overall process that defined the company's purpose. His position and identity of "process owner" reflected how he fit within the organization, the activities he should perform, who he should manage (technicians on the shop floor), and who he was performing his activities for (his colleagues involved in other parts of the overall process). He improvised a good reputation, and the identity of being a good team-member in relation to his engineering colleagues, but also with the technicians he worked with. In part this was due to his

agency; he didn't want to be like other inconsiderate colleagues, but at the same time his relationships with technicians were a structural requirement for effective work, as they provided him with new kinds of information. He explained,

He's been working that same boring mill for 40 years now. So, if you have a question about what he's been working on, he knows more than most of the engineers about it...I think it's important for a lot of young engineers to kind of have that understanding. I've talked to a lot of operators and machinists that have this idea of engineers always talking down to them. They always think they know more. It's really oftentimes the other way around. So, I think being open to that idea is a big thing if you're going to work in a manufacturing type environment. - A, 6-Month

Participants' identity improvisations within one organization could have meanings for distant parts of that organization, or even for other organizations. For instance, in G's case, her identity as de facto "go to" person on a project within her branch of the company was recognized by other branches of the company:

Because I am the graduate engineer that's working the most on the project I have sort of become the go to person for a lot of questions from the electrical team and the fire protection tech team. - G, 6-Month

Participants' connections both inside and outside their companies presented opportunities for identity improvisation. The identities that engineers improvised through one social organization could prove meaningful for their identity development in other areas of their figured worlds. For instance, C's choice to work on a design problem for his friend reflected multiple meanings for him – imagined possibilities of consulting job independent of his current company, an opportunity to improvise an identity of engineering as he experienced it in capstone, or another way to perform the identity of "asset" to his company, all opportunities for growth. He noted,

One thing I do miss in engineering is kind of coming up with new ideas or a new product, or wow, that's a problem no one solved. I did sit down recently [with my buddy and talked about a problem he had...]And I realized look I have some expertise in that area, and I'm interested. So I started to sit down and started to yesterday after work I just kind of sat down and started to draw up some basic customer needs, and what was the problem he was going through? What might be some limitations? And what kind of a solution might be beneficial to my friend's situation, but also on a broader scale, is this something I could pursue?[...]I could work on this and possibly present a

product idea to a company that we work with, and maybe that's another way to become an asset of the company...I am displaying talents kind of beyond what's written on my contract. -C, 12-Month

Similarly, K improvised an identity of leadership with his external innovation group, G improvised an identity of green energy work within her mentorship group, and J improvised an identity within the company's cleaning staff where she was not degraded.

At the same time, participation in a social organization was not always beneficial, and an identity inadvertently developed within an organization could come at a personal cost or could otherwise conflict with a participants' agentic desires. For instance, H was invested in the team she led at her company, but she could not convince her supervisors that the team did not "suck," so, in order to avoid a negative reputation within the company, she felt she had to leave for another team. As she said,

I knew areas we could improve. But to me, the biggest thing of why I didn't continue is because I felt this huge mindset already built in to [exec] management about how this team sucks, and they would associate me with being with them. So even if we did a good job, I don't know how much it would take for me to actually give a good impression. - H, 12-Month

She did make identity improvisations even in that instance, choosing to save face and try to remain an effective leader in the eyes of her company, and the new teams also presented an opportunity for her to become more technically savvy, but her decision involved weighing her options, none of which were ideal. She did not have complete freedom and she ultimately did not have opportunities to redefine the identity of her old team.

Multiple participants talked about reputation as a structure outside of their current job that still influenced their identity improvisations. E and M both discussed their reputations as hard-working employees, which was connected to landing new jobs. D was at a temporary student position, and was interested in her reputation for other jobs from the beginning:

I don't know if it's true. But, I've heard that once you do weapons research sometimes you get black listed as you have a super high security clearance and you've been doing weapons research and so sometimes people don't want to

hire you, because of the bad press. Sometimes. I don't know how much truth there is to that, but I would like to keep my options open. -D, Exit

Finally, B's example was the most extreme - she continued to work for her company even though it made her unhappy in order to avoid the threat of being identified as untrustworthy to other companies.

She explained,

I am not willing to risk my career stability and my word as an employee, you accept an offer, you're not at least going to make the company money unless you stay, I've heard the metric is two years, because it takes a year to figure out what you're doing, and a year until you're fully fledged as an employee, and then making that money back. And that seems like at least a basic metric on which to judge how long you should stay at a company, because I don't want the company to just think I'm going to use them and leave, because then they're not going to hire me, and that's really bad for me.
- B 12-Month

Ultimately, the networks and sub-networks of organizations that formed participants' figured worlds provided them more opportunities for identity improvisation, sometimes in ways that structures strictly associated with their companies or jobs could not. But those social organizations also came with their own constraints.

5.1.4. *Landscapes of Activity*

As may be evident from previous sections, these figured worlds presented opportunities for a variety of activities and associated identities that participants navigated. This range of activities formed a landscape – participants' acclimation to their workplaces meant that they grew to recognize features and identities among that landscape, and locate themselves within it, that is, to identify themselves using that range of activities.

A given position within an organization did not fully determine a newcomer's identity because even within positions there were landscapes of activity to navigate, and participants could exercise their agency. For example, L, within her newcomer position, was exposed to multiple activities: CAD, financial calculations and energy audits, and design. Through her exposure to design, she realized that

was the identity she wanted to improvise, whether or not her company could provide that identity – she eventually left her company in pursuit of better opportunities for that identity.

I've figured out the design aspect way more than I did the [energy engineering]...the whole time, I didn't feel like I was doing "engineering" work. I felt like I was an accountant...looking at a bunch of bar graphs. And I felt like I just had the title "engineer," but nothing else...finally they were just like, "Oh wait! She likes design." Then they were just like, "Okay, let's start assigning her stuff like this."

As another example, K was restricted to a newcomer position at his company (to his dismay), but he still sought opportunities for challenging coding tasks when they arose, in part because seeking challenges and growth was an important part of the identity he wanted to perform for himself and his company.

Even though positions and activities were defined in historical terms, the complexity of ongoing historical practices still created landscapes of activity for newcomers to navigate. For instance, the well-established practices at A's company still required multiple process owners distributed across the landscape of activity, and employees at the company could expect to be shifted to new areas of the landscape about every 15 years. As another example, even though F characterized her company as having a well-established defense mission that she disagreed with, there were still multiple positions that she felt her company could offer her for her to avoid boredom. And there was enough prior interest in green energy projects for G's mentorship group to provide opportunities for new activities outside typical CAD practices.

At the same time, power, positioning, and organization meant that not all activities were equally accessible – there were constraints on the activities that were available to newcomers. For instance, G needed to wait at least a year before her company assigned her and other newcomers to energy modeling tasks. G's green energy financial calculations were also associated with the sub-organization of her mentorship group, and once it dissolved she also had less opportunities to engage in those activities. As another example, H's position as one of the first project managers meant that she could

prioritize her team’s psychological safety and could resist her manager’s recommendations to “whip [the team] into shape.” But she also needed to respond to her manager’s requests, and the ways that she was being identified by her manager and the rest of the company. Continuing to work with her team would give her a bad reputation, and in this way her opportunities to keep working with the team were diminished. As she put it, she “had no choice.”

For each participant, then the activities available for them through the landscape of activity also determined the identities they could improvise. An example of those activities and identities is listed below for each participant.

Table 9

Relationships between Identity and Activity within Figured Worlds

Participant	Examples of Identities Achieved Through or Represented by Activity
A	His work with military technology allows him to become proud of his work once he associates it with protecting military lives.
B	Continuing to work at her current job preserves her reputation, and avoids making the mistake of doing what a millennial would do.
C	His work at the company originally provided him the opportunity to grow, but after a year the continued activities give him less opportunities for that identity.
D	After understanding the way engineers at her job approach problems, and their bottom line, she becomes assured that she does not have to worry about ethical problems.
E	He becomes more comfortable with his work once he can do work he considers “engineering” at his third company.
F	She is not sure whether she should leave her defense job, since it is not her dream job, and it has a mission she doesn’t agree with.
G	The speed at which she completes her work makes her consider whether she is a slow worker, compared to her colleagues.
H	Continuing to work with her old team, which “sucks” in the eyes of management, would associate her with it, and give her a bad reputation.
J	Practicing empathy and listening to her teammates is connected to her identity as a woman.
K	He originally has a “do-it-no-matter-what” attitude, but becomes more skeptical when his opportunities for leadership activities are limited.

- L In considering her second job, she imagines the lower pressure and greater resources she might have at other jobs.
- M At his second job, he weighs the environmental mission of the company against their tacit military support.

Choosing between an array of identity possibilities was not as straightforward as is suggested in traditional narratives. The options were not only “management” or “design,” nor was the choice about finding the one job they were passionate about, or self-actualized by, or even whichever paid the most. Each participant made their own identity negotiations in their specific context, though an exercise of their agency. As described by Bakhtin’s work, newcomer’s experiences allowed them to form multiple voices to guide their decision-making (Holland et al., 1998).

Some participants (C, G, H and M) considered the activities to which they were distributed in terms of whether they allowed them to achieve the identity of “asset.” For instance, C would sign up for the specific projects that would allow him to establish himself as reliable.

I would say, as an asset right now, I'm reliable. I'm someone who's willing to do the extra hour in the office, I've always signed up whenever they've offered, there has been some times when we have to do certain projects that have to be done on the weekend, when people aren't at whatever site we're going to, people aren't there[...]I'm always willing to do those jobs. So I think I have established myself as someone who is made available and very reliable to get that work done. - C, 12-Month

Similarly, M strove to be a “yes man,” not wanting to disappoint by shying away from work, but also internalizing the goal of improved profit margins.

I really wanted to be on top of things and be the yes man. So I feel like I was doing all my jobs very quickly and very efficiently. And making the most profit margin over each one just because I spent the least amount of time of it. - M, 12-Month

K was a special instance of this desire to be good at his job. For his first 6 months of work, he criticized his fellow new hires for not being “growth-oriented,” and for not working hard enough, and he struggled to understand their lack of commitment to the company. But after distribution to activities he

didn't find meaningful, where he had less autonomy than he thought he should, he began to question his own commitments to the company, and to consider questioning the company to be a viable reaction to its structures.

Some newcomer engineers had other desires, especially novelty or constant learning, as mentioned before, and would look for the role that would allow that to claim that identity. Some participants were able to find such a role at their company, although in many cases it was a short-lived position, or even a set of tasks not associated with a position, in which case they might begin to consider jobs elsewhere, as in L's case. But, as seen the first quote from L, being distributed to new activities could reveal more information or suggest a possible identity that they had not previously considered. As another example, F knew she did not want to be working on defense projects, but work at her company had made her realize that she could travel and get paid for it.

Just [Company 1] in general. They're defense, right, and it's not really what I want to do with myself...I'd like to do something more on the lines of sustainability...you hear from everyone that [this company] is a great place to work, and it really is. The pay is good, and like I said, there's a lot of opportunity. They kind of encourage you almost to move around, move from group to group so you're never just stuck doing one thing...[Before the job,] I was like, nobody travels like this and gets paid for it, so it wasn't like a goal of mine, I should say, so that's why I say I'm very fortunate. I didn't necessarily seek out the travel very hard, but it just showed up in front and I put a little bit of effort towards it, so that I could check that kind of item off of my bucket list. - F, 24-month

Similarly, at her second job, L realized that working from home at a startup was convenient, but also without the resources of a large company.

Newcomers' navigation of landscapes of activity not only provided them with opportunities to improvise identities associated with those activities, but their distribution across multiple activities within those contexts gave the newcomers a chance to understand what they wanted and did not want. As described by Bakhtin's work, newcomer's experiences allowed them to tune into multiple voices to guide their decision-making (Holland et al., 1998), and their engagement in activities was an act of

self-authoring, choosing who to be inside the company, but also in negotiation with their internal values. For instance, E (like many participants) saw the activities he engaged in at work in terms of whether it made him feel like an authentic engineer or not – and E was able to articulate that the activities of his first job were not engineering once he was engaged with the engineering activities of his third job.

This theme, newcomer's identity discoveries through being distributed to activities, gave way to an emergent theme, dissonance. Participants' experiences, and the discoveries they made through a role, could conflict with their expectations for the role. For instance, C originally felt like being an asset and taking on tasks that exhibited reliability would also help him achieve distance from "the big chill," but he also failed to satisfactorily achieve that identity through that activity, so he began to consider alternative paths to achieving that identity. The theme of dissonance is discussed more in section 5.3.4.

5.2. Patterns by Demographic Variables

5.2.1. *Effects of Company Size*

Companies of various sizes had differences in the featured worlds they represented for participants, and thus differences in the ways that participants agentially improvised their identities. The primary differences were that small companies had less history to adhere to and fewer positions, which required engagement in more activities compared to larger companies.

Three participants (C, J, and L) worked at small companies (though L started at a large company). As L noted, her second company had less history to inform both her and her manager's identity improvisation; hence they had to adjust to each other rather than to a historical structure. The improvisations that L went through were not in relation to a long-standing company identity, and her definition of engineering was very general,

more general like, "Hey, you should probably know this. If you don't, I'm going to yell at you for it, and if you do, why don't you fix it right now." First person in line, [cannon fodder] to the client. - L, 24-Month

She also felt insecure; it was unclear exactly how hard she should be working, in her view, anyone who could work more than her was liable to replace her. And although L's small company had little history, both C and J ran up against established histories of their small companies – C in terms of the trainings and work necessary for a promotion, and J in terms of the promises her CEO had made, which restricted even her practice.

it's been hard also trying to support my team, when a generic manufacturing company...doesn't want to sell you screws. - J, 24-Month

However, even within these more constrained histories, participants in small companies were more likely to “wear a lot of hats” (Mathias, 2014), because they had to occupy more of the landscape of activity. Participants had more varied tasks, and less specialization, simply because at small companies there are fewer people available to do necessary tasks. As L explains,

The negative side is that again, there's not really a good backup plan...if one person goes on vacation and the other person is sick or has an emergency, that's two thirds of your company. There's no one else. There's no one else to kind of push the responsibility onto...When you have such a small company, you're both an engineer, a manager, and a secretary at the same time. - L, 12-Month

For C this meant that his job involved meeting with clients directly, rather than receiving clients design requirements indirectly through a longer chain of communication. L also directly met with clients, and J's team was responsible for things like presenting prototypes directly to clients. Additionally, wearing more hats made it more likely, among this group of participants at least, that one of those hats would be “design.” Neither L nor J complained about a lack of design at their small companies. And even though C lamented a lack of design work, the lack seemed to be because he was accepting mundane tasks in pursuit of being reliable rather than because no design work was available.

Large companies, in contrast, had more structures in place across all the dimensions of figured worlds, and thus had more well-established employee identities and more methods to encourage adoption of an existing identity. Standardized rotation/training programs, and references to prior employees' career paths helped specify the identity resources that newcomers had at the company.

they did a lot of panels with former grads or principals at [the company] where you got to hear their experiences, and how they started at the company, and how they worked their way up ... I forget that I'm also trying to build my career out of this and I'm trying to figure out what direction I wanna take it in. - G, 3-Month

But this specification also meant that newcomers at large companies experienced more identity constraints that resulted from these company processes. At large companies, there were explicit company philosophies to follow, and multiple managers to negotiate with when looking to change positions. Two quotes from A and K make this clear,

Somebody's got a design somewhere. And they pass down from all of their simulation that say, this dimension is critical, this factor is absolutely critical. So, we'll put super, super, super tight tolerances on it. And we'll measure trends that aren't there just to make sure that we're within our very tight tolerances. So, a lot of it is out of my control. But, it is a very specific process that has very specific attributes that we need to make sure happen. - A, 12-Month

I actually asked my manager a few weeks ago if there are more opportunities to learn, I guess, and I guess it came off as I was asking for more advanced leadership position, which doesn't fit into the college hire programs that I'm part of, and supposed to take three years. She said that it might be a better idea for me just to wait, financially because once you are promoted, the raises don't happen as often. - K, 12-Month

Medium companies seemed to sit at a middle ground between small and large companies. Like large companies, medium companies still required specialization, but there also seemed to be more opportunities for new identities and jobs within that. B could move roles multiple times in her training. E had the option to do work with a completely different group if it meant the company could still pull in money. H had choices for working on different teams within the company, although in the end she felt like she didn't have a choice, and her ability to practice Scrum in more flexible ways was also

constrained by those above her. L also had multiple options for roles within her first company, although none particularly interested her. In short, medium companies, though more structured than small ones, had less hierarchy and enforcement of identities than large companies, as these quotes from B and E show,

It seems like typically the structure of the whole company is quite self-paced, because all people are really busy, so you have to go and find work when you don't have work to get done. But when they plan well you are given a lot of work. - B, 3-month

I'm at a big enough company now that there's just so much variety in what I could be doing... - E, 12-Month

Ultimately these structures meant that for smaller companies, participants interested in improvising a new role would have to either create their own, as C imagined he might do by consulting for a friend, and J tried to do by collaborating with other working groups, or they would consider moving to a new company (C, J and L all did consider leaving, for different reasons). This was contrasted by the negotiations between different offered positions that newcomers at medium and large companies could do. And at large and medium companies, there were more established positions, and participants would first consider working to attain those to keep with their desired identities, though these positions didn't always satisfy them, in which case they too would consider leaving for another company.

5.2.2. *Impacts of Schooling*

While there were differences between each of universities that participants had graduated from, and their university experiences did affect their identity development, I did not discern any patterns connecting any particular university of origin to any particular approach to identity development. Having more participants from each university, I may have been able to explore this effect more satisfactorily, though other cross-site comparisons in the C2W study also showed no differences across sites (Deters, Paretto and Ott, 2020). Across all sites, however, participants' education shaped their

understanding of engineering prior to entering work in similar ways, particularly with respect to their definition of engineering.

Many participants (A, C, E, F, and L (in her first job)) mentioned that their work involved less calculations or design than their capstone or university engineering did, and often expressed disappointment at the lack of engineering as they understood it. A was satisfied with his non-design work, but C, for instance, said in his 12-month that he “[Missed] coming up with new ideas or products.” F was happy with her job when it involved design, like capstone, but by her 2-year interview, once her short-lived design role had dissolved, she was unhappy that she wasn’t doing engineering, in her view. Similarly, B, E, M (in his first job) and F all went as far as to say that the opportunities they were presented with were not actually engineering, because they were not creative, or because they weren’t like the engineering they knew. And in response to the discrepancy between engineering at work and engineering as they understood it, newcomers took different strategies to either bring a new version of engineering into being (finding design work) or leaving work to find their preferred version of engineering.

Another reason that I left that position[...]is because the work wasn’t necessarily engineering-related. Which is actually something I’ve heard from a lot of friends that I’ve had that graduated and went straight to work, is that it’s not engineering-related work, it’s more, I don’t know...regulatory support type, quality assurance work than what I would consider engineering work. The position that I went to after that was completely design-based engineering work, but it wasn’t - there was no design creativity associated with it. Since it was an HVAC, it was very like stick-to-the-template type design work, so it was just more of a CAD job than anything else. And then this position that I’m in now is more engineering...it’s not really design work, but it’s still what I would consider like traditional engineering work. -E, 12-Month

The desire for a familiar version of engineering did not just mean a pursuit of design. For instance, J. was unique in that she never complained about her job having lack of engineering or design, but she still felt that work lacked a sense of community she had in university.

I miss it so much, yeah...we all knew each other. I got along with everyone...being able to talk to people and kind of being able to relate to people...Instead of here, where I can't necessarily do that. I have to seek out the people I usually talk to, because not everyone here is that friendly as they appear to be. So I miss that. I miss, I think, being surrounded by women...And I realize that I definitely miss being around people that in some ways look like me. J, 24-Month

This pattern didn't describe all participants, however. Some participants viewed work at a company as the "real" engineering in contrast to their university experiences, and developed a new sense of engineering based on their improvisations at work. For instance, M's company experiences led him to conclude that all engineering was driven by money, something he wished he had the opportunity to learn in school,

I honestly had a very narrow thought of what engineering was. I thought it was just doing the engineering cycle and that was it. One of the first things I learned that changed my view of engineering was how much money is involved in everything in engineering. -M, 12-Month

K also leaned into the engineering identities he was provided at work (at least in his first 6 months) because he was trying to mature beyond being a recent hire. And while A did not initially consider his work to be engineering, he got a sense of how "real" his work was when he fully realized he was protecting military lives. While some participants rejected the engineering they were introduced to at work because it was not autonomous or creative, and sought to recreate engineering as they had preconceived it, these other participants were eager to reproduce the engineering identities that were present in their new figured world. Even if the activities were not the same as in school, these participants accepted that acclimating to work would make them engineers.

5.3. Emergent Themes

The preceding sections used Holland et al's concept of figured worlds to understand participant's identity development in terms improvisations between the individual structural features of figured worlds and participants' agency. In this section, I turn to themes that cut across these features

and describe patterns that influenced multiple aspects of each participants' process of becoming. These themes emerged inductively and abductively from the narrative constructions as a means to better understand both the individual narratives and the threads they held in common. They result, as explained in Chapter 3, from memoing and my efforts to understand the interaction between different facets of the figured worlds, in light of the larger intentions of this study to critique of traditional narratives.

5.3.1. Sexism

While not all the women in this the study talked about sexism, it was present in multiple narratives and played a role in who participants were asked to be and who they chose to be. At the same time, identifying this theme also offers insight into injustices that participants faced in their identity improvisation, even for those narratives where sexism was not visible or a main feature.

Sexism plays a role in participants' identity development because belonging to and being recognized as a member of the community mattered to all of the participants. For instance, A expected to work at his company for the rest of his career; and he therefore not only wanted to be an effective engineer, but a good team-mate, someone who was willing to stop what he was doing to help someone else. C also wanted to be a good teammate, reliable, and taken seriously by his colleagues and his clients. E wanted to be someone others would recommend and to form connections with colleagues that would expand his career options. K was interested in being visible and liked working with people who had similar commitments to growth and teamwork. Each of these male newcomers linked being an engineer in their companies to socialization rather than only technical expertise.

Similarly, the women in this study also saw being taken seriously and properly identified as an engineer by colleagues as important. For several of the participants, however, sexist structures forced gender to emerge as a mitigating factor in that process, and participants responded to that sexism

differently. B, for example, though she identified practices that would be deemed sexist, did not seem to want to make it a significant issue, as evident in her deflection of her colleagues use of pet names.

She explain that those names were “not super inappropriate,”

Like they just called me like nicknames and like pet names, which is not okay[...]it's part of the job, but it's something in the real world they also don't learn to deal with in school[...]it's good to have another female there to talk things through with and figure out how to handle situations.

- B 6-Month

Perhaps less explicitly, interpersonal conflicts also seemed to be a place where gender might play a role since she considered them something she wished she could handle differently:

There is a certain lightness that you need as a project manager, that my boss had in spades. He was great at just diffusing situations and not being offended...just being funny and light, even when contractors were not happy.

- B 6-Month

B's gender thus influenced how some colleagues saw her (social positioning) as well as the kind of engineer she would need to be (and the activities she would need to engage in) to fit in. She would need to learn to handle, and possibly diffuse a kind of sexism that she did not expect to change. In addition to having allies nearby to help make sense of the situation, she talked about needing to become more comfortable with advocating for herself and making sure she sold herself well enough to avoid being underpaid. Notably, however, she did not connect the threat of being underpaid to any structural sexism within the company.

G similarly did not identify sexism as a significant issue at work, although during her 25-month interview she described ways the company addressed sexism on a structural level by elevating several women to leadership. At the same time, G noted that communication and care were devalued in her company work, particularly when compared to her activism work. Moreover, with the company, the responsibility for practicing care and proper communication had been distributed to her rather than her superiors, mirroring patterns of sexism that other scholars have documented (Faulkner, 2007) and the

explicit pattern of sexism experienced by J. But G herself did not register that pattern as structural sexism.

F also deflected the possibility of overt sexism. She acknowledged, for example, being treated differently because she was a woman, but she deemed it for “good reason” given that within some landscapes of activity, she was physically incapable of doing certain things. At the same time, her colleagues sometimes identified her as a “little sister,” which did bother her, as she explained:

So, as a female, I feel like I really, really, really have to maintain my emotions because if a guy overreacts, it's not treated the same as when a female overreacts. When I overreact, people try to hug me, and I don't understand why they try and hug me. Is it because I'm a female? I just want people to listen to me and tell me and deal with it is I'm trying to tell them the things that are frustrating me...I don't want to be calmed down, I want to tell you, and I want you to listen[...]I think because I'm seen as a little sister to a lot of people, they immediately try to calm me down and make me feel better, and that's not what I want. I just want to tell you why I'm upset with you, and I want you to not do it in the future. Why can't we just have that conversation? - F, 24-Month

Her comments here suggest that not only did sexism limit her range of achievable identities to those that could fit under “little sister,” but it also limited her colleagues’ effective response to the engineering problems she identified and forced her to monitor her emotions in gender-specific ways.

J. had the most explicit and constraining sexism in her narrative, which also intersected with her race. Even after two years at the company, she felt she wasn’t being taken seriously. Her colleagues were consistently surprised by her technical abilities, and she was often regulated to role of note-taker rather than an engineer. She had made significant efforts to practice compassion in communicating with her colleagues, which was appreciated and allowed her to stay true to herself, but she often had to rely on her manager to make requests on her behalf because people took him more seriously. In response, she asked almost the same questions F asked:

Why can't I be treated as an equal here? Why can't you think that I am capable of understanding these things? - J, 24-Month

She thought she needed to be a better advocate for herself, to not let the negativity get to her, and to be more confident - she had been working on confidence since undergrad. She also reacted to these constraints by joining other social groups beyond her engineering colleagues:

If I'm talking to people casually in the lunchroom, for example, I'll talk to the people who work at technicians. The people who work in the cleaning staff, those are the people I talk to because...they look like me. And they understand me[...]in some way, I feel like they're proud of me for being a representative of our people in a higher position. - J, 24-Month

The intersection of racism and sexism limited her navigation of the landscape of activity at her job, and the identities she was able to improvise. By her second-year interview, she was looking for other jobs, in part because of the sexism she experienced.

In contrast, D, H and L never described explicit or implicit sexism. In fact, L cited the lack of sexism as being due to her second company consisting of three women. D and H mentioned being identified by their companies as inexperienced, or as only an undergraduate in D's case, but their narratives showed no evidence that being a woman played any role in their negotiation of an engineering identity.

Being a woman in engineering was not a challenge for all of the female newcomers of this study, but for B, F, G, and J, the sexist structures of work made improvising the identity of a woman in engineering more difficult. These newcomers were misrecognized by their colleagues because of their gender in ways that limited their ability to improvise identities of respect, or of technical ability, which no male participant in this study faced. The landscapes of activity of their figured worlds offered them less opportunities, and also required activities such as diffusing tension, self-advocacy, and regulation of emotions in order to attain respect similar to their male colleagues.

5.3.2. Objectification

The second emergent theme is objectification. While objectification is typically an injustice related to sexual-objectification, I draw here on Nussbaum, who expands the concept to multiple properties of objectification independent of sexual-objectification, such as violability, instrumentality, and denial of subjectivity (LaCroix & Pratto, 2015). Violability refers to the ways that a person is treated as not having boundaries worth respecting, or not having boundaries at all. Instrumentality refers to the ways that persons are seen as a means to another's ends, or only considered insofar as they satisfy another's needs. Denial of subjectivity is defined as the failure to recognize that an individual might have their own subjective interests or perspectives (Nussbaum, 1995).

Across participants narratives emerged the ways that the figured worlds of work objectified them. In several cases, for example, the historical practices of the company, combined with the social positioning of these new engineers, objectified participants by treating the boundaries between professional and personal life as violable, and shaping the landscape of activity without reference to those boundaries. A, C, F, G, and L all mentioned the possibility of work encroaching upon their daily life. C worked occasional long hours that gave him nothing to do at home but eat, sleep, and prepare for the next day. Similarly, while at her first job, L claimed she would quit if she was made to overwork, when she worked from home in her second job, she found that it was hard to stop working constantly. For G, being a newcomer meant work would assign 80-hour work weeks to her, which was affecting her friendships.

For some participants, exercising agency meant resisting this encroachment by maintaining boundaries between work and the rest of their life. A, for instance, saw identities that other employees had historically attained, where their "whole life was working," and his response was to try to build a life outside of work. As he explained,

That's the only thing they know, they don't have any hobbies. You hear it more often that somebody will work until they're 80 or 85 and when they finally decide to retire, they die a week or two afterwards. Because, their whole life was working. We had one guy like that about six months ago who was 86 years old working in the shop[...]two weeks after he retired, he just died. So, you've got to have something else to do. -A, 12-Month

Similarly, B talked about learning to “say no” to more work as she gained experience in her job. Both A, B and L (at her first job) responded to the structures of work by maintaining identities where work was separated from other aspects of life, even if it wasn't comfortable at first.

But other participants chose to work in a way that encroached upon the rest of their life. G, for example, noted,

I will say a lot of my friendships have gotten really tenuous because I'm just so fucking busy and I don't think that some people understand that. But it's also I'm choosing to do this, and I won't be coordinator for [Activist Group] next year, so I'll have more time next year. For now, I'm just kind of like, ooh I'm going to ride this roller coaster until the end of my term, which is in the winter. - G, 24-Month

G chose to take on tasks for both her activism group and for work. At the same time, she did not choose time-intensive newcomer projects; those were the historical practices that she was assigned, given her newcomer status. C worked as hard as he did because of his pursuit of growth; here his agency, in the form of his personal goals, led him to lean into the expectations of the figured world. L, in contrast, chose to work constantly in part because she was afraid of being replaced – a fear that she admitted had more to do with her own confidence than with any structure.

Objectification in the form of simultaneous instrumentality and denial of subjectivity was evident in other identity improvisations. In B, E, J, K and M's cases, their companies seemed to provide positions or else their activities were restricted to those that served the company itself without considering the subjective interests of them as individuals. For example, E was considering taking a new job because his company had been losing clients, but the company continuously told their employees not to worry:

A big part of the frustration with everyone, is the fact that it's kind of being swept under the rug by upper management. No one's really addressing that there's a concern here..No one's really saying anything even though we see a pattern similar to patterns we've seen in the past where it's ended in layoffs. - E, 6-Month

In this way, the company prioritized E's continued labor over his subjective interests, and was restricting his ability to knowledgeably choose a job that worked for him. In response, he exchanged information with employees that were suffering alongside him, as well as with former employees, to understand the situation and secure himself a job. B was also restricted in her ability to seek a new job, and she continued her work for her company for her fear that the company would assign her the label of "untrustworthy."

M and K both had overwhelming commitments to work, and they focused on the value they could generate for their companies, believing that they would be rewarded with new positions or more autonomy. Neither of them were, and only their companies' interests were served by their identities of wholehearted loyalty. However, again, their instrumentality was evidently due to their own agency, because they both approached their navigation of the structures of work with the intention of overwhelming commitment, with the belief that that was what they should do. Eventually K became skeptical of his original identity, which only seemed to be serving the company – he hadn't received the rewards he expected, and he began to understand and identify with people who worked for their own development and followed their own life path.

H was denied her subjectivity when her superiors failed to consider any of her accounts of her team's work, nor any of her understandings of how the company should be organized, and instead suggested that she "whip them into shape." The structures of H's work did not recognize her knowledge of her own team or company to be valid, and also did not recognize the validity of her position as project manager. After a year, she felt that her perspective was not valued by the company, that she would not be heard if she brought up any more issues.

J was objectified in multiple ways. She was continuously denied any identity that recognized her interests and knowledge, nor was she afforded the dignity she thought she deserved. At two years of work, after being threatened with physical harm, in addition to sexism, and a lack of opportunity to improvise in accordance with her commitments to green energy, she found her identities at the company untenable, and settled on leaving,

In my mind we are supposed to be working as a team, and clearly that's not how, I guess, the company sees us[...]I don't think there's a future at the company anymore. Just a lot of trust's been broken.

- J, 24-Month

In response to the degrading identities that her company provided her, she focused on finding her own life path in spite of her company, as an exception to the blind loyalty of some of her colleagues.

Some more advice that I would probably give is to prioritize yourself over the company you work with. - J, 6-month

Yet, her experiences at 2 years were not her first experiences of objectification. She had been considering prioritizing herself over her company since at least 6 months of work, yet, contrary to her experiences of degradation, she also still expected her company to view her as part of a team. This ambiguity, and the complicated nature of preconceptions and self-objectifying identities is addressed in the Discussion chapter.

In many of these cases, participants' objectification amounted to their exploitation, because their objectification was with the intent to benefit to their company (Zwolinski & Wertheimer, 2017). While exploitation didn't describe the entire individual-company relationship for any of the participants, and its presence didn't rule out the possibility that newcomers may have benefitted from exploitation, the presence of exploitation in structure-agency relationships shows that companies often provided identities for newcomers where their only purpose was to fulfill their company's bottom line, and neither the participants' interests nor knowledge would be considered in pursuit of that purpose. And in response to those identities, some participants resisted by maintaining boundaries, or by networking

with groups outside of the strict bounds of their company. Some participants, however, were prepared to improvise those identities of objectification.

One exception to the pattern of objectification and exploitation was D, who was given the advice to treat her student position at her job as a steppingstone to other jobs. Her activity seemed to be about her personal development and her ability to transition to new jobs or to develop new skills, and that development was significantly self-determined. And through these structures of work, her identities other than “employee” were recognized and preserved, as her life after her one-year position was considered.

5.3.3. *Alienation*

The third cross-cutting theme I term “alienation.” Alienation has multiple theoretical definitions (Schact, 1970), including a Marxist definition that describes a family of conditions that workers experience under capitalism, but generally the term refers to problematic separation. In this case I use it to refer to a separation between engineers and the impacts of their work; that is, the structure of their figured worlds serves to alienate these newcomer engineers from the general “society” that their engineering would supposedly benefit. The landscapes of activity represented by the figured worlds of work often involved generating value for the company itself, rather than for “society.” And the one-directional acclimation to historical practices, and the self-regulating requirements for attaining higher positions meant that improvising activities with new benefactors, or with new considerations of impact, was almost not an option for newcomers. Some participants attempted to improvise identities that

reflected their commitments to beneficence among the limited options provided by their companies.³

For other participants, the defining factor for whether or not their improvised identity was tenable to themselves was whether it allowed for growth, autonomy, or novelty, without consideration of impact beyond the benefits for their companies.

The identity of “asset” was one that many participants found meaningful within the figured worlds of work. Not only did “asset” mean that participants could reproduce historical practices in a self-regulated way, but for some participants (B, C, E, K, M) their being an asset was explicitly defined in terms of how much money they could make or save for their companies:

I didn't want to be the guy that was cut because he wasn't doing good enough work or he was losing the company job. So thankfully it looks and sounds like I've met their goals and met their standards... I'm asking questions to the designers and I possibly saved the company a lot of work and money. And that way I feel great, you know. That's what keeps me going. - M, 3-Month

Turning from someone who is doing a lot of learning to someone who is really an asset to the company, someone who is completing projects and helping the company earn more money. - C, 3-Month

You're expected to create value. That's why people are invested in you, because you have a lot of potential value to them. - K, 3-Month

And if it wasn't structured explicitly in those terms, for other participants (G and L) it could tacitly be measured in terms of efficiency or speed.

I think it's better now that I'm fully, fully focused all the time...everything is on a budget and budget relates to time. Then you find yourself trying to do things really fast at the expense of your work. - G, 24-Month

³ For this theme I did not distinguish between environmental benefit, environmental justice and societal benefit. From a “strong” sustainability standpoint they are linked (Antunes, 2012)

For these participants, the structures of their work defined the benefit of their work in corporate terms, rather than benefit for general society, and these structures also specified which activities were appropriate: which projects to complete, and how much time to spend on each task before you were costing the company money. Importantly, the improvisation of identities of corporate benefit was not entirely due to company structures. Some participants came into work inclined to be an asset for their company, with the understanding that this meant generating value for their company.

However, most participants also conceived of their work as linked to social good. Many connected their engineering identity to the beneficial impacts they wanted to have on society, the causes they were committed to by working with their companies, or the ways they felt engineering generally solved society's problems. D talked about it at length:

my definition of what an engineer is they are someone who finds a problem and works at solving it. Whether that's making something 5% more efficient, 5% cheaper, or 5% longer lasting. Or coming up with an entirely new idea... Engineers solve day to day life problems...everything from smart grid technology to self-driving cars, to saving the biomedical world. And those are all things people face day to day, they use every day. And we're working at solutions to make them better. D, 6-Month

However, these considerations only occasionally influenced their identity improvisations. Their more influential agentic commitments were towards growth, enjoyability, or an opportunity for "true" engineering in their work. These commitments were the primary deciding factors for what kinds of problems engineers wanted to solve, as in B's case:

One of the guys left for the same reason that I'm seeing. And my other friend is looking for other jobs actively because of what she's seeing as well, because we're all seeing the same things. We're all not really thrilled. We're not challenged. - B, 12-Month

In F's case, her interest in enjoyability conflicted with her commitments to beneficence. She knew that she wasn't at her dream job, because its defense mission was against her goals:

I want to put my efforts into saving the planet, and saving animals, and making sure there's enough food for all the people, and all the people who are on the planet are well cared for. - F, 24-Month

Yet those commitments needed to be considered alongside the travel benefits the job offered, and the opportunities to not be bored. There were sustainability opportunities at her company, but she hesitated to pursue those because of “red tape,” and structural barriers that would lead to a lot of paperwork.

When participants did agentially pursue their interest in beneficence, it was, in part, by claiming commitments to beneficence, novelty, and corporate interest simultaneously. The commitments were conflated, their lines were blurred. For many participants (A, C, E, K, M) this took the form of conflating their commitments to a broader beneficence with their commitment to meeting the needs of their clients, or to the military.⁴ As K put it,

I want to learn things and that's kind of what motivates me, what keeps me going is learning and whatever I do, I have to believe in the bigger impact that I'm working on. Definitely I think having a bigger impact...helps me achieve a lot more and be more successful than something like where the motivation is getting a good grade, because it's not as big impact. It doesn't help people as much. It helps me, mostly, so it's good in itself, I guess, but just working on something that's going to touch a lot of different people, millions, is a whole new level. - K, 6-Month

While these participants were concerned with the impacts of their work, this commitment could be satisfied through working for their client, or working for military purposes. In this way participants were alienated on an agentic level when the beneficence of their work was equated to corporate effort in their improvisation, and on a structural level when they lacked options among the landscape of activity for legitimately beneficent work, nor accessible opportunities to improvise new non-historical practices.

⁴ I draw a distinction between military effort and societal benefit, which is asserted by engineering education and STS scholars (Riley, 2008; Leydens, Lucena & Schneider, 2010), but which is nonetheless dependent upon my positionality.

Participant M reflected on the way that his adherence to historical practices limited his questioning of the beneficence of his work, and led to a focus on meeting client needs:

I think a lot of it is lost, to be perfectly honest. Because it's all about getting what the client wants and the client wants the cheapest thing and that is done in the quickest amount of time. I definitely think, maybe not specifically for me but for anyone is that, we're given a job to do and we're gonna do it and then we totally forget or don't think about consequences.
- M 6-Month

But beyond reflecting on this issue, he was also able to improvise an engineering identity in consideration of his impacts – once he was laid off from his first job, he considered his impacts in pursuit of his second job and settled for a job that allowed him to feel like a “good guy.” M was one of the exceptions, because he considered his beneficence aside from being an engineer, and allowed beneficence to influence his identity improvisation in a significant way. M was one of the most successful participants at being engaged and reflecting on his impact, as it led him to be more flexible in his job choices and led him to pick a job where he could hold commitments to environmental benefit. However, even in his case, the identities he was able to improvise at his second job had unresolved tensions between environmental and military benefit.

However, newcomers who did seek out and improvise identities of beneficence invariably faced structural obstacles that limited their agentic improvisations. G eventually had to return to the work that she “needed to do.” J felt there was not a future for her at the company, in part because her work seemed more about money than their green mission. H also felt dragged away from her purpose, as she explained:

I have times where I stress; I don't know why I'm doing what I'm doing. I don't know if I'm really making impact now of the kind I used to. It seems like I've had less responsibility, but at the same time, no. The things I like doing, I'm doing less of. I'm doing more of things I don't want to do. But I didn't necessarily have a choice. H, 12-Month

In the end, non-alienation was an infrequent part of the improvisation of participants’ identities. Participants generally glossed corporate, client and societal benefit, or else they simply were interested

in meeting structural demands of their companies, which were defined in terms of corporate benefit. While many participants claimed an interest in beneficent work, only a few involved that interest in their improvisation of their engineering identity – novelty, growth and other factors were much more significant. And the landscape of activities, adherence to historical practices, and limited power of newcomers to influence practice provided obstacles to the improvisation of commitments to beneficence, for those who were committed to doing so.

5.3.4. *Dissonance*

Finally, to understand the identity improvisation of the participants of this study, it is necessary to understand the ways that participants often espoused multiple perspectives of their figured worlds simultaneously and revealed multiple facets of their agency in the process. Dissonance here refers to the ways these perspectives would sometimes contradict each other, and the ways they would act in accordance with a perspective that ran counter to their experiences (Garai, 1986). Some participants seemed to act against their stated interests, and would sometimes act or speak with the seeming purpose of reaffirming an optimistic view of their work.

Before discussing the theme itself, though, I note that highlighting participants' dissonance is complex methodologically and ontologically. At face, it involves treating the participants as unreliable narrators, which may call into question the reliability of the narratives, as well as the researcher's interpretation of them. Critical realism and judgmental rationality shed some light on the issue. Participants never contradicted themselves on the level of the *real* or the *actual* – they were consistent and reliable when relaying the events of their workplace, the “what happened” of their stories. However, participants own interpretations of those events, at the level of the *empirical*, sometimes shifted with time, and were sometimes contradictory. In addition, dissonance emerged when comparing participants' own views, rather than between my view and their views. In fact, newcomer dissonance

was a surprising finding that emerged through abduction and the attempt to preserve multiple perspectives (even if contradictory) in participants' narratives.

Participants' dissonance did not suggest that they could not make any sense of their figured world, or that they were being dishonest; rather dissonance was part of how they made sense of their figured world and their agency within it. To introduce the concept of dissonance, I will use H's example, which was a more innocuous form of it. H was clear about her desires to preserve a people-over-profit philosophy at her company while also learning about new technologies, and her commitments to both the mission of the company, and the success of her first team. In opposition to that, her company denied her subjectivity, and reduced her options to act in accordance with those desires and commitments, alienating her as well. In her 12-month interview she claimed she was at her lowest point, but in that same interview, she also hazards a speculation that maybe things "aren't as bad as they seem." While she had experienced the negative impacts of her company's structure and had needed to navigate it in a way that conflicted with many of her desires and even her subjectivity, she was at least considering a viewpoint that contradicted her experiences. She held out hope that perhaps her perspective of her company was inaccurate, and that she had more opportunities to improvise a desired identity that she had not come across yet.

Other participants' dissonances were not so innocuous because they more seriously considered these contradictory viewpoints. For the sake of illustration of the rest of the theme, I will focus on K's case, which had features similar to other participants. K started work with a perspective about the kind of engineer and employee he should be. As discussed before, he was committed to improvising an identity of "asset," which also meant objectification in the context of his automotive company, and alienation as well in the sense that he defined his purpose as generating revenue,

The primary goal of people to interact with you and deal with you basically in college is to help you grow and to help you be ready for the future,

whereas the primary goal of people that interact with each other in corporate America is to create value and generate revenue. - K, 3-Month

In addition to these identities, K was also interested in leadership and growth, and his perspective was that his company would provide opportunities to improvise these combined desired identities. For other participants they imagined their figured world as providing opportunities for practicing engineering as they learned about it in school (C, E, F, M), for enacting commitments to beneficence (G, H, J), for settling down (A) or developing skills and job flexibility (D).

With these preconceptions about work, K struggled to understand the perspective of some of his teammates, who didn't feel valued enough, and who he viewed as disgruntled,

One thing that I kind of feel that I encounter in work is disgruntled employees, that they're just super negative all the time and they're like, "Why are we even here? Why are we working for corporate America and stuff like that? We're just a cog in the wheel or whatever." - K, 3-Month

From his perspective, they were not motivated enough, and it was important for any employee to go above and beyond, and to have a positive attitude. It was not the company's responsibility to help employees grow anymore; it was their responsibility to create value for the company.

However, K's experiences after a year conflicted with his preconceptions. Although he had found opportunities for leadership in a company sponsored innovation group, and despite his efforts to be "visible" within his company, his position as a new hire denied him the opportunity for leadership activities. He also felt that the requirement to adhere to the ongoing practices had left him with a disappointing lack of opportunities for growth.

At this point in participants' narratives, when they had experiences to contradict their initial perspectives, there were two main categories to describe their responses. The first group of participants maintained contradictory perspective simultaneously. B for instance gave advice that indicated that there were opportunities for self-actualization or creativity at work, and that newcomers should "stick it out" even though she was considering leaving because she had not found those opportunities. G

simultaneously held the perspective that her company was a good place to work, which wouldn't fire someone for working part-time, while also feeling like she was being forced to do work she did not love, and considering the possibility she would be laid off if she worked part-time. And L had expected to be happier at her new design job, but also felt overworked, and was not sure why she was not happier. In these cases, participants' experiences seemed to conflict with optimistic preconceptions of work as having opportunities for improvising their desired identities. These dissonances also influenced their identity improvisations, in the sense that they continued working – the contradictions did not cause participants to leave although many of them considered it.

The second group of participants changed their perspectives of work to match their experiences. K was one example. His experiences of not being able to improvise a desired identity at work caused him to reconsider the perspectives of colleagues who he previously viewed as disgruntled:

When I started, they were starting to make those sort of comments ... I was like, "Okay." I didn't really get it, then I was like, "Man, you were in such a great company and you just got to keep a positive attitude and always just work as hard as you can you will be rewarded and stuff like that." Now I'm in their shoes a year in and I'm like, "It's okay to question where you are and look at what more you want out of life if that helps you plan for the future and figure out what you want to do, I guess, look at it from it from a skeptical attitude as opposed to Gung Ho, I'll do it no matter what, attitude."
- K, 12-Month

A and D were two other participants whose preconceptions did not match their initial experiences of work, although they seemed to resolve that dissonance around 6 months of work. J was another participant who, after two years of work, had developed a new perspective, and realized that she could not improvise a tenable identity at her company, at which point she resolved to leave. Participants' resolutions of their dissonance often came with an affirmation of their commitment to their own life paths apart from their identities within the company. When J resolved to quit, she explained her attitude:

That's me trying to stay true to who I am[...]I think there's a lot of things that I've changed as an individual and how I perceive the world. But at the core, my morals haven't changed. And so, I don't feel lost about who I am, regardless of the current situation.

- J, 24-Month

K discussed a similar resolve to navigate his own life path, independent of being recognized as valuable for his company, which might lead him to work for a different company. A had recognized that he needed to be a person outside of work, but for him work provided him many of the necessary resources to become the person he wanted to be. And D also felt that work gave her the flexibility and skills to navigate the job market in an agile way.

This theme showed that participants did not always have a clear, unambiguous path or imagined identity that guided their agency. In many cases, they came into work with stereotypes, untested ideas about the identities they would improvise. In engaging with multiple activities in the landscape of activity that was the figured world of their work, and discovering new identities and aspects about those identities, they did not always incorporate that new information into their agentic identity improvisation. Participant were surprised to find that their new position or promotion was not like they thought it would be, some of them changed their idea of engineering work (A and D), or work at their companies (J and K) and some of them had not resolved their dissonances (C and L). In other cases (B, G, J, M), a lack of clarity made them unable to voice a clear relationship with their work, and yet work still required their efforts. Resolving their dissonances depended on affirming and enacting their commitments to their own life paths.

CHAPTER 6: DISCUSSION

The themes discussed in the previous chapter describe the figured worlds that newcomers entered, and the responses and agency of newcomers interacting with those figured worlds. This chapter uses the themes to develop explicit and direct answers to the research questions, and contextualizes and explains those themes with literature using relevant frameworks of identity development, critical pedagogy and justice. The first two sections answer the research questions with literature and terms laid out in Chapter 2. The next three sections, 6.3 – 6.5, draw on new literature to explore potential underlying causes and explanations for the themes that emerged from participants' narratives.

6.1. Who Are Engineers Asked to be by Work?

Newcomers' narratives described a range of identities they were asked to improvise in order to participate in the ongoing practices at their companies. Being identified as an engineer in their companies depended on their ability to employ socio-technical skills such as knowledge of CAD, their ability to collaborate across teams, and their ability to adapt to each company's technical protocols. Their participation also depended on their improvisation choices as they pursued identities such as that of a company asset or a good team member, even when such pursuits led to the objectification and dissonance described in Chapter 5. The presence of these corporate socio-technical requirements in some ways aligns with existing preparation narratives of the kind described by the NAE (2004) or Flumerfelt et al. (2015). However, multiple other aspects of the figured worlds of participants' narratives, such as one-directional acclimation, the idiosyncratic nature of socio-cultural learning, and the dehumanizing structures of work, were deviations from preparation narratives.

First, given the opportunities that newcomers were provided, and the obstacles they faced, it was evident that engineering newcomers were generally asked to acclimate to and not change the

ongoing practices of their companies. They are asked, that is, to become compliant employees. More specifically, newcomers needed to acclimate to ongoing practices by occupying or taking ownership over a part of ongoing processes, such as specifying parts using a catalogue or CAD (B, G, M), ordering supplies (F), filling out company-specific reports (C, E), testing already written code (K), or managing knowledge and colleagues (A, H). Some participants were able to implement changes to their practices: A brought new knowledge of existing software, B engaged in new coding practices, C implemented note-taking, G learned new financial calculations, and H implemented new versions of Scrum. But these practices were generally evaluated in terms of whether they contributed to ongoing practice; if not, or even if they simply deviated too far, new practices were dismissed. Company structures indicated that in most cases, participants needed to demonstrate self-regulation and mastery over existing company practices to be recognized as an asset by their superiors, and this structure was maintained through superiors' direct challenges to newcomers' deviations. Official positions or job titles, too, were dependent on participants' abilities to engage in ongoing practice unsupervised, or on their degree of internalization of the company's bottom line. In these cases, newcomers were called to acclimate to a prescribed problem solving approach. In the rare case when they could implement something new and acceptable that contributed to solving prescribed problems, there were generally no structures for them to determine, challenge or change the problem being solved.

In general, then, the structures of work called for one directional acclimation to a narrow range of employee identities, and newcomers were expected to adapt to structures of work without changing them. This dynamic deviates from the preparation narratives described in Chapter 2 in several ways. First, it calls into question the skills needed for work – particularly the creativity and leadership suggested by the NAE report (2004). Newcomers were solving open-ended problems in socio-cultural contexts, as might be predicted by research about engineering work (Korte et al., 2008; Jonassen, 2014), but they were not creatively developing technologies, and the problems they were solving were not

completely open ended. The problems participants solved were often more closed than those they had experienced in or expected from their capstone courses. Instead, the work they engaged in more closely reflected Russel and Vinsel's characterization of engineering work as maintenance rather than innovation (Russel and Vinsel, 2019), as in A's ownership of a process or G's routine CAD work. When participants sought creativity or leadership (as in A, E, G, L, and K's cases) it was generally through boundary spanning to create new roles as described by Jesiek et al. (2021) or through job choice to align with identity as described by Godwin et al. (2016) and Matusovitch et al. (2010). Such moves were necessary because the boundaries of their work often consigned them to less creative but more necessary (for the company bottom line) tasks.

The second, related, deviation from existing preparation narratives is that newcomers' narratives point to the necessity of localized, idiosyncratic sociocultural learning that limits the direct transferability of skills from school to work. The socio-cultural and socio-technical knowledge required in order to participate in ongoing practices at each company confirm the research of other scholars such as Lutz and Paretti (2021), Ford et al. (2021), Perry (2021) and Johri and Olds (2008). In contrast to better preparation through increased attention to professional skills promised by traditional preparation narratives, participants in this study did not engage in generic, directly transferable socio-technical practices. Instead, their identity improvisation involved building and depending on relationships with their co-workers, internalizing the priorities and bottom line of the company (which often included developing a sense of the clientele), and adjusting to specific methods, reporting forms, tools and software. Acclimation did require prior technical skills, and professional skills, but these skills were not sufficient, nor were they standard – or standardizable – across companies. Even when participants had prior knowledge of their companies (A and H), they still needed to improvise new identities within their figured worlds; prior knowledge was not an immediate ticket to a professional engineering identity. Prior knowledge often provided familiarity, not functionality, for newcomers, and attaining

“asset” identities necessitated regular feedback, on-the-job-learning, and self-regulation to be trusted with the responsibility of a non-newcomer position. This aspect of acclimation also reflects the one-directional nature noted earlier. Because the figured worlds of work were not inclined to accommodate newcomers’ knowledge or to adjust constraints regarding acceptable practice and knowledge, newcomers had to adjust themselves in order to improvise the idiosyncratic identities necessary for participating in ongoing practice.

While the need for idiosyncratic knowledge in participants’ narratives does not contradict the call for engineers with new skills (NAE, 2004), or broader or more narrow education (Flumerfelt et al., 2015), it does call into question the institutions responsible for answering the call. Traditional narratives place the responsibility for narrowing the gap on universities, but situated learning theories – and the experiences of these twelve participants - tell us that universities cannot narrow gaps of this variety, or to this degree, without adopting or simulating the idiosyncrasies of companies (Johri and Olds, 2008). While it may be possible to change universities in this way, this itself is problematic because it can threaten the possibilities of liberal and liberatory possibilities of education (Hora, 2018; Judson-King & Pister, 2015; Silbey, 2015).

The structural pre-occupation with ongoing practice also deviates from existing preparation narratives linking engineering to social good because the roles provided to participants were generally not concerned with sustainability nor beneficence for general society, as evidenced in the emergent theme of alienation. As might be predicted by Buch (2016), Riley (2008), or Noble (1977), newcomers’ roles were pre-defined in terms of ongoing *profitable* work. Even companies like G and J’s, which claimed sustainable missions, failed to translate those missions into structural requirements or encouragements (though it was possible for G to act in alignment with a sustainable mission through boundary spanning, and this translation may have happened at M’s third company). A company concerned with sustainability or justice might require sustainability or Engineering for Social Justice

(E4SJ) skills and tasks in their specification of identities of going practice, but such requirements would be a step beyond the inherent connection between engineering effort and societal benefit suggested by preparation narratives and engineering education (Downey, 2014; Leydens and Lucena, 2017). The structures that narrowed the range of acceptable practice identities also confirmed critiques of holistic preparation narratives (Buch, 2016) because participants were not freely able to engage in engineering in the ways they envisioned or desired. The experiences of these participants across multiple industries and positions, moreover, suggest that the case studies by Buch (2016) and Paretto and McNair (2012) are not isolated instances of constraint, but likely reflective of larger patterns.

Finally, the identities that participants were offered and that they acclimated to involved dimensions outside their lives as employees, which preparation narratives do not account for. The emergent themes of sexism, objectification, alienation and dissonance consistently constrained who these newcomers were able to be, leading to concerns about instability, boredom, loss of self-respect, and work that was not “true” engineering. The structures of work thus not only constrained and specified not only participants’ socio-technical abilities, but also these other dimensions of their identities. For instance, some of the women in this study were only given opportunities for a demeaning identity at their companies, reproducing an environment of sexism that many scholars have already identified in engineering work (Faulkner, 2007; Gewirtz et al., 2020; Silbey et al., 2016; Tonso, 2006). For some women, acclimation to ongoing practice ultimately meant that they needed to improvise an identity and develop their engineering practice within an enduringly sexist environment of work. Some participants were called on to diminish the boundaries between work and the rest of their lives, or to sacrifice their life outside of work to attain an identity within work, reflecting other scholars claims about objectification of employees (Gregory & Milner, 2009; Jaffe, 2021; Watts, 2008). Participants were called to contribute to missions separate from their personal missions, which recalls research on marginalization of problems and problem solvers (Danielak, Gupta & Elby, 2014; Secules et al., 2018;

Smith & Lucena, 2016), as well as alienation and pedagogies of oppression (Case, 2007; Freire & Ramos, 1970; Kartal, 2018;). These constraints, and these identities specified by engineering work, were not reflected in traditional preparation narratives. Accounting for them is part of humanizing students and regarding them as more than human capital (Kahn, 2017).

6.2. Who Do Engineers Choose to be in Response?

In response to the identities asked of them, participants navigated the structures of work with multiple strategies, including aligning themselves with the structures of work or seeking out new positions among the ones offered by work, but also, if they felt limited in the possibilities offered, improvising identities in organizations outside of work, seeking new jobs, or simply resisting the workplace structures. Through those strategies, newcomers chose to improvise a variety of identities – identities of being an asset, identities of beneficence, identities that aligned more closely with engineering as they conceived it, and tenable identities that accounted for at least some of their needs.

First, many participants improvised identities of value for their companies. That is, when asked to be assets, they chose to do so. But in line with the figured worlds framework, even the identity of “asset” was not always simple. Participants’ desires for the asset identity were negotiated, or at least held simultaneously, with other desired identities in a process described by Bakhtin as self-authoring (as cited in Holland et al., 1998), or self-authorship (Abes, Jones & McEwen, 2007). Some newcomers, for example, sought to become assets to achieve a separate goal of stability; they viewed themselves in terms of their value for their companies as a way to protect themselves from being laid off (L at her second company, M at his first), and relatedly, to protect their reputation for future jobs (B). On the other hand, some newcomers sought to fulfil their role in traditional preparation narratives because they were expressly interested in becoming an asset for their companies. While for some participants being an asset was a structural requirement in order to improvise other identities within their companies, C, G,

K, and M all agentially sought stereotypical identities of “asset” apart from structural requirements, although, as the emergent themes suggest, they did so in ways that had the capacity to objectify them and reduce them to human capital.

Second, most engineers sought to improvise identities of beneficence. Some newcomers took agentic steps to improvise those identities, reflectively questioning the ways that their engineering problems were framed by structure (Riley, 2008). Some felt that they needed to consider beneficence when improvising their engineering identities, as when G consistently sought out energy modeling work or M considered the beneficence of his work in his job search. Others seemed satisfied with the assumed beneficence of their engineering work, and their improvisations reflected engineering stereotypes of automatic beneficence (Downey, 2015; Leydens & Lucena, 2017). Still others improvised identities that stereotypically conflated their beneficence with meeting client needs (Lucena, Leydens, Schneider, 2010), or with basic engineering effort (Downey, 2014).

Third, many participants (B, C, E, F, K, L and M) were disappointed with the engineering identities offered by their companies and sought to improvise identities of creativity, autonomy or design, often informed by their capstone design experiences, and/or identities that mirrored the “technist” understanding of engineering practice described by Faulkner (2007) that positions mathematical and technical work as more “real engineering” than the social dimensions. Participants’ views on engineering also mirrored optimistic and naïve understandings of engineers’ having unconstrained control over technology (Goncher & Johri, 2015; Jasanoff 2003; McNair & Paretto, 2012; Wisnioski, 2012). These participants often found that the identities offered by work did not meet their expectations; some even viewed their work as not truly engineering, consistent with earlier research by Anderson et al. (2010), Trevelyan (2019), and others. Their improvisations reflected the narratives and rhetoric of maintenance work as being unglamorous or not worth identifying oneself with (Russel and Vinsel, 2019). In response to the call to participate in ongoing practice, some newcomers left (or

considered leaving) their jobs to seek out better opportunities to become designers, or to engage in what they perceived to be true engineering work. Others weighed the perceived lack of opportunities for engineering against other identities they sought to improvise. For instance, B felt like her work was not engineering but was afraid to damage her reputation by leaving her job, and she did find an outlet and opportunity for autonomous work by resisting her superiors' critiques and continuing to code "stealthily." And while K was originally invested in improvising an asset identity at his job, by the end of his narrative he was considering the possibility that another job would give him better opportunities for growth.

Finally, and overall, newcomers sought to improvise identities that were tenable, that were in accordance with at least some of their values and needs (Wenger, 1998). Recalling the way Nussbaum defines justice in terms of whether people are given the capabilities for living worthwhile lives (2011), not all participants enjoyed an equal amount of justice, but they all strove for livability in the form of enjoyment of their work, self-respect, and/or their relationships with each other and with their environments. In general, each participant strove to improvise and author an identity that was not completely authoritatively determined. For participants A and D, the identity resources provided by work were satisfactory for them – A would be settling down into a stable job in his hometown, and D was preparing herself with skills for a job change she expected in a few years - their response to work was mostly acclimation, but for their own ends. Participants E and M were able to find tenable identities as well, at their third companies, but that tenability was defined on their own terms. For the women who experienced sexism, the challenges to their ability to be women and engineers at the same time were aspects of the structure that reduced opportunities for identities of self-respect, and reduced the tenability of engineering identities at their companies. They suggested strategies for resisting these structures such diffusion, skeptical questioning, or leaving for other jobs.

In pursuit of tenable identities, some participants were unsure of how to view themselves, or their companies, as reflected in the theme of dissonance. Throughout these identity improvisations, some participants relied more on stereotypes in their pursuit of a tenable identity, and they needed to reckon with the limitations of those stereotypes to account for their human experiences (Baxter-Magolda, 2009). Gender stereotypes framed women's engineering identities as inauthentic. While newcomers felt they needed opportunities for growth, improvising identities of human capital and stereotypical loyalty did not account for those needs. And stereotypes of beneficence did not account for the ways that improvising an identity of beneficence was not automatic.

Within the figured worlds of work, then, the participants in this study drew on their own resources and exercised agency to negotiate engineering identities that provided them meaning in the form of being an asset, practicing "engineering" as they defined it, providing beneficence, or accommodating their personhood. These participants' narratives, in addition to illuminating new dimensions about the transition from school to work, also pave the way for explanatory critiques that illuminate underlying dynamics of these structure agency negotiations, and point to new directions for education that embody commitments to justice and student flourishing.

It is important to note, again, that these commitments belong to myself and other scholars, but they did not necessarily inform or shape participants' own choices and improvisations, even though I relate participants narratives to these commitments in my analysis. Even more importantly, any person's commitments and identity improvisations change over time, and neither participants' agencies nor their identity achievements as captured in this dissertation are final. People are constantly improvising their identities in figured worlds (Holland et al., 1998), and participants' improvisations and navigations did not end with the end of their narratives as represented in this study. With these caveats in mind, the themes of this study represent relationships with work that were potentially problematic and unanticipated (or at least not anticipated by existing narratives), but they do not

describe each participant's navigation of engineering with finality, nor should they be considered universal archetypes. In their futures, these participants may have reasons to shift their priorities with the events of their lives – some voices may grow louder or quieter. Moreover, though I attempted to represent their agency as accurately as I could, it is still possible that participants did not disclose information which would have led me to different conclusions. In making sense of the themes, the reader is invited to consider the way these themes conflict with or amplify their own understanding of engineering work, but also to imagine multiple possible continuations of these stories.

6.3. Explanatory Critiques

While the two previous sections answer the primary research questions and situate the findings within the larger body of research on engineering work, the following sections address underlying relationships that explain participants' identity improvisations. These explanations lay the foundation for the challenges and alternatives to the traditional narratives laid out in the concluding chapter.

6.3.1. Self-Objectification, Self-Authorship, and Historical Contexts

One of the key questions raised by the findings of this study is why participants were inclined to participate in their own objectification and exploitation. K's example is the most enlightening, he entered work with a preconceived identity of loyalty to his company, but the company had not granted him the leadership or autonomy opportunities he expected would come with the identity, and so he became more skeptical of the "do-it-no-matter-what" attitude that he had entered work with. C, K and M all seemed to be improvising identities based on preconceptions they entered work with, but which also objectified them, and their narratives reflected dissonance along these lines.

The concept of self-authorship can help analyze the relationship between these self-objectifying preconceptions and their influence on identity improvisation. Holland et al. refer to Bakhtin to describe

self-authoring, the way that we make meaning of ourselves and define ourselves through the dialogue between multiple voices (1998, p. 173). Abes, Jones and McEwen (2007), drawing on the work of Baxter-Magolda, used the concept of internal self-authoring to describe the ways that individuals negotiate between multiple identities to make meaning of themselves and the world; those negotiations can range from a reliance on stereotypes and external formulas (what Bakhtin refers to as reliance on authoritative discourse) to a more nuanced self-authorship that allows individuals to develop identities and construct life paths that take into account their own deepest needs and values (Bakhtin's internally persuasive discourse).

Returning to K's example, he understood himself in terms of the value he generated for his company, a preconception and stereotype that failed to account for his other identities, his full humanity (given that the identity was objectifying), or his desires to be a leader. But as Abes et al. (2007) and Baxter-Magolda (2009) assert, individuals can develop a skepticism of stereotypes, and can recognize the limitations of stereotypes in trying to understand themselves (since no person is a stereotype), at which point they move closer to authoring their own unique and non-stereotypical identities that better match who they are. Mirroring this pattern, K seemed to have become better able to author his own identity and consider his other values such as leadership once he became skeptical of his "do-it-no-matter-what attitude."

Bakhtin's framework for selfhood also indicates that any authorship occurs in a context that contributes multiple voices (as discussed in the Landscapes of Activity theme), which includes the voices of authority (Holland et al., 1998, p. 173). Participants' stereotypes of "asset" often involved a deference to authority, in the sense that they relied on the authoritative voices of their workplaces to define the tasks required to become an asset, in turn helping them define themselves. Participants inclined to objectify themselves for the purposes of serving their company were situated among authoritatively imposed stereotypes that did not reflect their boundaries or their own interests.

However, as Holland et al. suggest (1998, p. 169), this identity negotiation was not simplistic nor an unproblematic reproduction or adoption of external identity – it was evidently a source of dissonance between voices, mirroring the state of relying on “external formulas” or (in K and J’s case) “crossroads” described in Baxter-Magolda’s (2009) self-authorship framework. Most commonly, participants’ dissonances were between voices that advocated for or sympathized with their company (authority) and voices that advocated for their own interests. Voices that gave companies the benefit of the doubt and suggested participants’ continued acclimation to existing practice were in dialogue with participants’ own desires for work that was not boring, would respect their boundaries between work and the rest of their lives, would allow them to grow, or more generally would allow them to lead their own life path of flourishing.

Participants’ dissonance in their identity development was aligned with accounts of knowledge injustice. Knowledge justice is a framework that describes the injustices of not being able to ascertain the knowledge necessary for self-determination (Egert & Allen, 2017; Fricker, 2007). Knowledge justice involves preparing individuals with language and concepts that allow them to understand their circumstances and thus knowledgeably navigate them. Those who are victim to knowledge injustice often experience their predicaments as through clouded glass, unable to name or explain their feelings of unease (2007). Participants own dissonances indicated that they were not able to form an unambiguous account of their circumstances. Participants voiced multiple perspectives, but they tended to preserve or reproduce the voices that painted their companies in a positive light, even if those conflicted with their experiences or other identities. So, newcomers were not generally prepared to understand the limitations of stereotypical engineering identities, or to develop identities that challenged a neoliberal status quo. Newcomers maintained their dissonant identities even as they worked, and their dissonances generally seemed to lead to benefits for their companies, because they involved giving their companies the benefit of the doubt rather than spurring self-authorship.

In addition to considering self-authorship as an internal process, Holland et al. note that these negotiations happen against the background of a specific historical context (1998) beyond the local historical structures of the figured world. The participants in this study are constructing their identities, for example, within the historical definition and practice of engineering work in the early 21st century of the U.S. In his historical analysis, Noble (1977) describes the professional education of engineers in manufacturing terms. As engineering skills become more and more specified for industry, the narrative of students as raw material that must be processed is strengthened (Pawley, 2008). This objectification of engineering students for corporate purposes is part of the human capital model of education, where higher education supports existing economies by turning students into valuable laborers (Spring, 2016). The shift of higher education to be about the development of human capital is part of neoliberalism, the privatization of what should be public goods (Giroux, 2019). Neoliberalism for higher education means its transformation from an institution that should defend and provide public goods into a profit-interested business. Neoliberalism plays a role in human capital education by framing choice and agency around, for instance, which job to pick, or how to navigate said job, choices that do not necessarily disturb a human capital model (McMillan, 2018). Ultimately, choice within the context of neoliberalism gives the illusion of freedom while maintaining business as usual – the bottom line of profit is never subjected to questioning, and is not framed as open to choice (Eagleton-Peirce, 2017).

The context of engineers' formation can also be viewed from the lens of pedagogies of oppression. Freire's (Freire & Ramos, 1970) description of oppression includes its capacity to limit the imagination of the possibility of resistance, and to make students passive participants in societal issues, thus leading to the reproduction of status quo (Freire & Ramos, 1970). The objectifying structures of work were aided by objectifying identities that some participants were prepared to improvise – and although they had intentions to become subjects, to achieve their subjective desires, objectification was evidently not a path to achieving those desired identities. While education or work may frame passion,

unquestioning commitment, and self-objectification as necessary or noble bases for identity improvisation within a company, Jaffe has pointed out that unconditional commitments to work can allow corporations to take advantage of employees, and pay less or demand more work, without protest (2021).

Preparing students only with stereotypes of becoming assets for their companies, and not with the ability to navigate the structures of work to their own benefit, was a knowledge injustice, one that pedagogy for self-authorship could remedy. Not all participants needed more knowledge (of themselves or the workplace) to make self-determined decisions – A and D’s adherence to work seemed to serve them well in the improvisation of their desired identities, and A did resist at least exploitation by maintaining his boundaries. But B, C, K and M (in his first job) acted on stereotypical identities of engineers being human capital for their companies, which constrained their identity improvisations and made them more susceptible to exploitation. And G, H and J expressed dissonances between optimism about their workplaces and dismay at the inability to improvise their desired identities. At the very least, K and J were able to improvise identities that involved self-determination rather than being determined by stereotypes.

6.3.2. *Engaged Engineering*

Just as the self-objectification participants experienced was shaped by the structures of U.S. engineering education and work, their experiences of alienation also reflect these structures. Almost all participants mentioned an impact on society as a feature of engineering identity that they either desired or were already enacting, but many participants did not improvise their identities with a consideration of the ways it would influence their impact. Their conceptions confirmed much of the existing research on engineers’ relationships with beneficence: that they erroneously assume that any engineering effort is beneficial (Downey, 2015) or that they conflate meeting client and consumer needs with societal

benefit (while not considering politics or the harms of market logic) (Lucena, Schneider, Leydens, 2010). Research has shown that even when engineering efforts appear to be socially beneficial on the surface, their underlying commitments may be instead to profit, or to political or social control (Campbell, 2013; Jasanoff, 2004; Riley, 2008). Engineering for societal benefit requires, among other things, a nuanced definition of good, rooted in justice for those affected by technology, lest engineering effort be co-opted to other ends (Riley, 2008; Vesilind, 2010). Although scholars such as Trevelyan assert that in order to provide benefits to society, engineers must accept “that productivity improvement is the engineering *raison d’être*, its ultimate purpose” (2019), this is only the case if we also accept the neoliberal assumption that engineers can be trusted to benefit society by contributing to ongoing corporate practices. The research suggests that we should not.

This tension between the good intentions of engineers, and the truth of engineers’ work for industry, has been reflected in historical engineering identities. Engineering has a history of professional societies providing and seeking identities to match a claim to social responsibility, despite the reality of the impacts of their corporate work (Layton, 1986; Wisnioski, 2012). Of course, it should be recognized that engineers’ efforts can provide valuable work for parts of society. On a cultural level, working for corporations as socio-economic structure does provide for some people’s needs, or (to use justice terminology) distributes basic goods to some (Fraser, 2015), and fosters the human capabilities of some people (Ornelas Martins, 2016; Sen, 2009). Traits that are common to many engineers, such as a willingness to help and persistence in working towards that goal, are valuable in the pursuit of social justice (Riley, 2008). I do not mean to frame corporate and societal benefit as necessarily mutually exclusive. The problematic issue is that they are and were conflated.

On a structural level, scholars point out how corporations themselves contribute to blurred lines between corporate and social benefit. Through neoliberal strategies such as greenwashing, a corporation might maintain an outward appearance of holding commitments to environmental

protection, while their true intentions are to protect their bottom line of profit and pre-empting protest (Riley, 2008). Corporations may enact “weak” sustainability programs, which create structures to seek environmental beneficence but only as much as it generates profit (Antunes, 2012). Such structures may explain how participants like G and J, who were interested in environmental beneficence, found themselves initially invested in their companies, but struggling to act on those commitments at two years of work.

On an agentic level, other participants placed other identities, such as growth, or the ability to practice design, as more influential in their improvisations. Participants’ search for new engineering problems (for growth, true engineering, or non-boredom) reflected their lack of consideration of societal benefit in their improvisation. Aligning with stereotypes, many newcomers were inclined to fashion identities of design, or of engineering as they knew it, in whatever capacity a company could provide, without considering the impacts of their work. On the other hand, participants G, H, J, and M, all mentioned their impact on society as being an influential factor in their job choice and in their agentic identity improvisations. Participants G, J and M mentioned a kind of self-determination apart from company identities in considering their own commitments to beneficence. For instance, G needed to defend her time management decisions to balance typical company work with green energy work. Constructing identities with legitimate consideration of their impacts required self-authoring and the ability to hold commitments outside of the ones prescribed by stereotypes, or asset identities.

Understanding newcomers alienated preconceptions of engineering as stereotypes, and non-alienated identities as involving self-authorship, we can also consider these identity developments in terms of critical pedagogy. Oppressive pedagogies frame distant or personally irrelevant problems as central, train students to be comfortable with disenfranchisement, and ultimately prepare them to work on “problems” and regurgitate knowledge without making social change (1970). Another alienating factor of oppressive education is that students with diverse (in gender, race, socio-economic class, or

thought) backgrounds and attendant problems are marginalized, which limits the problems that engineers commit themselves to solving and the communities they work with (Danielak, Gupta & Elby, 2014; Smith & Lucena, 2016). Engineering for Social Justice (ES4J) requires critical thinking and the ability to reflect on problem frames (Leydens and Lucena, 2017; Riley, 2008). In practice, it also requires the ability to understand problems with their agency, not simply understanding problems as they are given. Some participants did reflect on the problem frames they were provided, questioning the priorities of efficiency (G and K), or questioning the variables and impacts left out of their efforts (M), but participants' general concern with novelty over impact indicated a prevalence of unreflective problem solving that did not lead them to question their assumptions of automatic beneficence. Their reliance on stereotypes of engineering allowed companies to define the benefactors of their work, and whether or not it was boring work, their companies were generally interested in newcomers working within the bounds of company history to generate profits.

Newcomers' inclination for novelty in engineering was not necessarily an injustice for the newcomers themselves (although they often found themselves disappointed with the realities of engineering). On an agentic level, if their search for novelty, and their passivity regarding beneficence, left them vulnerable to being co-opted to work for corporate benefit and led them to accept stereotypes instead of reflecting on their problem framing, it also left them less able to enact justice with their engineering. On a structural level, newcomers interested in improvising identities of beneficence were constrained by the figured worlds of engineering they found themselves in, the limited range of activities that allowed for their commitments, and the historical practices they were asked to adhere to. But the fact that some engineering newcomers were inclined to resist, or to consider societal impact in their identity improvisations, meant that there was the possibility of alternative worlds of non-alienated identities, realistic opportunities for change, as discussed in the next chapter.

6.3.3. Sexism and Engineering Stereotypes

Finally, the structures that marginalized women, and their responses to those structures, are contextualized using other cultural studies of engineers that explore gendered stereotypes. Faulkner's classic study of an engineering firm showed that sociotechnical engineering activities tend to be considered separate and gendered along an imposed social and technical divide, with "social" engineering activities being feminized, and "technical" activities being masculinized. She also introduced the term "gender inauthenticity" to describe the ways that women engineers needed "routinely to (re)establish their engineering credentials," (2007, p. 4) because their identities as women were incongruent with their identities as engineers. Tonso's own work using the figured worlds framework to understand student engineering identities found that they "seldom referred to women and when they did it was often in a pejorative way" (2006, p. 284). Some of the women of this study faced these same engineering identity constraints. For the men of J's workplace, she felt they viewed her as a woman of color before they viewed her as an engineer, despite her experience, and the men of F's workplace did not interpret her frustration as information of technical import, more as the feelings of a woman who they needed to console.

Additionally, deviation from ongoing practice was potentially rooted in womanhood. While J explicitly rooted her attempts at empathy and listening in her identity as a woman, G and H also took communication approaches that required resistance against men – G against one of her managers who was making her feel "dumb", and H against her managers who encouraged her to whip her team into shape. Not only did the structures of work prevent some women from improvising tenable identities where they achieved the respect they deserved, but those structures also deemed a narrow range of communication and concerns as acceptable and valuable – and these may have been associated with patriarchy.

Surely all newcomers needed to belong to their workplace to properly carry out their roles, or at least find their identity tenable. But for some women the sexism of their work conflicted with this belonging and the tenability of their identities, and asked them to fit into roles that were demeaning to them – pet names, little sisters, note-takers⁵. These were all examples of injustice in the workplace - at least three women were given reduced options for identity that meant less status and being demeaned. Here too, improvising a tenable identity of self-respect depended upon resisting external definitions and on their self-authoring, although opportunities for realistic change extend beyond individual resistance of stereotypes, as will be discussed in the conclusions.

⁵ In J's case, my interpretation is that "note-taker" was a demeaning identity not because of the potential socio-economic class implications associated with the identity, but because misrecognizing her as not an engineer also intrinsically meant not recognizing the efforts she had put in to support her team, her company, and her products.

CHAPTER 7: CONCLUSIONS

The overarching goal of this dissertation is to use narratives of recent graduates becoming practicing engineers to challenge and critique existing narratives of engineering preparation and re-envision both the relationship between school and work and the larger goals of engineering education. In this concluding chapter, I summarize those challenges and alternatives and offer implications for both researchers and educators to invite and sustain a more socially just engineering education.

7.1. Challenges to Narratives

In light of participants' narratives, the structures they navigated, and their agentic responses to those structures, the findings from this dissertation suggest extending and further developing critiques of the dominant narratives of engineering preparation.

7.1.1. *Challenges to Competency Gap*

As noted at the outset of this study, the competency gap narrative describes a wide range of skills that engineers will need as engineering work advances to keep up with new technologies. It also prescribes an imperative – engineering education needs to prepare engineers with these skills so that they can solve the problems of advancing technologies, and currently, engineering education is falling behind. But the narratives of newcomers in this study counter this grand narrative in several major ways.

First, newcomers were generally pre-occupied with the task of acclimating to their companies and supporting ongoing work. While many calls for change in engineering education describe a future with a need for an innovative, creative and “critical thinking” engineering workforce, scholars like Russell and Vinsel have critiqued those calls on multiple fronts (2019). Innovation is not the only way that engineers interact with technology, nor should it be. The tasks that engineers find themselves doing

do not always require the “creative destruction” or disruption of innovation, and a focus on innovation undervalues precaution and care in our relationships with technology (Russell & Vinsel, 2019). The narratives of this study confirm that engineers, or at least engineering newcomers, were not valued for their ability to disrupt and transform the technical practices they were a part of, rather for their ability to carry them out. And the way newcomers were valued, and the identities they were offered, conflicted with the identities they were prepared by education to improvise. The lack of opportunities for creativity and design is not problematic in and of itself, especially when unglamorous maintenance tasks represent the bulk of the need for engineers in a nation of outdated infrastructure (ASCE, 2021). This aspect of the critique simply points out the inaccuracy of preparation narratives that describe engineering as inherently innovative or creative. Yet these narratives and stereotypes may persist, because they affirm engineers hubristic beliefs in their control of technology (Wisnioski, Hintz, and Kleine, 2019), and because they are also perpetuated by their own industry – hinged on developing and diffusing precious methods of innovation to companies and universities alike (Winner, 2017).

Second, newcomers primarily needed the skills to solve problems for their companies. The socio-cultural and socio-technical knowledge required in order to participate in ongoing practices at each company confirms the research of other scholars (e.g. Lutz and Paretti, 2021) pointing to gaps in context in addition to, or perhaps even instead of, gaps in competence. In doing so, it reflects a key inaccuracy in traditional preparation narratives. Traditional narratives place the responsibility for narrowing the gap on universities, when universities cannot narrow gaps of this variety without themselves adopting the idiosyncrasies of companies (which itself is problematic because it threatens the liberal and liberatory possibilities of education).

Finally, the existing narrative is problematic for its dependence on a human capital view of education, did not account for the evident mismatch between students’ life paths and the corporate structures that newcomers navigated, which were often objectifying, alienating, and sexist. That

problematic nature has been borne out in participants narratives. A lack of preparation for mismatch would explain newcomer's dissonance between their inclinations to view their companies as supportive, or as providing worthwhile opportunities to become the person they wanted to become, and their contradictory thoughts and experiences. Even holistic engineering education approaches could have this problem, if they failed to prepare students for the ways they would be constrained by their companies, and failed to prepare them to live a life outside of being an employee.

At a higher level, the existing preparation narrative seems to serve a focusing function, defining the purpose of education to be preparation of students for corporations, even while that narrative espoused an inaccurate account, at least for these 12 participants, of what students needed, who students would become, and the problems that students would solve. The narratives of this study do not disprove the presence of a gap narrative as defined in engineering reports. However, there is still the possibility to influence changes in education with this study as an explanatory critique, by providing narratives that are true to engineers' experiences that challenge the gap aspect of the narrative. As Caroline New explains,

Explanatory critiques do not represent the whole of political argument, but they are essential to an emancipatory politics based in the nature of the world...However well grounded they are in social scientific investigation, they have no automatic power to move. Social movements carry explanatory critiques like banners...and their capacity to change the world at a given time is a function of the current balance of power as well as the knowledge, strategy, tactics and determination of their bearers. (2003, p. 61)

Even if the competency gap narrative is false (has been false), it has influenced policy and educational decisions, because it exists at a subjective level. The narratives of this study address the competency gap narrative at an objective level through contradictory evidence, and at a subjective level by suggesting alternative narratives (detailed later in this chapter) humanizing engineering newcomers. Humanizing newcomers was not only about generating sympathy for them; these are not tales of woe (though sympathy may be called for). Instead, accounting for these issues is intended to present a more

accurate narrative of participants' relationships with work and the diminishment of their self-determination. Education to provide self-determination for students has implications for their ability to develop fulfilling life paths (Abes et al., 2007; Baxter-Magolda, 2008), but also has implications at a societal level. Individuals who can act for themselves and work towards their own values are the basis for an informed democratic republic (Anderson, 2018; McMillan, 2018). And education can help spur morphogenesis (Case, 2015), a mechanism by which larger structural shifts emerge from the internal shifts of individual agency (2014). By giving engineering students more tools for self-determination, we invite new relationships between engineers and their work that can accommodate values other than efficiency and profit.

7.1.2. Challenging Automatic Beneficence Narrative

The beneficence aspects of the narrative describes a whole host of societal problems and asserts that engineers can solve them only if they possess the proper array of skills. Newcomers' narratives contradicted this aspect of the narrative in several ways.

First, newcomers were generally asked to acclimate to ongoing practices without changing them, and the ongoing work that engineers acclimated to was often for the purpose of company profit, military dominance, or was at least ambiguous regarding its benefit. Moreover, the skills and identities required for becoming an asset rarely resembled the skills and identities specified for Engineering for Social Justice (Leydens & Lucena, 2017).

Second, the identities that newcomers improvised were sometimes more concerned with being an asset, or securing stability or novelty, than they were with beneficence, and this meant that the societal impacts of their work were defined by structure rather than agency. Some newcomers understood their beneficence to come from the way they worked to satisfy their clients' needs, or simply from their work on technology, yet the tasks required of newcomers, and the beneficiaries of

newcomers' work, were different from the broadly drawn "society" that is featured in preparation narratives.

That some engineering newcomers blurred the lines between corporate, client and societal benefit has confirmed some of the value of holistic engineering education. Holistic engineering education may have been able to help students differentiate between these kinds of value (Downey et al., 2006), prepared them with other skills for social justice (Bucciarelli and Drew, 2015; Lucena and Leydens, 2017), and helped them deviate from engineering stereotypes that took the beneficence of engineering and their work for granted. So this study identifies some ways that holistic engineering education may be useful. However, even if students were prepared with this necessary discrimination/skepticism of corporate benefit, the narratives show that such preparation would not be sufficient for improvising identities with sustained connections to societal benefit given the obstacles that participants faced and the strategies they used in response. Even in the newcomers' narratives where the missions and practices of a company seemed clearly beneficial for society (at least from the engineers' perspective), their identity improvisations showed their relationship to that benefit to again be less clear cut – obstacles to deviations were present at those corporations, and some participants felt disconnected from their purposes even there.

With regards to the societal beneficence aspect of the narrative, the narratives produced by this study operate in similar way to the previous aspect. They do not necessarily disprove the automatic beneficence of engineering work, but they do provide a platform to challenge the existing narrative or summarize the mounting challenges to the existing narrative. In this way the newcomers' narratives

may clear the ground and form clearer connections between societal beneficence and engineering work, by demonstrating what these connections might look like in practice – being intrepid with job choice⁶, skeptical of company commitments to beneficence, reliant on external groups for opportunities to learn and improvise beneficent projects. This study’s focus on the agency of engineering newcomers highlights the necessity of holistic engineering education for preparing engineers to discriminate between societal benefit and corporate benefit, and highlights the scenarios where engineering newcomers may be able to work towards societal benefit even when work structures call for engineers who work towards corporate benefit.

The critique of the beneficence narrative is not about whether the missions of each company were beneficent enough, nor is about suggesting an uncomplicated mission or technology that companies should adopt. There are no uncomplicated or apolitical technologies that engineers should uncritically commit to, even those that are widely considered “green” or beneficial (Mulvaney, 2013). Instead, the purpose is to re-illustrate, in the light of structure and agency, a relationship that multiple scholars have already described to some extent, as disengagement (Cech, 2014a), as depoliticization (Cech, 2013), as normative holism (Downey, 2014), as hubris (Jasanoff, 2007). And as I have discussed, engineers’ relationships to technology corresponded with their self-determination (or lack thereof). Solving societal problems requires critical self-fashioning and skeptical problem framing, the same qualities needed for liberation.

⁶ There is a so far unacknowledged privilege of being able to switch jobs in pursuit of a beneficent ideal – even E mentioned how vulnerable he would be if he lost his job. This is discussed more in the next section.

7.2. Realistic Opportunities for Change

The narratives of agency in figured worlds produced by this study are a way to address the problematic aspects of traditional preparation narratives. In the previous sections the traditional narratives have been discussed in terms of how they are inaccurate, but also in terms of how they suggest educations that obstruct the goals of justice for students and justice for those affected by engineering effort. Beyond critiques of traditional narratives, the empirical accounts of participants experiences allow us to imagine opportunities for change in sociotechnical practice with reference to their “real worlds.” This section discusses the opportunities for change suggested by participants narratives, in dialogue with existing recommendations for change.

7.2.1. *Moving Beyond Human Capital*

One key opportunity for change lies in paving the way for engineering graduates to become more than human capital. In response to the constraints on identity and practice that engineers face at work, Buch has advocated for engineers to be trained to resist the structures of corporations (2016). Samuelson and Litzler (2016) suggest that engineers can develop the capacity to resist stereotypes through faculty and student training (although their conception of resistance refers to racial and gender stereotypes).

Education can give individuals the ability to negotiate among conflicting identities, and to define themselves outside of the scope of stereotypes, even to define themselves in ways that have not existed before (Abes, 2007). Education can also help individuals go beyond using stereotypes to identify themselves, and thus can help them decide how to live their lives well (Baxter-Magolda, 2004a; Kivelä, 2018). As Baxter-Magolda asserts, education should be responsible for developing students’ abilities to self-author, in place of a reliance on stereotypes (2009). For Freire, liberatory education is the possibility to be more than externally determined (Freire & Ramos, 1970). The below quote from

bell hooks affirms the responsibility for liberatory pedagogy to develop whole persons, rather than maintaining dissonances or stereotypes:

It is crucial that we not ignore the self nor the longing people have to transform the self, that we make the conditions for wholeness such that they are mirrored both in our own beings and in social and political reality. (1989, p. 32)

Not only is it important for educators to focus on student's lives outside of their potential as employees, but it is also important for educators to encourage students to do the same, to see themselves as more than value generators for companies. In the figured worlds framework, agency is not only a feature of individual's identity development; it is what generates alternative worlds, opportunities to improvise resistive identities (Holland et al., 1998). These identity commitments are what lead to strategies such as A's defense of his work-life boundaries, and J's search for another job.

In interpreting Freire, hooks discusses her personal identification with his statement that "we cannot enter the struggle as objects in order later to become subjects," and reaffirms the liberatory power of understanding "self and identity in relation to one's political circumstance" (1996, pp. 46-47). More practically, Freire describes liberatory pedagogies as rooted in action research, interacting with real world problems, reflecting on them, and fashioning oneself in response to those problems (Freire & Ramos, 1970). Baxter-Magolda has developed a Learning Partnerships Model for developing students' self-authorship, which depends on principles such as treating students as having valuable knowledge to contribute (2012). Other scholars have discussed alternative engineering worlds where engineers can include their personal experiences in problem framing, and thus can solve local problems rather than only those for corporations (Campbell, 2013; Lucena, Schneider, Leydens, 2010; Wilson-Lopez et al., 2016). It is plausible to imagine a workplace that would give freedom to develop and implement their own engineering practices – therefore allowing for a wider range of improvised identities to be acceptable. Seron and Silbey have imagined a similar freedom and tolerance emerging from the unique engineering undergraduate programs at Olin and Smith college (2009).

7.2.2. *Individual Vs Collective Liberation*

A second key opportunity for change involves thinking beyond the level of the individual. While some newcomer's strategies focused on a preservation of their identity in the face of workplace structures, a concern about realistic change raises the issue of the distinction between individual and collective liberation. While I have discussed self-authorship and liberation thus far as an individual negotiation, for scholars like Freire, liberation is a collective struggle. Mirón conceptualizes the collective struggle for reflective change (praxis) along two dimensions: the first being shared knowledge and conscious awareness, and the second being practical collective social actions taken to accomplish change (2018). Concerning the first dimension, while I have thus far only described self-determination as an individual process, for Freire, humanization and accumulation of knowledge happens through dialogue, through a collective sharing and interpretation of personal experiences. This should not exclusively be in an affirming way, but in a way that allows a collective to come to their own understandings, informed by many individuals, independent of and critical of their oppression (Dias, 2019; Weiler, 1991). This process also specifies the role of the educator, as one voice in the collective, and each member of the collective is recognized as having valuable knowledge (Dias, 2019). This role of the educator is ultimately reflected in education for self-authorship (Baxter-Magolda, 2012), which prioritizes the knowledge of the student. And the dialogic nature of collective sensemaking is also reflected in the figured worlds theory of structure and agency, where multiple voices are offered (heteroglossia) and negotiated (Holland et al. 1998).

Given that some of the participants of this study were dehumanized by sexism, however, I note that Freire's critical pedagogy has been criticized for limitations in its ability to accommodate feminism (hooks, 1996) and its inability to address the ways that oppression is not uniform across oppressed groups (Weiler, 1991). Weiler (1991) suggests three ways that feminist pedagogy can build on the Pedagogy of the Oppressed: by acknowledging the teacher as a human with their own race, gender and

relationship with oppression, which is inevitably involved in the classroom; by permitting new knowledge and epistemologies to count as truth and valid testimony; and by recognizing difference as sometimes being fundamental and sometimes resulting in conflict, which must also be factored into the concept of liberatory dialogue.

Regarding the second dimension of praxis, collectively organized action, recognizing it as a necessity implicates a new dimension of neoliberal schooling as problematic. Neoliberal higher education follows a student-as-customer model, which tends to focus on individualized self-development and justifies itself as better for the individual student even while it precludes collective sensemaking and collective action (França, 2019; Mintz, 2021). In other words, neoliberal higher education advertises its purpose as individualized social mobility and the adjustment of individual circumstance, without providing the mindsets nor practical tools for collective education that are necessary for changing social order (Visanich, 2020). To avoid the student-as-customer model of education, self-authorship perhaps should be regarded as a necessary but insufficient aspect of liberatory education, and not as a replacement for students' preparation for collective action. But the two concepts are neither mutually exclusive nor separate, as seen in participants' narratives. Part of newcomers' resistance to stereotypes involved improvising identities through socializing outside of the strict bounds of work in, for example, mentorship groups or former employee groups, which were subject to different identity constraints. Participating in non-company organizations allowed participants like G to make sense of and improvise commitments to sustainability, and allowed G and E to develop new kinds of knowledge that their companies didn't provide them. On the other hand, G's commitments to sustainability are what led to her collaborative work on sustainable projects. So, in G's case, self-authoring and participation in organizations interacted with each other, and depended on each other.

One final point regarding collective liberation is that the necessity of collective sensemaking not only specifies the role of the educator, but also the role of the engineer, as someone who works alongside the community, rather than positioning themselves as gatekeepers of extraordinary knowledge (Lucena, Schneider & Leydens, 2010). Advocates for citizen participation in science and technology governance suggest that for engineering justice, engineers must have the humility to listen to and be guided by the knowledge of those affected by their technologies (Allen, 2018; Jasanoff, 2003). Engineer's preparation for collective liberation involves not only allowing them to make sense of themselves and their work within collectives, but also preparation for their work to be contextualized and driven by collectives. In this way participatory justice, that those affected by decisions should have some say in them, can be secured (Allen, 2018; Leydens and Lucena, 2017).

In part this study's focus on individuals is a limitation which emerges from the type of data: individuals who do not know each other who were interviewed about their individual identities and improvisations. However, even with limitations, so long as the student-as-customer model is avoided, the self-authorship promoted by this study should be compatible with collective liberation. Affirming this compatibility, hooks describes the process of coming to know oneself through liberatory education as "self-recovery" and also places it at the root of feminist revolution (1989). And Mirón, in discussing collective action, can leave us with this quote:

personal awareness is merely the starting point for a shared theoretical understanding of the conditions that wrought, among other forms of oppression, poverty, racism, the exploitation of women, and homophobia (p. 191)

7.2.3. *Searching for New Jobs?*

Finally, participants considered their employment choices as an opportunity for changing their practice, though as I argue, it is a strategy that comes with limitations. One strategy that participants took or considered as a way to change their circumstances and improvise new identities involved the

search for new jobs. Many participants discussed job selection as an opportunity to improvise identities closer to their values. Some participants were able to change jobs to find one that they could commit themselves to (E and M), while others were afraid to change jobs for fear of confirming a millennial stereotype and risking their job stability (B). It is unsurprising that engineers were motivated to construct professional identities that matched their values given prior research done by scholars such as Matusovitch et al. (2010). However, job selection is not an unproblematic mechanism of resistance. For one, it still relies on corporations to define the problems that engineers work on, and engineers interested in beneficence might find that there are limited options for improvising those commitments through this method (Rulifson, 2019). Another issue, job improvisation places the onus of change on individual students, which comes with the cost of going without work until they find an opportunity that matches their desired identities, which ultimately is part of the neoliberal strategy (Eagleton-Peirce, 2017). Finally, it is possible that the strategy may lead to structural change in choosing only companies that do not objectify, or that allow for the kinds of engineering and growth that students desire, may encourage companies to change how they structure their tasks. But it is also possible that companies may change their advertisement and recruitment strategies without changing the identities that are possible to improvise at the company (Australian Competition and Consumer Commission, 2011).

If job navigation was a primary method for the engineers of this study to find work that matched their desired identities, including stability and societal beneficence, then it suggests that education should aid engineering graduates in their navigation, giving them knowledge to discern company promises from identity improvisation possibilities, and also giving them more of an ability to resolve dissonances without optimistic perspectives of their companies. However, job selection is a limited solution, because it does not challenge the neoliberal systems that specify students' conformity to corporate work (McMillan, 2018). For critical pedagogy, resistance to external definition and self-

authoring must be developed outside of an employability context (McMillan, 2018; Riley and Claris, 2012).

While participants were sometimes able to resist the impositions and requirements of their companies, this was often without influencing ongoing practice unless that was to make it more efficient. Given the limitations for newcomers to influence ongoing practice, it seems that structural level change must necessarily extend beyond the education of individual resisters to strategies such as Corporate Social Responsibility (CSR) (Lyon et al., 2018), civic politics in the form of protest or journalism (Garwood, 2020), or the development of counter-expertise (Egert and Allen, 2017). CSR approaches need to move beyond being alternative strategies for profit, and must bridge the gap between company practices and stakeholders (Høvring, Anderson and Nielsen, 2018), but otherwise CSR can be in line with the collective action suggested by liberatory pedagogies. Engineers must be able to participate in efforts to critique and change socio-technical practice outside of the strict bounds of their employment, because employment may require their acclimation rather than resistance.

As briefly mentioned in the *engaged engineering* section – it is possible for engineering corporate efforts to serve societally beneficial functions, and to create appropriate technologies; to not acknowledge the benefits of capitalism would be an incomplete argument (O'Connor, Schonsheck & Wright, 2018). Rather than simply identifying corporate engineering as wholly problematic, the findings of this study both depend on and suggest that certain assumptions about corporate engineering are problematic. While traditional narratives conflate corporate engineering with societal benefit, this study is part of a branch of research that disentangles them. And, particularly through the lens of my own positionality and philosophical commitments detailed in Chapter 1, the disentangling suggests that we should be skeptical of the role of corporations in society. While some corporations may maintain societal and/or environmental benefit as part of their bottom line, again, without careful investigation these declarations may prove to be part of a profit strategy that does not secure justice (e.g.

greenwashing) (Escobar, 2018; Riley, 2008). And even if companies can legitimately connect their practices with securing justice, factors such as the promise of profit, incomplete knowledge about the effects of a technology, or incomplete knowledge of how a public will act, can compromise the goal of justice, meaning that we cannot unilaterally trust corporate engineering to be self-regulated or market-regulated for a public's best interest, and so corporate engineering must be regulated in other ways (Chapman, 2013; Harremoës et al., 2001)

At the same time, the narratives of this study should not be read to suggest that corporations are inherently malicious or to be avoided by a newcomer engineer seeking to improvise an identity of benefit. More specifically, the narratives advocate for disentangling beneficence and corporate effort at the level of identity improvisation because they suggest that the identities required for each may conflict with each other, or may simply run parallel without reinforcing each other, although the possibility that they can overlap was not ruled out. The questioning inspired by the narratives also suggests that we can and should seriously imagine engineering effort that revolves around societal problems – through alternative worlds that may or may not be corporate.

7.3. An Alternative Preparation Narrative

Given these critiques of traditional preparation narratives and the possibilities for realistic change, we can imagine an aspirational preparation narrative that is better rooted in newcomer engineers' experiences.

At the level of individual agency, engineers might develop a simultaneously skeptical and self-assured relationship with their company, as opposed to a “do-it-no-matter-what” or a “blind loyalty” attitude. Students would ideally know their values and purposes before entering work and would be able to judge whether their workplaces were giving them opportunities to enact those values. Skills would matter in this narrative, too, except the imperative of this narrative would be for engineers to

develop the skills necessary for them to act on their commitments, rather than the skills necessary to carry out a company's practices. Not meeting this imperative would run the risk of students' domestication.

If we were concerned with change to socio-technical practice and the impacts of corporate developed technology, job selection might not be a strong enough mechanism to guarantee that change. However, students could develop the skills of building social capital and developing identities outside of strict corporate bounds to prepare for alternative engineering practices – in participants narratives, these connections were one way to multiply their agency. The shift beyond employability would work to decouple engineering practice and corporations. It could depose the primacy of corporations in determining the aims and practices of engineering and would potentially hold companies more accountable to engineers' own skepticism about those aims and practices. Optimistically, more engineers would solve problems framed by community need rather than corporate benefit.

Of course, holistic education would be part of the ideal. Engineers would be educated about legitimate ways that their work can accomplish justice, rather than assuming their work does good by default. Allowing engineers to engage with societally beneficial problems would also entail educating in a way that does not marginalize students who define or approach their problems differently, and thus means providing tenable, authentic and respectable identities of engineering work.

Even with changes to education to support students' ability to act on their own agency and address problems outside of corporate bounds, there would need to be structural level changes as well. Focusing entirely on individual agency, whether that was in the form of job choice or skills, would distribute too much responsibility to students who were not be involved yet in maintaining the systems we sought to change. On the structural front, universities would have to reflect on their corporate entanglements (Giroux, 2010; Hohendahl, 2011), because it would inevitably be a conflict of interest for universities to educate skeptical engineers if universities were simultaneously receiving direction

and profit in their collaborations with corporations. But the oppressive consequences of those entanglements should motivate us to cast off an outdated and neoliberal competency gap narrative, and embrace a liberatory mission for the university.

Marxists would suggest that eliminating alienation would require engineers to seize the means of production; that is, engineers would design not according to a capitalist marketing logic, and not for the production of private property, but according to user needs that they directly receive and interpret (Schact, 1970). Another alternative is that corporate social responsibility (CSR) could hold corporations accountable for their impacts on society, and influence the practices and opportunities available to engineers. But this approach, too, has limitations – there are discrepancies between how companies disclose their CSR actions, and the actual CSR actions that companies take; strong and more holistic CSR assessments are needed (Filosof, 2017; Lyon et al., 2018).

Ultimately, the structures that prioritize corporate benefit and adherence to ongoing practice would need to be reevaluated. If productivity was formerly the engineer’s purpose for existing in order to support societal wellbeing (Trevelyan, 2019), instead, wellbeing itself, or justice, could become the purpose that we educate future engineers for.

7.4. Future Work

While the above alternative preparation narrative is meant to take participants narratives into account, and is intended to humanize students and better prepare them for lives of self-authorship and beneficence socio-technical practice, this narrative must be taken to heart in order to have impact. Taking the findings of this study to heart and bringing about these alternative worlds/narratives both present educators and researchers with responsibilities. As Jasanoff describes “Imaginaries...encode not only visions of what is attainable through science and technology but also of how life ought, or ought not, to be lived” (2015, p. 4). Such imaginaries are already encoded in engineering education at

multiple levels – in the ways researchers justify their work to grant awarding institutions, and in the ways that educators seek to simulate for students the activities of engineering work as they imagine them. This final section describe ways that researchers and educators can take the imaginaries suggested by this study to heart.

7.4.1. Implications for Researchers

For engineering education researchers this study should highlight the importance of accounting for agency of participants. This study concerned newcomers’ agency at multiple levels: in theory, methods, and in results – hopefully it has demonstrated how no research participant can be completely described by the structures that surround them. Not accounting for agency runs the risk of drawing participants in too broad of strokes, a “downwards conflation” that cannot differentiate between structures and the choices that individuals make (Archer, 1996). In this way, not allowing participants to define themselves on their own terms threatens ethical validity (Secules et al., 2018; Sochacka et al., 2018), without which we risk reproducing stereotypes of engineers and engineering students with our research, rather than representing their lived experiences.

Another responsibility for researchers is to question their reliance on traditional preparation narratives as a justification for research funding. Research developed with the intention to prepare students for work (at the expense of preparation for self-authorship) may contribute to engineers’ domestication, but also to researchers’ own domestication. The neoliberal deference to human capital models of education transforms university research programs, where knowledge becomes intellectual capital (valued for its profitability), and faculty become entrepreneurial workers hired for producing that capital (del Cerro Santamaría, 2020).

Finally, this study’s decoupling of school and work also suggests the imperative for other decouplings. Where might opportunities for engineering practice be found outside of the corporation?

What structures besides corporate work can provide opportunities for individuals (students or not) to improvise engineering identities? Hypothetically, citizen engineering movements would fit well with the need for collective sensemaking in liberatory pedagogy (Riley et al., 2016). More generally, liberatory education requires that educators and researchers remain in contact with the sites of liberation, the place where de-domestication happens (Apple, 2011) – engineering researchers should seek these sites.

7.4.2. *Implications for Educators*

For educators, the results of this study first suggest questions they can ask themselves about how they imagine engineers at work. While the narratives of this study are not proof, they are also not unusual or outlying. And even if the experiences of these newcomers do not match educators' firsthand experiences, or the accounts of experiences they receive from enthusiastic students, this study still identifies multiple problematic aspects of the traditional narratives used to understand engineers at work. Even for those who are inclined to doubt qualitative research, this study should raise questions about the assumptions that underpin their imaginaries. Do engineers get to work on millennial problems? Do they practice creativity at work? Will newcomers' workplaces make good on the promises of novelty and impact? Is engineering education failing to prepare newcomers for a variety of complex and changing problems? Is educating engineers enough to make social change?

The next responsibility for educators is to imagine alternative narratives, and take those to heart. From participants' narratives, newcomers do consider the version of engineering they experienced in education when they improvise their identities – often they seek a creative or design-oriented definition of engineering they were promised in school. So “engineering” as educators imagine it and teach it does matter. Engineering can be decoupled from supporting corporate missions, as other scholars have discussed (Lucena, Schneider & Leydens, 2010). Engineering can also be decoupled from glamorous or

“innovative” technology, and we can “make way for maintainers” and prize the ability for engineers to support vital but old infrastructure (Russel and Vinsel, 2019). In addition to the skills traditionally considered as part of engineering, we know that skills such as listening and caring can prove important to engineers, but this study also shows that the ability to understand one’s own identity and negotiate dissonance are other important skills. We can imagine other goals for education, preparation for the exploitation, alienation and sexism they may experience. Students need to be given better tools to deal with those realities, but the presence of dissonance should give hope that newcomers are at least somewhat inclined to question and resist, that they would be receptive to change, rather than preferring domestication.

Finally, educators must act to bring about those alternative worlds. Liberatory education, and education for self-authorship both prescribe approaches that prioritize the knowledge of the student and validate them as knowers (Baxter-Magolda, 2012; Weiler, 1991). Students have problems they would like to solve and are knowledgeable about, and these can be fruitful starts to project-based learning and service learning (Wilson-Lopez et al., 2016). Taking on the approaches of Vygotsky (who Holland et al. lean on), the Zone of Proximal Development (ZPD) model can help educators fit in the interaction between agency and structure. Educators’ purpose in these alternative narratives would be as one voice in the space of authoring (Holland et al., 1998) helping students achieve what they may already agentially inclined to do, while modeling sociotechnical skills, and values of integrity and altruism.

Drawing on Borrego and Henderson (2014) we can imagine different levels at which new preparation narratives can challenge engineering education practice. In reflecting on our educational practices and conferring with our peers, we can ask ourselves, to what extent am I depending on an outdated or neoliberal narrative of engineering? In developing new policy, we can explicitly require education to be about liberatory development of persons, we can assess ourselves according to non-corporate values, and we can assess corporate structures according to values of justice and liberation.

At the level of shared vision, we can challenge each-other to hold more accurate and critical views of the relationships between higher education, corporations, students and ourselves. And ultimately, we must not give up on the vision of the university as a place of liberatory development.

APPENDICES

Appendix A – Interview Protocol⁷

The interview will employ a semi-structured protocol, below, to prompt participants to reflect on the ways in which their capstone experience did and didn't prepare them for their current workplace experiences. Interviews will explore participants' experiences in the first few months of their job following graduation. Because this interview will come after previous data collection (anticipatory interview, weekly workplace surveys, and, for 6- and 12-month interviews, after earlier workplace interviews), prompts may be tailored to follow up on comments or experiences identified in previous data.

The interview will begin with a review of the Informed Consent.

The protocol will follow the pattern below, but is semi-structured to allow for flexibility and exploration of potentially salient but unanticipated topics. The exact language may shift slightly in the course of the interview to create a smooth flow of conversation.

Introduction: As I mentioned when we reviewed the informed consent, what I'm really interested in today is exploring your recent experiences in your job and how they might relate to your capstone design experience.

7. More details about C2W interview collection can be found in Paretti et al. (2021).

6- and 12-month interviews (ONLY): I'm going to start by asking you more or less the same questions I asked in our previous interview. If things are the same, I'd still like to hear about them, but I'm especially interested in things that have changed since the previous interview.

I'd like to start by learning a little bit more about your job.

1. (At 3 month-interview ONLY) [If they had a job at graduation]: In the recruitment survey/first interview, you thought you'd be working for an X-size company in X industry. Is that still correct? If not, what's different?

[If participant didn't have a job at graduation, now ask the following:

- a. What size company do you work for? (a) <100 employees, 100-1000 employees, >1000 employees - large multinational
 - b. What industry are you in: Aerospace, Defense, Automotive, Consumer Products, Electrical/Electronics, Energy, Biomedical or Pharmaceutical, Civil /Infrastructure, Environmental, Consulting, Other (can select multiple)
2. Tell me a little bit about your job.
 - a. What are your typical responsibilities? [6- and 12-month ONLY]: Has this changed much in the last 3 months?
 - b. What does a typical week look like for you? What kinds of tasks and activities do you do? Who do you interact with?
 - c. [3-month interview only] Using the same scale we used in the weekly surveys, on a scale of 1-7, how prepared do you feel for your responsibilities?
 - d. What aspects of your job have you felt the most prepared for over the past 3 months? Why or how?
 - e. What aspects of your job have you felt least prepared for over the past 3 months? Why or how?
 3. What skills have been necessary for you to do your job?
 - a. Where did you develop those skills?
 - b. How much or what kind of training have you received from your employer for this work?

- c. If they had training: Tell me a little bit about that experience?
4. Thinking broadly, what has been your most significant accomplishment at work over the past 3 months?
- a. What made it so significant?
 - b. In what ways did your capstone experience prepare you for that accomplishment? In what ways did other experiences prepare you (internships, extracurricular activities, other classes, etc.)
5. Thinking broadly, what has been most challenging about your job over the past 3 months?
- a. What do you think made that so challenging?
 - b. How have you dealt/are you dealing with that challenge?
 - c. In what ways did your capstone experience prepare you for that challenges? In what ways did other experiences prepare you (internships, extracurricular activities, other classes, etc.)

Now I'd like to talk a little bit about how your job compares to your past experiences and expectations.

6. First, how do your work responsibilities compare to what you experienced in your capstone course?
- a. In what ways were your experiences aligned with your capstone course?
 - b. In what ways were they different?
7. How did your experiences at work match your initial expectations? (Have notes in from the anticipatory interview as prompts for those expectations)
8. At your previous interview, we talked about how you define engineering.
- a. Based on your experience so far, how would you now describe what it means to be an engineer and what engineers do?
 - b. In light of what you just said, to what extent do you see yourself as an engineer at this time? Why? Probe for specific experiences at work that do/do not seem like engineering.
 - c. One of the things that undergraduate programs often address are the "broader impacts" of engineering work - e.g. social, economic, political, or cultural issues. Do you see any factors like these impacting your engineering work?

[3-month interview ONLY] Now I'd like to talk in a little bit more detail about some things that you described in your weekly responses:

9. Based on [interesting survey response or prior interview comments], it looks like [this time] was pretty important for your transition. Can you elaborate a bit more on what was going on then?
 - a. Researcher will have participant-specific prompts based on journal entries

Now I'd like to step back a little and talk more broadly about the transition from your capstone/senior design class to work.

10. Knowing what you know now, is there anything that you wish you would have learned about in capstone?
 - a. Why would that have been important?
 - b. Was there anything in capstone that you would take out or change?
11. If you could give advice to the next class of graduating seniors about what to expect when they enter their jobs, what would that be?
 - a. Why would that advice be useful?
 - b. Would you have listened to that advice?
12. If you could give any advice to your capstone design instructor - including not only what to change, but what to keep doing - what would you say?
13. (6 and 12 month ONLY) Did you receive performance reviews from a supervisor?
 - a. Would you be comfortable describing the feedback you received? (If so, please do)

(12 month interview ONLY) Now that we're at the end of this study, we'd like you to take a step back and think more broadly about your company and broader work context this year.

14. How would you describe the culture of your organization? What's your workplace environment like?
15. How did your understanding of the broader context of your work/your company evolve over the past year?
 - a. To what extent were you aware of this bigger picture when you started?

- b. How has your work been impacted by this bigger picture? How have you had to adapt to work in a larger context?
 - c. Are there any ways you think capstone design could have prepared you to recognize and to adapt to this environment? Why or why not?
16. Thank you for your time, is there anything else you would like to add that we maybe haven't covered, as I try to understand how individuals experience this transition from school to work?

Appendix B – Codebook

Agency	subcodes describe the agency of the participant, an identity distinct from their surroundings.
Action Resulting from Negotiation	indicates a scenario with negotiation between the participants own agency and the structures that surround them. Each narrative should have these moments as centerpieces.
Identity Resource	These are the identities that exist inside and outside of a person for them to use to improvise their own identity.
Company	an identity provided by the company or is encouraged by the company.
Engineering	an identity is provided by engineering or could be called engineering
Non-Engineering	an identity is provided by a source outside of engineering or could be described as distinct from engineering.
Not Company	an identity is provided by a source outside the company. This is particularly relevant for describing engineering identities which come from outside the company.
Questioning allowed?	From a Bakhtinian perspective, is the participant allowed to raise questioning discourse? Are they allowed to do something other than what they are told (even if they choose not to)?
Questioning? - No	indicates that the participant is not allowed to question or challenge (Authoritative Discourse).
Questioning? - Yes	Indicates that participant is allowed to question or challenge the structures of work (Internally persuasive discourse).
Relationship to Mission	indicates the participants relationship to the mission of the company. Code may be used when the excerpt says something about the relationship which is ambiguous.
Mission - Against	The excerpt indicates that the participant's identity is positioned against the mission.
Mission - New	indicates the participant is trying to advance a new mission within the company (new and improved counts as well).
Mission - Support	indicates the participant is in support of the mission of the company.
Relationship to Philosophy	indicate the participants relationship to the philosophy of the company. Code may be used when the excerpt says something about the relationship that is ambiguous.
Philosophy - Against	indicates that the participant's identity is positioned against the ways of thinking at the company.
Philosophy - New	indicates the participant is trying to advance a new way of thinking within the company.
Philosophy - With	indicates the participant agrees with or wants to think in a way that is encouraged by the company.
Relationship to Practice	indicates the participants relationship to the practices of the company. Code might be used if the excerpt says something about the relationship that is ambiguous.
Practice - Against	indicates the participant wants to do different/new practices but does not feel free to.
Practice - New	The excerpt indicates the participant is engaging in a practice that is new to the company.
Practice - Traditional	The excerpt indicates the participant is engaging in practices that are well known and old to the company,

Structure	Structures indicate what the standard identity is at the company: the practices people identify themselves by, the ways people think, the goals they should be motivated to accomplish.
Company Mission	The mission refers to the justification for the company. Participants describe these in technical terms but also in non-technical terms such as "protecting our country," "providing a needed service," etc.
Company Philosophy	a reasoning or way of thinking that is standardized at the company. Examples are "efficiency," "sustainability," beliefs about work/life balance.
Company Practice	Technical and non-technical things that people must do in the course of work towards the mission. Examples include specific kinds of modeling, calculations, protocols for communication.
Narrative	Codes which later can be used to reconstruct and represent a narrative of a participant's experiences.
Background Details	Specific details about a participants story that give context, these are usually technical details.
Character	Parent Code for any characters mentioned in the interviews which may be represented in the narrative.
Client	The excerpt describes the character of the client from the participant's perspective.
Colleague	The excerpt describes a colleague, or colleagues, or teammates, or classmates, from the participant's perspective.
Other	The excerpt describes another relevant character (professor, family member, etc.) from the participant's perspective.
Self	Code is used for excerpts which help communicate who the participant is.
Supervisor	The excerpt describes managers, or supervisors, or senior colleagues, from the participant's perspective.
Plot	These codes help indicate the chronological and logical relationship between different excerpts and scenarios.
Conflict	A scenario or challenge that the participant must go through to accomplish their goals.
Falling Action / Resolution	indicates scenarios or accomplishments that occur post-conflict. As these are narratives are real-life people, there is little in the way of complete closure.
Flashback	The excerpt takes place in the participants past, though they feel it is relevant to bring it into interview.
Motif	The excerpt indicates a regularly occurring theme that helps establish the logic of the participant's story. Ex: D - "research," C - "stagnation/the-big-chill"
Rising Action / Foreshadowing	The excerpts which describe expectations or strategies that precede conflict. These excerpts should be kept in mind for later interviews, to describe how things "work out."
Purpose	Excerpts which indicate the participant's purpose or motivation. This code could also be called "Goals."
Setting	Excerpts which describe a relevant place or context, which may not necessarily be work
Emotion	Codes used to identify the emotions of the participant, aided by listening to the audio for the interview.
Ashamed	
Confident	
Disappointment	
Excited	

Fear/Nerves
Frustration
Hopeful
Hurt
Intrepid/Curious
Invested
Pride
Sad
Satisfaction
Tired/Burned Out
Unsure

Appendix C – Full Narratives

A's Narrative

A's Exit

A had interned at a defense manufacturing contractor for 2 summers prior to his senior design course. That was the company that was sponsoring his senior design project, and that was where he was going to start work after graduation. *It was a classified facility, so he already had a security clearance. His role in senior design was to be the liaison between the company's terms and what he could reveal to his team. And he was the team leader, though not in the sense that he was the one with all the power. It was more just reminding them of when to turn stuff in.*

It was a lot of work for them to get the project out to the team. They would make site visits, which just meant going to the visitor's center and hanging out in one of the conference rooms. But it was still a good experience for the team to actual see the security gates – it hit home for the other team members.

A had grown up around the company. *They were located in his hometown. They were the largest source of jobs there, so they were a reputable company. He knew a lot of dads that were engineers there, worked there in the shop, so he had heard a lot of good things about it. When he was deciding what he wanted to do after graduation, he could see himself working there. His freshman year, he*

didn't get an internship there, but his internship at another company was what got his foot in the door the summer after. Then at the end of his second summer of interning there, they interviewed him and offered him a job. It just all worked out really nicely, as good as he would've hoped.

The first semester of senior design was underwhelming. They only had two big assignments and then everything else was little hoops like, "Come up with customer needs and then send them out to your customer." And then next week they give them back to you and say, "Yeah, those look good." It wasn't fulfilling at all, because they weren't actually building anything. He understood why he wasn't as motivated. It wasn't until they started finishing their design and talking about how they were going to test it, how they were going to build it, that it clicked for him. And for the larger assignments in the later semester, they had started to figure out how the game was played. "Do exactly what the rubric says." If you were able to see what you were going to get graded on, do that. He was not the most creative person, so it was helpful for him.

Going into work he wasn't exactly sure what it would entail. He had already done most of the onboarding for new hires. If he hadn't already worked there, it would probably scare the shit out of him.

The big security gate with scanners and metal detectors, plus armed guards. But the work itself, he expected it to challenge him, but not scare him. He knew to expect regular performance assessments until one year at work, and then yearly assessment after that. He was going to be a process engineer, which he understood as making sure that any deviations in the process were fixed. Dealing with a customer and making sure that they were happy. Doing any testing on any sort of modifications to the process and that sort of thing. It would be a lot of communication with the guys in the shop, the customer, and then other engineers on the team. It was less on the development side, he didn't want to do that, because he didn't think he was very good at it. It was more on the back-end, building and troubleshooting their system.

He would be taking a few things he had already learned into work. For instance, *how to be a professional - doing work with other people, recognizing that you were not just getting a grade, you were getting paid. People were putting money on the line for this.* Another thing was *confidence in himself, knowing that he was part of a team that came up with a solution to a problem. He was able to take it from day one and deliver a product that works.* In the future, *if he was making another engineering judgment or making a decision based on his gut, he would have the confidence that he had done it before.*

He was *most excited about getting off work at 5 o'clock and not having any homework.* He was also *excited to have the opportunity to be encountered with a bunch of other different people and different problems - being a part of something that makes a really cool product. Maybe he was naïve about it, maybe it wouldn't be as good as he was thinking. But he was excited to take the next step. Get a whole new set of problems that he could solve.* There was also the prospect of staying at the company for a long time – *there were a lot of people that had been there for 25, 30 years. That gave him confidence that it was a good place to work. He could see himself doing that - he liked the area, he had family in the area, the company could also help him pay for an MBA. Once he got an understanding of the process through engineering in the first five, ten years, he could move up into a more managerial role. At that point the people he would be working with would be more important than the process. Moving up, being responsible for more and more people, wherever that took him, that was the plan.*

He figured that anybody *would be nervous about doing well and succeeding, making sure that you were up to par. But, at the end of the day, that par was up to you. If you thought that you were doing as good as you could, you could be happy with that. Everybody's checked off box was going look the same, but It was up to you whether or not you were proud of what you had done. Though, every now and then it took somebody to kick you in the pants, and say, "You need to raise that bar a little bit. You can do*

better." As long as he was being pushed to constantly do his best, everything else would take care of itself.

A's 4-Month

At four months of work, A is getting into the swing of things. He's not reliant on other people to give him work. He can find his own work now, rather than waiting for something to happen. When the guys on the shop floor come to him with questions he is able to answer them on his own. He feels like he is actually doing real work, because it makes the days go by faster.

He is not really designing anything, or at least not yet. He will probably never use the thermodynamics or fluid mechanics he learned in school. His last two-and-a-half years of school taught technical content way above what is necessary for the job. The most correlation between school and the work is the time management and being on a timeline with a project. At the end of the day, he does feel like what he does is engineering, because even though they don't design anything, he is in charge of something being made, and if something goes wrong, then it's up to him to fix it.

On the other hand, he does do a bit of statistics now, though he didn't learn statistics in school. Right now, he's a six-sigma yellow belt and it's very relevant to his manufacturing-centered job. It's not really a knock against the ME curriculum, more that his job is not an ME-heavy mindset job. It's more about general engineering, problem solving.

It might not be specific to engineering, but he also needs social skills for his job. Asking questions, collaborating, or consulting someone to address an issue - these are things he would have had a hard time with three years ago, but they come more easily now that he has been in this environment and had his internships. Talking to people is always nice, it keeps the day fresh and it perks you up. The people are probably the most interesting part of his job. He's been able to shadow engineers and hang out with them for no reason other than to learn. And when you work with a group, you know the people

that command the most respect. When they say something people really pay attention, their opinions during meetings carry weight, so he has been watching those people. He's trying to be that kind engineer, and by he uses them, what he thinks a good engineer is, as a scale for how good he is doing.

There is a maturity difference between a 22-year-old college kid and a 22-year-old professional engineer. And one of easiest ways to mature is by talking to people that are in the profession, just soaking in everything. Understand that you don't know everything, you're not gonna know everything, but also that you have a very different mindset than some of the people that are 40 and 50 years old, so leverage that difference.

He has been leveraging his young age. The next oldest person in his group is 46, he's more than double A's age, so he didn't even know what Visual Basic was. A has written macros for them and even designed a little button to display their data and their graphs. It's an interesting dynamic because they have all the process knowledge, and he has all the computer and technological knowledge. And it's important, to find out what you're good at and not to be a dick about it, not hold it over somebody's head. He might have picked that up in capstone too, the dynamic of being on a team.

Learning coding has been a bonus of the job. And having computer knowledge and being younger has allowed him to help out on various projects he wouldn't have access to otherwise. So coding is one area he could have benefitted greatly from having learned in school, especially Excel, which he spends most of his time coding with.

He has been going to training. Every quarter, they do division-wide training on things like shop safety protocol. The last one was about code compliance and contract wording, an hour-and-a-half long, and they were just reading directly off a PowerPoint. It's the corporate mumbo jumbo that gets forced down on the engineers that doesn't really affect their day to day. The most he takes it into account is when he's writing a document, he'll look up the document that tells him exactly the formatting he needs. It's

common sense. Everybody is aware of it, and they know it's there, and they know they have to use it, but then they still have to go to trainings every quarter to remind them to do it. It feels like a freshman level class, something that you attend to check a box.

A challenging part of work has been trying to take in all the important information and keeping track of all of the different relationships between himself and the guys on the shop floor, as well as that between himself and the customer, the ultimate customer. They will have meetings, and he doesn't know what to say or how to contribute. But it is changing.

A doesn't see any glaring weakness in his effort. He is giving it his best. When an issue with their process came up, he worked long hours and some overtime. And during that 3-day stretch, after a lot of communication with the customer and other engineers, they were able to solve the problem and work their way through the steps of how things went wrong. It was a fulfilling process at the end, and there were specific things that he contributed to that process. Would the group have made it to that same conclusion without him? Probably, but he felt like he actually helped with an engineering problem. The fulfillment he got from that might be the indication he was doing well.

His group presides over a smaller aspect of the company, and for the last year-and-a-half, everything's been going really well. An average week has nothing going wrong. Things are slow, because there's nothing out of the ordinary to keep them occupied outside of regular check ins. That's why the 3-day stretch problem was such a big deal, and why so many people got involved, because it was such a deviation from the long-standing status quo. They are a big company, the tolerances are so small, and everything's so tightly defined that any little deviation gets noticed and corrected immediately. It's hard for big things to go wrong, so when they do it's a big to-do, but they usually keep it between the lines.

A's 7-Month

A doesn't feel like a *recent college graduate anymore, more like a professional engineer. It's getting more real.* He has finished up the three-month *probationary period, and the person he will be replacing has been slowly handing over some of his duties. Within the next few months, he will be transitioning into the process owner role* he's been preparing for.

A isn't really a *shadow* anymore, he doesn't only *follow and listen.* He is *gaining confidence,* and he is *self-sufficient* – more open to suggest solutions and to follow up on problems. *He figures things out as an independent thinker.* His responsibilities won't *change on paper* until the transition, and he still works on fairly similar tasks, what's different is he doesn't usually *wait on someone to tell him what to do.*

He hasn't yet *faced anything that's stumped him too hard or for too long.* Most of it is not about knowing the information offhand, but rather *knowing the people that know the information he needs.* *It's been cool to interact socially and technically to solve those problems.* Work has that aspect because of the *specialized nature* of his work – these aren't tasks he can gain *technical expertise* in without *time and intimacy with the process,* which he doesn't have yet. On top of that, *many of the guys have been there for 30-40 years, seen the product from cradle to almost grave, so they know literally everything about what the group is making.* When he does run into a problem, often the response is *an immediate escalation to the guy who knows the answer. It's the quickest way, the most efficient way.*

The person he will replace is one of those guys. The “training” *started as A going to him for all of his questions. As A's knowledge increased and the questions got more complex, he would refer A to the people that were specialized in each area.* And each engineer *is in charge of his own process, is worried about his own product.* “Training” also involved *going through and reviewing specific documents, hanging out with and getting to know the machinists on the shop floor. It wasn't really*

training, not like he was going to take a test at the end of the day. It was more like building intimacy. He was the only one to get this kind of training, the only one going into the role.

Talking to the machinists, periodic oversight of the shop floor, is a part of his duty. All the engineers are in cubes above where all the work gets done, so he has to walk down the stairs, put on safety glasses, and walk in. It's loud – there are machines running and chips flying. When you talk to a machinist you have to yell because they can't hear you. They are blue-collar workers, and their way of speaking is different from academia. It used to be pained, for him to talk with them. It felt like he was following a script. How's everything going today? Any problems? Anything you need? But things are getting better now. It feels looser, less scripted. He comes away from conversations feeling understood.

You can't work off the assumption that somebody is stupid. He has talked to a lot of machinists that feel engineers talk down to them. But oftentimes the machinist knows more. If they don't understand something, it's because he didn't do a very good job explaining. It's important to keep an open mind, to not take anybody for granted, and keep high expectations. A machinist might have been working their same boring mill for 40 years now. So if you have a question about what he's been working on, he knows more than most of the engineers. He can know immediately when something's not right. Moments like that were eye-openers for A. It's important for young engineers to have that understanding.

In his role, he isn't designing or testing all the time. He doesn't come up with customer needs, doesn't come up with a mission statement. They aren't starting a brand new product line. He has been thrown into a 30-year-old process that's been well defined and refined and almost all the kinks worked out. They try to get as many of their product in the door with as few defects. But it's still engineering. At the end of the day what they make is engineered. They use an engineering mindset, looking at their process. You've got your inputs and your outputs and how they affect each other. But then, it might be

just a problem-solving thing. You could probably take anybody adept at solving problems and after a year of training they could probably do his job.

He's not in a rut, but he does really do the same thing almost every day. Go to work, fix a cup of coffee. Get down and check in with the guys on the shop floor. Do some more work. Fix another cup of coffee. It's really nice. Work 7 to 4:30. No homework. It's wonderful. The first day he got home he realized he didn't have anything to work on. He has started reading books and playing guitar more.

It's no question, he intends on staying at this company. Many people have worked for the company for 35, 40, 50, almost 60 years, made careers out of working for the company, and it gives him hope that this place doesn't wear people out. He enjoys it enough, and he loves the flexibility of possibly working on other parts of projects. Ideally he will be working in a management realm, being able to use the MBA he is planning on getting (and he's not really interested in a PE). In 5 years or so he should have at least one promotion under his belt.

A's 13-Month

Things are going great for A. His official transition date is this week. There will be an official ceremony. The process owner role comes from a period where the process wasn't in control and they needed one person to sit down and manage everything with a specific process. That was 15 years ago, and that one person lasted for five or so years. Then they hired a new guy specifically for the role. And they had a ceremony to pass along ownership of the process to him. And now the next generation of it is coming about with this transition. The guys in his group like to have fun. Somebody could bring donuts. And it will be a good time, very informal. And afterwards he'll be initiated into the role.

He's had a good amount of time to learn how to take ownership of part of a process. He has transitioned from learning how to be an engineer, to learning how to be a professional engineer, to learning how to be a process owner. At the company, once you get comfortable with being a full time

engineer, you're given more responsibility. And, you start to get uncomfortable with some of the responsibilities that are given to you. And then, you get comfortable with those, and then your new challenges keep coming up. Becoming a process owner has been the latest challenge. Instead of the older guy, everyone is coming to him to ask questions. That's when he could tell it was time to transition.

The role is key to the whole company's process, so he gets a lot of facetime with upper management in presentations and reviews. It's not your normal process engineering, where you focus on inventory and parts. It's much more businesslike. Even for this role he was uncomfortable at first with people that had been working there for 30 years asking him for help. But he has matured a lot. They talk about the weather and politics and adult stuff, instead of video games. For his colleagues with kids, he relates to them through their kids. He has no problem walking up to his department manager and asking them how their golf game was last weekend. He's not nervous anymore. And he's also not the only employee in their 20's anymore, as they recently hired another young engineer.

Engineering is a whole lot less calculus than he thought. It's being able to understand the people as well as the process. Your process is only as strong as the people that make it happen. As an example, *if he needs a part completed by a deadline, but it means that somebody's needs to work the weekend, that's a cost he has to weigh. That said, the designs that get passed down have super tight tolerances on them. And they have to measure trends to make sure everything is within their tight tolerances. A lot of it is out of his control. All these aspects of the role were a shock to him, but as time went on he got used to those, too.*

One thing that upsets him is people who don't seem to consider others, who turn down work. *As a new engineer, if you go ask somebody for help, you always had the excuse that you're new and you didn't know any better. But there are some people that are reluctant to take some of their time to help you, regardless of if they're busy or not. Not everybody's a people pleaser. If the roles were reversed, he*

200

is sure he would set his work down and at least have a conversation with them for the *mutual benefit* of him and the person asking him for help. He gets *gratification out of helping people*. He still gets *excited* when people need his input to solve a crisis.

He is also proud of the impact of his work. *Working for a defense contractor, it makes it a whole lot easier to see his impact*. When he sees large military projects, *he's proud that he contributes to that*. When he first started and things were slow, he would walk around the shop and look at all the massive things they were making. It made him say "Okay. This is real." He could compare his presentations to the real objects on the shop floor. *It's pretty simple, you don't have to think about it too hard. National security is pretty self-explanatory. He can take pride in his work because he knows that he's doing a good job and helping out people that are protecting our country. He didn't think it was that important, at first, he wasn't expecting that feeling. But in this position it feels very important. If he was somewhere else, he might make several people's lives more convenient, but it wouldn't be the broad impact. It is the only real job he's ever had, so it's hard to compare. It is all he knows, but he doesn't think he would have had that realization of "this is real" at a different company.*

Working for the military, you have to be able to manage all of your responsibilities, be they technical issues, production issues or people issues. It's a balancing act of handling emails, phone calls, technical questions. When there are issues, they report up through the chain of command, and the higher ups are local. And if anything just goes a little bit wrong, they have to report it to determine if there's a violation. They have to prove to first themselves, then QC and operations what the right decision is. And then they all tell the customer what the decision is. It's an intermingled web-ladder-chain-of-command-thing, but what it amounts to is a lot of emails to people that you've never met before. But when people are reaching out and he is involved in conversations, that's an indication that he is developing, a high watermark. And being comfortable with managing different projects and different people, different stakeholders, is what makes you a professional engineer.

There are people that work 10-12 hour days - if there's something that needs to get done, they just take everything way too seriously. He tries not to be that person. He works 6:30 to 4:00 and he can't talk about his work outside of work, so at 4:00 he is done. There's no expectation that you take everything so seriously, that you be an all star. In college there were similar people, who always had to be studying more than you, or stayed up until 4:00 in the morning working. He can get his job done without that, and he stays comfortable because he knows that he is doing what he needs to be doing. If you do work extremely long hours, it starts to take control of your life. One of the things he noticed is that when he comes home from work, he doesn't have anything to do. And that is liberating. Not to have to worry about your next assignment, like you did in school. But also, learning what to do with time outside of work is important. Some of his colleagues just like working because that's the only thing they know, they don't have any hobbies. He has heard stories of people that get burnt out. It makes sense to him that someone would get burnt out if they've been in the same job, doing the exact same thing, for 35 years. At some point you're going to know everything that there is practically to know about that process, and what's the fun in that?

He hears of people at the company who work until they're 80 or 85, and when they finally decide to retire, they die a week or two afterwards, because their whole life was working. You've got to have something else to do.

In the past year, he has done more reflecting than he has in his entire life. Reflecting on a house, on leadership, on ethics, on marketing. His wife went through a liberal arts program, and she says all she ever did was reflect. And that is one difference between his and her training. You take a calculus test, and you say to yourself, "Okay. You got eight questions right and you got two questions wrong. And that's it." Maybe you figure out why you got those two questions wrong or you just move on. You just move onto the next thing. You got so much stuff that you're dealing with that you didn't really have the time or resources to devote to figuring out why you missed every problem you missed. The way that all

the classes were structured, you don't get any tangible benefit from reflecting. That's not as fulfilling as talking about a specific ethics issue and how that relates to you, those problems are more applicable to you as a human and they make it more real.

B's Narrative

B's Exit

B's project was industry-sponsored, though their sponsors did not financially back the team, and they were not responsive throughout the whole process. The team would email and get no response. So they had to come up with the needs and parameters on their own, and design for a general case instead of a specific case, something you could implement in any manufacturing facility. Three months after they sent the original emails, a month before the project needed to be presented, they asked how the project was going. They were also under the impression the team was going to give them the technology for free. It sounds like they were trying to take advantage of free labor, through awkwardness, or miscommunication. Their advisor was good about that. He was upfront and said that they weren't gonna deal with this, "You guys don't worry about them. Do your own thing."

The team didn't have defined roles for the first half of the semester – they were all mechanical engineers, and one programming guy. They had electrical guys but there wasn't much for them to do. It was mostly mechanical-heavy and then programming-heavy. She spent a lot of time the first semester designing, coming up with ideas, and then doing a lot of the CAD, because she liked CAD.

They all shared evenly the responsibilities of brainstorming and evaluating their ideas. They were pretty late with deciding on a concept, a week before they were supposed to have it in. That could have been partially been her fault, because she had this one idea that she wanted to follow. She thought it was cool but, in the end, it wasn't feasible from an engineering perspective. That was something that

took a while for her to get through her head, and it might have slowed the team down a little bit, because she was so verbal in supporting this idea.

She thought it would be simple, that they would hook it up and it would work. But they ran into so many problems she didn't foresee. So she spent a lot of her time trouble-shooting, learning about the specific kind of motors and what their problems were, what you needed for a motor. Because mechanical engineering classes always talked about motors. Mechanical engineers were supposed to be all about motors, motors, motors. This is their thing. But she didn't know anything about motors.

Their advisor had told them, "Guys, I don't think you guys can do this. This is gonna take too long." But she still thought it could, she didn't let the team put it to rest. But after conversation with their team lead, it dawned on her that the whole team was not on board, there was no way she could push it through herself. She had learned how to work as a team. You had to be willing to put your own ideas aside if everyone else wasn't on board, and for the sake of the team you also had to be on-board with the second Idea.

Communication was also important. There were times when team-members would bring up problems during meetings with their advisor, to the surprise of the rest of the team. That was a problem too, and their advisor told them it was unprofessional. *It was difficult because there multiple people on the team were not native English speakers. They were not as confident with using the language, so they weren't as forward with giving their ideas out. The team lead had to be very intentional about asking them for input. There were a couple of times they had to babysit a subgroup who wasn't performing as they should be. She wasn't sure how the team could have done it any better. It wasn't sustainable.*

After graduation, she was going to be working for manufacturing plants. It wasn't high class design. They were more about efficiency than perfection. It seemed like she would be helping design new manufacturing lines. The full-time engineers didn't have time to design new lines, because they were

busy up-keeping them. Designing could look like spec'ing out equipment, or coming up with new processes. They also had opportunities to work in their machine shop, potentially contributing to their side business with other designs. She was going to try to work her way into that.

In her co-op experiences, she had seen senior engineers. They knew the codes, the standards. They were fast, efficient and hard-working. That was the picture of success presented to her, the pinnacle of an engineer. It wasn't something she was looking forward to, not what she had planned for her career. It didn't seem like many engineers were creative or discovering something new. It was a lot of writing code, repeating processes, just making sure someone who knew what they were doing put their stamp on things. It wasn't interesting for her. She was going to start here, but hopefully branch out.

She was good at solving problems creatively and working with people. And she was a hard worker, and you were a hard worker you could learn anything. You didn't have to be anyone special to be an engineer, you just had to work hard. The difference between people who made it big and didn't, was hard work. It gave her confidence going forward.

*She didn't see herself as an engineer. Looking around, this was their life. They gave their life volunteering for design teams, going to conferences, looking at videos on engineering concepts in their free time. And that just wasn't her. She knew that's what you needed to be successful, so she wanted to try something else. If you were gonna be good at anything, you needed to be willing to spend time, and she wasn't willing to, maybe working in the machine shop could be fun. She was more geared towards, working with her hands, with things that were functional but also looked nice - it was a girly word. But she paid attention to *the form and the function*. She did get the chance in her senior design, but *looking good* was often missed in engineering. It was important in the consumer world.*

She had picked the job because it was something she was familiar with, and they were the first people who reached out to her, and they gave her a week to respond. She had thought, "I could be reasonably

happy there," and she didn't have other offers, so she took it. Unfortunately, two weeks later, she got interview requests for companies with design work that she was interested in. But once you gave your word, you gave your word, so she didn't want to back out of the contract. She gave herself two years. Leaving before then might look bad. She wished she had held out a little more. Especially in engineering, there were going to be jobs, she would've gotten something that fit her needs and interests better.

One of the things they had said in her co-op was to work on her *memory*. *Keeping track of things, more attention to detail. remembering feedback.* She also had to *check her work before she sent it out. In the business world, you couldn't give a 95% good thing, because that wasn't good enough. It had to be completely right, otherwise you were gonna lose the business.* You also had to balance asking too many questions and wasting an engineer's time, or not asking them enough and then doing the wrong thing. She also needed to be able to say "no," know her capacity, because that allowed other people to have a realistic expectation of what she could do. That would be hard for her, she was a *people-pleaser*.

Coming in they wouldn't expect you to completely know what you were doing completely. They expected some growing pains. She had good experiences from her co-op and from senior design, so she thought she would be alright, compared to everyone else. The one thing she was worried about was *fitting into groups.* At her previous job, there hadn't been a *connection* with her manager, and they didn't get along very well. It was just one of those things where they had no idea how to communicate with each other, despite either of their efforts. *she hoped she didn't run into someone like that again.*

B's 4-Month

Being out of school was going well. The day-to-day work was mostly drawing and marking up diagrams. Maybe 25% to 40% was secretarial work, checking that numbers match, and that forms were

correct before sending them on to her supervising engineer. That was going to change soon, they were going to send her to construction, a more hands on position.

She had been trying to craft her job. She had been asking for the transition to construction. She didn't want to sit behind a desk the whole time, so when the opportunity came up, she took it. She also knew she enjoyed coding, so whenever she had repetitive tasks, rather than doing it by hand, she had been writing codes to optimize that process. Some had been helpful, some had been a waste of time. On some tasks she had spent too much time coding, to the point where it would have been better to do it by hand. But she had enjoyed writing code. She also thought that it would be beneficial later on, although that could have been her rationalizing it to herself, since she liked what she was doing.

It seemed like the typical structure of the company was self-paced – everyone was busy, so you had to find work when you didn't have work. When they planned well, you were given a lot of work. Two weeks ago, she had suddenly run out of work. The client had asked for less than they thought they would, so she had two days where she had to figure out how she could continue to add value to the projects she had going on. There usually was bureaucracy involved – she could see holes in some projects, but she couldn't start working on them because the company couldn't bill for it yet.

She got her work from people. She would go to her project managers and see if they needed any help. Her immediate boss was responsible for her time, and if she was billable he would hear about it from his peers. She had been trying to change her way of approaching people. Some people asked by saying, "I'm billable, give me work." That was self-centered, she was trying to make it about wanting to help, rather than her needing work. Just putting it out there, "Hey, do you need help? I'm free, let me know." Another thing her company did, they filled out resource plans every week projecting the work they thought they were going to have the next week. She had been low on work for a while, until she started paying more attention to the resource plan, and putting more accurate numbers. When work was low, it

wasn't that they didn't have enough work, it was just communication. It was up to you to make yourself useful and find ways to improve value on the project.

Recently, her boss had wanted something done by Wednesday, and instead of saying "no it won't get done," she was able to do all she could. But she made him aware that she was only going to be able to get a portion done. She had set boundaries on what she could do, which is something she had struggled with, before. In another case, her boss had asked her if she could work over Christmas break, and she told him "no." She had already submitted for time off. He had tried to gloss over it, saying, "we'll work it out," "we'll work it out." She was going to let him go, but she realized that she didn't want to get caught committed to something she didn't want to. She had asked, "What does we'll work it out mean? Does that mean I'm working all of it? Half of it?" He responded, "We have an engineer who is available if need be." And she had said, "Okay great. Please plan on that. I don't want to work." It was awkward, and she felt a little passive aggressive, but eventually it was good. She was learning slowly.

There were a lot of military veterans at the company, it wasn't always easy to get along with them. But she had naturally fallen into a mentee/mentor relationship with a senior engineer, which had been helpful. Even though it had nothing to do with work, taking an interest their lives had been helpful with creating relationships. It had been unexpectedly good.

Sometimes she felt under challenged, the work she had been given was pretty mundane, boilerplate. She felt she would become stagnant within five or ten years. But she could be proven wrong, they had eighty-year-old employees who still told her they learned something new every day. It could have been that her lack of understanding of fluids and thermodynamics kept her from advancing to higher stages. She kept telling herself she needed to review those. One of the engineers who was mentoring her would ask her questions that seemed like they should be easy, but she wouldn't have any clue. She didn't have an intuitive sense of how things should be or why they were the way they were. She hadn't paid attention enough in her classes. There were courses she naturally found interesting, which gave her an

intuitive sense, such as mechanics and materials, but she hadn't taken the time to learn these very well. This gap in knowledge was her biggest challenge.

She was most proud of the diagrams she did only with oversight from the project manager, who was not a mechanical engineer. On those, she was responsible for making sure it was all correct. She had also been thinking about the best way to get ahead, which might be to make your boss look good. So she had been taking the diagram tasks for other people, including her busy and stressed product manager. It felt good to get positive feedback on these tasks, it meant that she had been meticulous and detail-oriented.

Still, she had been increasingly considering switching careers, not to mechanical engineering, but to either computer science or managerial work. The managerial work might not be new or interesting, but the coding would be. For now, she was happy at the job because she was learning new things every day.

If she could go back, she would have been a researcher. She would have followed her instincts. There was a point in school where she was thinking of switching but she thought she had already gone so far. You really needed to think about it. Especially if you came from a middle class family, where college was expected. You could lose sight of why you were going. A degree was not as useful if you didn't want to work in that field.

B's 7-Month

Her work was going well. She had really liked the position she was in for the last couple of months. She was doing project management. It had been fast paced. At any one time they had five or six projects going on, and she would do other tasks too. She would reach out and schedule things with their contacts. On the floor she would walk around and inspect things, and give updates to the client via text. It was a lot of talking to people, walking around, scheduling, talking on the phone. It was really fun. She would walk 10 miles a day. She got a heel spur at one point. They did programming of the

manufacturing lines, making sure that it all worked together, fixing any traffic jams and bottlenecks.

She was also under more informal supervision. Looking back, things might've been a little dangerous, working so close to conveyer belts while they were still running.

There was minimal engineering done, except for one project where her office only did some of the engineering. In that case they were just paid to give general advice. She had been expecting the position to be pretty hands on, and it wasn't, because there were rules of liability that governed their actions. They also had unions on site, which limited what she, as an engineer, could do. Her job couldn't overlap with theirs.

But it was fun, not because of the work, but because of the people. Her boss was fun to be around. It was the content too, she liked walking around, interacting with people and solving problems in real time. It was a high, a drug. She had been working 12 hour days, every week. It wasn't good for you and you were hating life, but there was an adrenaline rush of having a problem and then fixing it quickly, and it wasn't like anything she had dealt with at work.

She had felt really prepared. She was able to prioritize and get things done on time, which made her valuable. She was also proud of an edit she had made to one of the designs. It felt good, even though it was just geometry. It was a victory. You had to think in 3D to do that. She does wish she would've paid attention better in class, learned more about fluids. They were doing a lot of HVAC systems, and she had not seen the drawings before. And even when she had, she didn't quite understand everything in the drawing. With more knowledge she would have had more intuition about the systems, and she would be excelling a little more at work. She had noticed that of the three of the recent hires, one was doing actual analysis, stuff that they all did in college. She wondered if more technical knowledge would have gotten her that opportunity. She had a book she needed to read. There were opportunities to grow.

However, she wasn't *super thrilled with the job overall. It didn't seem like people did much engineering at her company*, and other young engineers agreed. *There was project management, cataloging parts, secretarial work, which was fine. She understood someone needed to do that; it typically fell to them.* But most people *didn't have a four-year degree.* She wasn't going to say it was below her, but she didn't want to *waste her degree there. She wanted to find something that used her degree and was interesting.*

It was problem solving in the sense that you were figuring out materials for the contractor, or modifying the process if any materials were forgotten. But it didn't require any theory. And no one was interested in doing a real engineering solution. It was less building, *less involved, less part design, less optimization, more broad brushing and quick fixes.* When she had suggested tracking down the source of a problem, a geometric misfitting, the foreman installing it was opposed to her ideas. She had been taught one way, but he just went ahead with his solution. *The company was more concerned about making it work in the field as best they could. She knew it was shallow of her, but to her it wasn't as prestigious as being in an office and doing engineering work. She didn't feel she had been given the opportunity to excel in work. She hadn't been given anything truly challenging yet.*

She was trying to find *some corollary to the construction management she had been doing, but in engineering world, she didn't know whether that job even existed.* Maybe she would be a contractor, more *empowered* in decision-making, and not just going off a *drawing that someone else gave you.* She also kept thinking *robotics could be cool. She knew it was a different genre of mechanical engineering, so she would probably have to switch careers for that. That would be fun, but she wasn't sure what her ideal job would look like or what career to switch to. And it might be a while before she got that job.* She was sure many people would want it, if it existed. And she didn't want to *renege on this job she had committed to and job hop.* She wanted to give it a chance, *it was a great company, so she was going to*

give it a year. She knew from her first interviews there was plenty of opportunity. She would probably start filling out applications in a few months, then look for where she wanted to go from here.

She was just now transitioning back to the slow pace of the office. There wasn't quick turnaround. It was more long-term design, which was also valuable and it stretched your mind, but it was not as exciting as being onsite. Now it seemed like they were low on work. She was paying more attention the work coming by, looking for actual engineering to put her name forward on. So she was torn between multiple directions. She did want to do something engineering focused, but she didn't want to be with the same contractors, but she did want to enjoy what she was going to be doing for the rest of her life.

The other thing she was dealing with was communicating with older males from the South. It was different from what she was used to, culturally. Relating to them was sometimes easy, but they had a different way of speaking and joking around. She thought it was rude. In one instance, a coworker had started cutting into her, asked, "Are you planning on putting the lights there?" B said, "yeah, I'm planning on putting the lights back." He asked, in a passive aggressive way, "don't I need to know about that?" And she said, "I thought you already did know about it,". After that, he said, "I hope you know I'm joking with you." But it didn't feel like a joke. She also had some older guys who would say inappropriate things. Maybe not super inappropriate, just pet names, though that wasn't okay. It was part of the job, but it was something in the real world they didn't talk about in school. There was a certain lightness that you needed. Her boss had in spades. He was great at just diffusing situations and not being offended, even when contractors were not happy. She wished she had that.

Her advice to newcomers was to find what you were really interested in, and keep learning about that. She had been starting to do that in her personal life. It would pay off in the end. It couldn't not. It would help you find what you really wanted. Even if you didn't end up liking your gig, if you were developing skills, it would help. You shouldn't worry about where you were going to end up. If you were committed to somewhere you hated, maybe consider leaving, but otherwise stick it out, try

and make the best of it. Things weren't set in stone – you didn't have to do one thing for the rest of your life. There were usually lots of opportunities to move within a company, or to move out of a company. As long as you were being responsible. If you didn't have a job yet, hold out for something that you really actually want to do.

B's 14-Month

Work is boring. She isn't doing anything that involves calculations or problem solving. It's a lot of repeating tasks. It seems like there's a difference between "engineering," which some firms do, and "design," which means doing things that you've done before, but with the weight of an engineer behind it to give it validity and sell it. "Design" seems to be what they typically do. So, it's not a challenge, it's not hands on, and it's frustrating. She likes to do hands on things, but she is producing documents. It's something that she doesn't want to do. Grunt work. It is very detail oriented. Engineers are typically detail-oriented, but she isn't someone who loves the details. She knows she's not typical. In the last couple of weeks, her responsibility has increased. People are giving her more work. But she still has the feeling, that wherever she wants to end up is not what the older engineers are doing. She and her coworkers agree, they all do what are essentially visual puzzles, making sure specs line up. There's no real creativity involved, just being meticulous and applying knowledge that they've already learned to a situation that is already there. Their engineer has already figured out what size the pipe needs to be, all they do is the leg work of looking it up and putting the answer down for the client. It's not difficult, you just look at it and confirm. The older engineers do the same work. They never create anything new.

She's holding out to see if that changes, but so far, it doesn't seem like it. She's not completely dissatisfied with the work, everything else is wonderful. The company is great. The people are great. The company policies are great. She and her coworkers joked around a lot. She never felt like she was

bothering her boss, and he never talked down to her. When she did work with the electrical department, the manager there was very helpful. The company also paid overtime, which was amazing. The employees were pretty free to take time off when they need to, and there wasn't a culture of overworking, unlike what she had seen with some of her friends (though overwork wasn't always bad if you enjoyed the work). She liked that the owners of the company wanted to treat their clients like family. Each department had its own culture, but the basic ideals trickled down. It seemed like a comfy place to be. But the work itself is just not interesting. The main thing she struggles against is boredom. She wants something intellectually stimulating, where she learns new marketable skills that aren't a lot of repetition and knowing codes, and standards. And ultimately, she was content to do the work because she knew she was getting paid for it.

She has had many thoughts. But she was not one to take quick action. She hasn't made any moves towards finding a new job, partly because, talking to other people, it seems wise to stay in a job for a good amount of time, a year to two years. She hasn't been looking for that reason.

But she's also not sure what exactly she wants to do. And she feels that coming out of college there was a worry that she wouldn't be able to get hired doing something that she really wanted to do. Which was silly. She should just go and apply to jobs. But she also knows that it would be hard to switch careers without connections. Now that she was out of college, it would be harder. She would have to do more digging, and she hasn't done that yet.

She hadn't voiced her unhappiness with the work to many people. She asks her coworkers questions, because she want to know if their experiences align with hers. But she would rather not tell them she's unhappy. One of her peers has left for these same reasons. Another friend is actively looking for jobs, because they all see the same things. They are all not thrilled, not challenged. And some of them have had even longer times of not having challenging work to do. The older people she has consulted have told her wisely that she might just have to get experience under her belt. And then she could start doing

things that she wanted to do. They're not as alarmed as her younger friends. You had to build trust in the industry.

She might need to take more initiative. She has spoken to her boss about working with the electrical department, that could be interesting to her. But she hasn't gotten the chance, she's been busy with other work. She does enjoy doing small parts, but she hasn't gotten the chance. She knows the company is trying to get new work and is growing. So, she's also considering the idea that she could stay with this company as it grows and become someone positioned to take more interesting projects. She doesn't know how much of a possibility that is.

Trying to go faster with her work could be a problem to solve. But she's just not motivated to do that. She's expected to do her work in a certain way, and she's received pushback. When she made one of their programs more efficient, a manager she was unfamiliar with had critiqued it. She heard his frustration, and it was good feedback from his point of view, but she took it with a grain of salt. He didn't see how much time writing that program saved her; he just gave her directions. If she does write a program in the future she will be more stealthy about it, and when she presents anything to her bosses she will only use the end result and edit it so they aren't confused. She enjoys writing programs, so maybe she will write them even if it's not the best thing. A lot of industries, including hers, seem slow to change their technology systems. It's not unexpected that they give pushback, and hesitate to change the way that they do normal business.

Taking on challenges doesn't make her happy, because it's to an end that she does not find compelling. She knows that some people, if they don't believe in their work, they're fine, maybe money motivates them. But it may be that she doesn't like working for something unimportant. Maybe it was a millennial thing. She knew that people switched jobs more than they used to. But if it was a millennial thing it was a career mistake she didn't want to make, a reason she should throw out before she buckled down and kept working. She was not willing to risk her career stability and her word as an employee – if you

215

accepted an offer, you weren't going to make the company money unless you stayed, she heard for at least two years. She didn't want companies thinking she was going to use them. She just needed to man up and talk to her boss, and treat the company like a person. You wouldn't want your friend to just stop talking to you, you would want them to talk about their issues instead of leaving. This company was a good company, and she didn't want to treat them poorly. They wanted her to be happy where she was. They had invested a lot of money in her, and they weren't going to make the money back unless she stayed.

Her six-month review didn't have anything of import, which was also a little frustrating. She was a little confused. They gave her a raise, but not a real one, just one to keep up with inflation. It seemed mostly positive, and he did value her coding to change the way that they did things. So that was encouraging. They were looking for innovation, at least in upper management, but it would be harder to get everyone else on board. Either way, she had heard that if you didn't negotiate and sell yourself, they wouldn't give you a raise, which was true with any company. She would try to negotiate a meaningful raise next time.

Her advice to newcomers is similar to last time. If you don't like it, stick it out. Try to change the way that you work. Try to be creative in your job. Make it something that you're interested in. Don't be afraid to advocate for yourself and don't be afraid to make waves. Build connections with your coworkers, it makes it more enjoyable. Don't worry about if you don't like it, things will develop and you're not going to be stuck there forever. Don't worry if you're not completely fulfilled and self-actualized by your job. There are other ways to get that fulfillment in other areas of your life. Stick it out. But also, while you're doing that, ask if it is something that you can see yourself doing forever, because once you do reach the two year mark, if you don't love it, then you should find something that is interesting, that you can really work hard in, because it's a long time to spend your life doing something you don't enjoy.

C's Narrative

C's Exit

C had enjoyed his senior design project. He had worked directly with a single client, designing a device to help them with their disability. He felt proud when they saw the client's reaction to their efforts. They were *doing real world problems*, as opposed to the typical undergrad approach of *doing a bunch of problems millions of people had already solved*, which was not as rewarding. *There might be a grade, but that was just a mark on the paper, didn't mean as much. It was nice to see an item that represented your work.*

Over the course of the year, *there had been such small increments of progress that he wasn't sure he'd realized how cool their product was. If someone had told him in the beginning that he would help develop the product, he would have been amazed that he was able to do that.*

C was the project manager on his team, but he also worked on the programming. It was *difficult*. He would *rather have been working on the mechanical side, doing CAD or doing stress, but he worked more with circuits, wiring, microcontrollers, coding. They weren't his preference but he knew they needed to get done. He felt like that was the best way to be a leader, to step up and take the hardest role.*

One thing he found as project manager was that *he had more trust in his mechanical engineers, than engineers from other departments. While the other engineers provided a lot to the project, and there were areas of the project that would not have gotten done without them, if he had to get something done he always went to his MEs first. If he had an issue, he knew the ME's would be willing to help him, so he made sure there was one of them on each sub-team. The other engineers' grades didn't*

217

depend as much on the work they needed to do, and he thought they had less motivation. He found the best way to get everyone to do their work was to assign tasks very specifically to each team-member at the weekly meetings.

In preparing for work. One of the things C was trying to learn was how to be a leader in an area he didn't understand. It was harder to be a leader. The leader didn't necessarily have to be the best, but if you weren't good, it was hard to be relied upon, it was hard for team mates to respect you if they saw you mess up.

It wasn't going to be all MEs at work. It was going to be a mix of people, and they were going to think differently from you. There was going to be someone on the business end, and he was going to ask, "Do you need this material? Can you use a cheaper material?" Everyone would think differently, but they were all trying to solve the same problem. They were trying to make the product, and you couldn't make it if you didn't have the money to make it. So, realistically, you had to think about money.

One day, after a seminar given by an engineering leader at the university, he caught up with him to ask about the problem team mates not being accountable. He recommended a strategy like the one C took. The idea was not to get mad at them. You should say, as an engineer would, "This is a problem because it was supposed to be done last week. How do we get it done?" Not blaming. The team-member would feel natural embarrassment because they had to say, "No, I did not get it done." You didn't have to give them anything else. "Now, how do we progress forward?"

He remembered an instance when he couldn't get his programming to work, and the feeling of letting someone down. And not just the client, his teammates as well - that was more detrimental than the negative grade. He dreaded having to see someone else's face and say, "Hey, I didn't get the job done, and I know you were relying on me to do that."

But his team was really supportive. One of his teammates patted him on the back, which might seem insignificant, but it helped him to feel like his team believed in him. Just like in team sports, it felt better to have other people around because it meant that when you didn't do well, someone else could pick up the slack.

Of course, the other thing that motivated him was that *the product was to help improve somebody's life. They weren't solving cancer, but they got to see a smile on somebody's face.* He chose a project with that motivation in mind. *He had seen some of the other projects which were business oriented, meant to help improve efficiency. That wasn't a bad thing, it was an awesome thing to be part of engineering, to know you helped something, made it better,* but it was different helping a human being. Going into the project, *C didn't see it as the most interesting, but he saw the client as someone who could really help him keep motivated.*

A few months ago, C accepted a position at a consulting firm, which required a move to a large city. He was a little worried about living in the city, *finding a good roommate who wouldn't leave the door unlocked, getting on the wrong train.* But he was also excited. The consulting involved a lot of *travel within the city. He was going to go places you'd never go, explore the city.* With the consulting, *there was a good amount of physics and engineering, but also a good amount of working with people, because everyone wanted something else. You had to figure out what they wanted.* He was excited to *talk to people.* It was also a technical topic that he was interested in, something he had been studying since 10th grade.

The position was the culmination of a goal he had set last summer, *to have two or three job offers by February, so he could decide by March. He only ended up getting an offer from the one company, but he still felt like he completed most of his goals. He got the job offer from his top company, a company which he had interned with the year prior, and was able to accept their offer by March.*

Setting goals going into this company was going to be good for him. He reminded himself of the quote: "Stop dreaming and start setting goals." Because very few people achieved their dreams, but when you made it a goal, it meant it was achievable, it was a thing you could do. His first goal was to get a promotion within a year or two. He had met someone there who was already an associate and hadn't been there a long time. Not only would it help his pay (and living in the city would be difficult based on his calculations), but, he didn't know why, he hated the idea having to tell somebody he was a "Junior" Associate. He was looking forward to getting started, and he didn't really want time off. He liked to keep himself going. He hadn't yet formulated his long term goals beyond four or five years, but he would also set goals for saving money - meeting some financial goals as well.

He was excited to move on to a company that would facilitate his growth. He wasn't done learning just because he had a degree. He wanted to be able to grow in the technical field he was consulting in, be like the idols that had inspired him to study it when he was younger. He was enthusiastic about working in a progressive workspace, with an open floorplan (though most companies were this way, now), where you could approach anyone with a question and they would be willing to answer it. If he was nervous about anything, it was having never worked on his own project before. A part of him knew that he had more to learn, and he was going to make mistakes, but it wasn't a big fear of his.

C's 5-Month

For C, it was going well. Everything was new and overstimulating. Every time he went somewhere or met with a client or did a new calculation, there was a lot he was taking in. Before, even just cooking dinner for himself and planning out pay rent was new. But it was starting to get easier, he was settling in, and he wasn't having to think about everything so much. He was getting closer to autonomy.

One thing he had learned was that in the *real world* a lot of writing was for non-engineers, *architects or developers, even lawyers*. In that spirit he'd been told to *take tables or graphs out of his reports, to*

make it easy for non-engineers to identify the specific data they needed to improve their design or their building.. Still, he needed to provide some numbers to differentiate his claims from an unprofessional opinion, to prove that he had an idea of what was going on.

His social connections were new as well. They were a little more serious and took more work. It was difficult to know what was appropriate. In college everyone was similar, born within a year of each other with similar interests and similar habits. Now he was usually the youngest in the room with the least experience. The people who taught you might also give you instructions to follow. There were people who had reached different milestones in their lives, kids, marriage. For him those were a long ways off, but he didn't shy away from talking to people about those topics. Now that he was looking at the long haul, he noticed he saw those people every day. It was important that he had a good chemistry with them, that he interact respectfully with the people above him. If you had a question, you didn't just walk in there, ask the question, and pop out. You sat down, had a conversation. In college the social thing was just something you did for fun, whereas now it had bigger implications.

He would have his year-end review next week. He had been writing down his strengths, as well as the places where he could improve. The first thing: due to train delays he had been a few minutes late to work on a couple of days, so he wanted to eliminate that completely. A bigger thing was his ability to speak with a client, which affected his ability to be a consultant. He was still unsure what kind of information he was supposed to be presenting to them, and in what form. Another one of his goals was getting more sleep so he could do better at work. All told, he really enjoyed his job, it made it easy for him to want to improve. One of his better aspects was his work ethic. And he was getting more comfortable with socializing in a mature way, a responsible way.

He was still trying to drop the “junior” in front of the “Junior associate” title, but he was realizing his goals of promotion within a year might have been a little lofty. He was a little ashamed of it, didn't want to tell other people he was a junior. That said, he did recognize it as a cushion. For the time being,

work *just wanted him to show up every, almost like an intern, and give energy to learning as much as possible. There was a lot of input the first six months, and they didn't expect a lot of output from you. After six months they started to expect more output from you.*

He was *trying to analyze the associates and the more senior employees* to see what his next steps were. He expected *more reports than what he currently did, and more autonomy – surveying visits* unsupervised. At this point he still was shadowing people, *just watching. Earlier in the day he went on a survey and was told politely, "Hey, this is nothing against you but just with the way this client works it's probably best if you don't say too much. If you have questions that's fine, but just let me do the talking."* He was *there to watch*. But generally, *everyone was welcoming of a question from a junior associate, and they fed his natural curiosity.*

He did do some things *on his own*. One task he *got stuck with by accident*, on a larger project. *It caused him two or three late nights at the office, but he got it done and he became really good at that task. Every time it came up, he kept volunteering for it. Now he turned out three or four in the past few days.* It was something the other junior associates didn't know how to do well.

He had also started *writing reports quicker*, and thus was doing more, *though he hadn't done any dense reports. It was usually simpler things. Usually they produced the report, a piece of paper that said what they did: here's your situation, here's what you need to do to fix it. They didn't make any monetary decisions for the client, they offered options and explained them.*

A good way to measure his production would be with number of reports. If he was able to produce more, then the company could also make more money because it would mean more jobs. It was important to him to turn from someone who was learning into someone *who was an asset to the company, someone who was completing projects and helping the company earn more money.* It seemed

most of the engineers he had *met in his short time working had to consider a bottom line*. They might be invested in a certain design, but if they weren't funded, *they had to find another way*.

In his opinion, *for an organization to run well, the leaders had to be respected. It wasn't that you couldn't question their methods, but sometimes you had to think that, "Their knowledge base is better than mine and even if I disagree I need to listen to what they say."* He wasn't very comfortable talking with everyone in the office or even some of the clients. *But luckily he just kept pushing himself.*

It wouldn't be long before he was ready to turn the corner. Being new again gave him some nostalgia for college. "Oh man. I wish we were at college where I had all my buddies. We'd all go to the same bars." But now he was past that. He wanted something more than that. He wanted to keep learning, and work had integrated him into their group. He liked being the new guy, but at some point, he would turn the corner.

C's 8-Month

C is *starting to be, not forced, but he has to produce more now*. And he's *tired*. It's not that he was told, *"Hey I need you to do more work," more that he's been given more responsibility*. A senior employee left for another company. *C inherited a few projects that he was working on with him. That's just how things worked out. He's not leading those projects, but he's pretty close*. So he's had to learn about those projects on the fly over the past few weeks.

Busyness can also come from more time on any given report. Usually they *advise* their clients how to go about a design, but recently *they had someone come up to them and say, "We want our project to be exactly like this other one,"* so they had to *check it out* and see if they could do that.

In their line of work, more happens as the weather gets warmer, and *everyone wants their stuff done*. One recent week he had to wake up around 4:30 AM for a week straight. Last week was *his busiest week ever*. He didn't get to do his usual routine. He came home, *hopefully ate some food, and then went to bed right away*. He doesn't mind it, but a whole week straight can be very taxing. He also had to stay later to get everything done. His productivity was actually down a little bit.

But, he is still enjoying it, and thankful he is still enjoying it. You're never sure whether someone will enjoy their job into the first few months. If the wrong thing happens, you might get exhausted. Luckily, he's still enjoying it.

The new responsibilities *haven't been intimidating, but they have been different*. He pays attention to all the emails and everything that comes through, everything they need of his group. Most of it, he can do by himself. Sometimes he relies on a more senior engineer, but C can't always rely on him because he has a lot of work. C has to be more decisive and has to use his intuition to figure out what the next step is and stay ahead. Some of that intuition had been developed in capstone, a voice in his head that told him to be proactive. And in his previous internship he had also been thrown into the *deep end* – those were situations too where *not only your abilities were challenged, but your mental capacity, your ability to face those challenges without cracking*.

He has made a few mistakes here and there. *Sleep was a still a big issue*. During his busy week, he didn't do a good job of getting enough rest. That definitely hurt him. Some of his mistakes were *due to lack of experience*. Maybe they weren't even mistakes, *more of not suggesting a product* in a report, even though it would have been appropriate, *because he didn't know it existed*. One mistake he is trying to curb is *showing up to a site survey without having the right equipment*. And finally, there was one mistake, *it wasn't major because there was no lost time because of it, but there was the possibility for something to go wrong*. He answered a group email without first checking with a higher up engineer.

She didn't find anything wrong with the email itself, but she let him know that he should have checked with her first.

Having a positive attitude made a big difference. If you had something difficult facing you or you made a mistake, it was important that you just accept it, swallow it, and move on. It could be a big waste of time to wallow in self-doubt or self-pity. At this company, they were willing to accept that you might make mistakes. He had never felt like anyone was critiquing him in a way that wasn't helpful, or educational, or beneficial. Really the only person that had ever doubted his abilities had been himself. And he also knew that the more mistakes you made, the less weight you put on each mistake.

He still felt at meetings that *he had little to contribute*. The people at the meetings were so *knowledgeable*, and *even if he did know the answer, it took him longer to think through it. Unless they called on him, he tried not to interrupt*. But participating in the meetings was *something that he wanted, not necessarily what was expected of him. He wanted to move quickly through things*. His superior has told him that he was doing a *good job* at his end of year review, just that he might be trying to *run before he had learned to crawl*.

What was expected of him was more reports, and he was definitely delivering on that expectation. And the more reports he did, with less revisions, the more projects he could take on, and the more reports he could do. He had been producing more reports, but there were other little things as well, his management of meetings by himself, or the conference calls he had done. He had also been compiling notes digitally that others might be able to use. He was an avid note taker since he was little, taking notes down so that he could fall asleep easier and put anxiety to rest. Now he takes what he can down on paper, and when he has free time he puts it in a digital format. He's known in the office for taking notes. There are a lot of things in his notes that you can't necessarily Google. It could be of benefit for people.

He also always makes a point to put on a shirt and tie. It's not necessary, but, he feels that people take you more seriously when you're dressed well. It's also that it puts him in a mode, that he needs to get work done. Through work you are forced to have a regular schedule. Get to sleep at a reasonable time. Do laundry and things. And take care of yourself. And not wear sweatpants and a sweatshirt every day. And converse with people whether you're a people person or not. He appreciates the maturity that he has built.

Thinking about what it means to be an engineer, he feels that it is using *whatever tools you have available to you like computers to solve problems in the real world.* He realized from his capstone project experience that *it was a lot less genius, and a lot more just late nights really working hard. It didn't take a lot of genius to get their project done. There are a lot of great ideas, but there are few people who are willing to go out and pursue those ideas and implement them in the real world.* A good engineer takes those tools and uses them.

One central aspect of being an engineer is doing something new every day. *While sometimes it's nice to be so good at your job that you never seen anything new, he thinks that's most engineers got into engineering because they face new issues all the time. Maybe there's just not enough money to do the normal solution so they have to come up with a different one.*

A passion for work is also important. There are going to be days when you're really tired and you need something to get you out of bed. If you're thinking about going home and going to bed, you can't do that once you complete college. It's really important that you get out of bed not just because you have to, because that only lasts so long. And that can lead to trouble, too.

C's 12-Month

C had finally been promoted, in *about two-thirds the normal time it would take to receive that promotion*. It felt good to have his *hard work noticed, to get that pat on the back*. With the promotion had come a few changes. There was more of an *expectation that he provide* now, and he had started to become an *asset to the company*. He had to *find ways* to get more work done - which wasn't a *huge change*, he was already *always looking for work to do*, it was just a matter of *continuing*. The *label of "associate" did have more weight to it*, a client might trust him more, *second guess his actions* less.

He had been doing a lot of one kind of project, which *didn't allow for much learning*. This one kind of project was *not difficult*, but it was *taxing* because it required that *you pay attention to a lot of details*. Because of that, while most older employees knew how to do it, it's not something anyone looked forward to. But he had gotten *skilled at them, efficient*, and he did a lot of them. *He tried not to turn down any opportunities*. The company had tried to keep him from being *typecast as the person who only did those projects*. They handed them off to others who needed to *improve in that area*, but he was *reliable*, and could *take care of them even if they were last minute*. *Having a younger associate to take those jobs was helpful*, though sometimes you had to ask for it.

His growth has started to slow a little compared to his start in the company. *He may not learn something everything single day if he doesn't stick his nose out*. *It's not that he can't learn, but it's a little more difficult*. *When you do something over and over, it becomes a routine*. *There were some days where he got his work done, but he let his curiosity fade, he didn't try and explore a new topic*. *He tries to read textbooks in his free time, even just a page or two a day, about an interesting new project, that can definitely help*. Sometimes it's a matter of trying to go after projects he doesn't know much about. *You have to go out there and find learning*. The company wants you to have skills, but they *aren't paid to educate you*. *And if you don't go for it, you can get stuck in a rut, a "big chill," where you get older and let your dreams fade, you slip into your job, wake up, do your thing every day, and life passes by*.

Instead of pushing to keep improving, you become comfortable with the way things are. You should never just be showing up, whether it's your job or something else. You should be providing something.

Part of his desire to be an asset comes from wanting to *repay* his coworkers for their *willingness to help and offer knowledge*. He also still wants to develop personal relationships with the people he works with. He doesn't want to let them down. Another part of it is based on his prior experience and advice from his dad: be reliable so that *when you do make an honest mistake, people are going to understand, it won't be attached to their idea of you*. So he is always *willing to do the extra hour in the office, come in on the weekend*. Finally, it's also about making up for the fact that, given that he's only a year into work, he doesn't have much to offer by way of unique skills.

He does feel *more part of the group* than 6 months ago. *Not that people were pushing him away, but he feels acclimated, like someone who is a true professional. He is proud of his behavior. Without even trying, just through trying to be a better worker, he has matured, and he has been able to develop another level of confidence that he didn't have before.*

Other important parts of the job involve being *agreeable*. *He never tries to put his own needs before the project. There are times you have a client that thinks they know the technical details, and it's difficult to tell them that they are wrong. And you don't want to be condescending, you want to keep getting work with them*. So you need a *positive attitude*, where the client feels listened to. With his capstone project he was fortunate enough to have an effect on another person. It was a project that where you see the effect on the client *immediately*. And he *helps people* in his job now. *Even if the client isn't entirely pleased with the work, they can change things. He does get some opportunities to see the end result, and see that it has helped.*

One thing he misses is coming up with new ideas or products, addressing problems no one has solved. Recently he tried to help his buddy with a personal construction project. One day after work he just sat

down and started to draw up some basic customer needs. What was the problem? What might be some limitations? What kind of a solution might be beneficial to his friend's situation? And on a broader scale, was this something he could pursue for work?

Getting an engineering degree is one of the biggest things you'll have in your 20's. And it prepares you for a lot of challenges, inside and outside of getting a job, because very few things in life will challenge you the way that an engineering degree will.

Giving advice for engineering newcomers, in their shoes *he would aim toward a job, even if it pays less, that was enjoyable. There'll be hard times, where you work late, or a day where you don't wanna be there. You should be at a job where you don't hate it, because you don't want hating your job to be another thing you have to deal with.*

He would also set some goals. His dad pushed him to do that, and had he not set his goals for promotion, he may not have gotten promoted so quickly. By setting goals, and then keeping his eye on them, he was able to accomplish them. Setting a goal is an important part of having accomplishments. And then obviously the most important ingredient is working hard toward them.

That said, *he has been thinking about it, but he hasn't come up with concrete long-term goals after getting the promotion. He has been asking himself whether his next goal is to get another promotion, because he doesn't think he joined the company with the idea of just climbing the corporate ladder. Getting promoted isn't really working towards something, it's not vague, but it's not where he wants to go specifically. He is open to other opportunities. If someone presented him with a really high paying, really cool job right now, he wouldn't take it, but he likes to keep open to things like that. In a few years, maybe he changes his mind, maybe something at the company changes, maybe he switches to another branch in another state. If this job doesn't work out, he could go into something with finance – he's always been interested in that. A lot of his long term goals have to do with his life outside of work,*

with what he *wants to experience as a person. He would like to own an orchard when he is much older. That way he could continue to work, could do it outside, change up his lifestyle. But that doesn't necessarily correlate to what he is doing at his job, so he needs to sit down and come up with, sooner rather than later, what his next big goal is. If he doesn't develop his next goal he is in danger of allowing a "Big Chill."*

D's Narrative

D's Exit

The goal of D's capstone project was to test an improvement on a prototype at *a range of environmental conditions and try to get it to work. They couldn't get it to work, and they didn't realize their prototype, which was a bummer. The team understood the engineering, but they didn't realize that the physics they were working with were so complicated.*

If they had been able to communicate better to the multiple knowledgeable groups involved in the project, they would have had a lot more success. Their sponsors had mentioned a modeling program to the team earlier on, but they didn't realize the entire project was dependent on it. If they had realized, *that would have saved a lot of effort, time, and frustration.* One group pointed out why their idea wouldn't work, and was able to take over some of the physics modeling once *they realized the team was in trouble, but their help didn't come in time.* From the project, she learned it was important to ask the *right questions.* By the end, they all decided it was more *reasonable* for the team to turn in a *theoretical model* rather than a *working prototype.*

She was team lead, which meant a lot of work, scheduling everyone, making sure they had something to do, but that they weren't overworked. Asking a mentor for advice about being team lead, she was told to *lead by example.* The biggest part of that was *showing up on time with a lot of energy, especially*

mid-semester when everybody was tired. If you showed up and had a smile, everyone was willing to work with you. Sometimes she picked up the slack. She did a lot of paperwork, starting deliverables and leaving her teammates to edit them when they weren't working on actual project tasks.

D has had a prior internship that dealt with green energy, but she also feels like she would enjoy most anything. The only job she didn't want to do for her first job was weapons research, because she felt that it would limit what she could apply for afterwards. She had heard that once you do weapons research you might get black listed, as you have a super high security clearance. Sometimes people didn't want to hire you, because of the bad press. She wanted to keep her options open. In searching for jobs, she just typed in "engineer" and found jobs that seemed interesting, some in the food industry, some in green energy. She was excited for problems, any kind of problem. She was excited to go apply everything she learned from school, whether that meant green energy, or making something 10% more efficient. She was excited to be given designs, and to be part of a team that solves the problem. With her level of education, she could play that role in almost any business. She was also excited to start paying off student loans.

She was excited to see if work was as bad as people said. But it was also nerve wracking. Could she do the job she was hired for? Could she perform eight hours a day, 300 days a year? Would she be worth what they paid her? In school, if you failed, you failed a class. You could retake it. If you failed at a design, it could cost millions of dollars, you could end up fired, you could end up un-hirable depending on what the mistake was, and if you knew about it. It was more high pressure.

The biggest thing she is unsure about is the ethics of work. How do you deal with a supervisor who pushes something that shouldn't be pushed? At least at this school, they don't have those problems. They're willing to work with you, they're willing to realize limits, and they want everybody to be safe because they don't want their name on the project that hurt students. At school there's a safety net. But ethics get tangled so fast. If a mistake is made, is it a two second fix that your supervisor can easily re-

approve? Or is it months and months, and people are going to get laid off because the company has to shut down? Ethics is a mess. She would like to say she would do the right thing in most situations. If her boss wasn't willing to work with her she would go to his supervisor and get it taken care of, especially if it's a big deal. But if it were something small, it would be tempting to let it slide. Especially if it would hurt the company's name, or cause people to lose their jobs. A lot of people are easily swayed by the people around them, herself included, though she would like not to be. If there was one thing she could ask of her first supervisor, she would ask for someone ethical, someone she knew would do the right thing, and would show her how to do it other places.

Communication would be a big skill, communicating to employees, co-workers and employers, over email and other technology. Being organized was another necessary skill. Being able to work on a couple of different projects at a time, able to bounce from project to project, and keep track of everything so that you weren't confused when switching.

In six years, she sees herself trying to get a PE, if for no other reason than to say she has it. She would like to work a couple of jobs in between. A job might be able to sponsor her PE, and if it could she would stay until she had that. If not, she would move around jobs until she found somewhere that could help her. She figures her first job won't matter for the first two years, since she will be figuring out how to live life. If the opportunity arose for her to become manager, she would consider whether she was happy at the company. And if she was, she I would probably accept it. She would love to do research. She would love to be part of whatever is next.

D's 5-Month

D has found a position at the national lab where she had interned previously. She is currently working in one of their green energy branches.

There's a *steep learning curve*. For example, one day a manager came to her and asked her whether she could *learn a particular programming language in a week*. After looking at what it took to learn the language, she told her that *she could probably get the basic understanding, but couldn't do what she wanted in a week*. Generally, *it's programming languages and tools like that they want you to learn really, really quickly. She has no experience with that, and it makes things difficult*. She has also needed to learn more technical details and *vocabulary, but that was not near as challenging* – in that case, the task was to *sit down and read a textbook for a couple hours each day. The textbooks that they have given her were very really specific ground level textbooks*. She has used them to look up very *specific vocabulary* for her branch, and she has found the textbooks to be very *useful*.

The principle investigators have also started her off with a little tasks on three separate projects. The biggest task was working with a specific software tool. She's been working on that *several hours everyday*. After some *practice*, with 40 hrs of work a week, she's *developed a basic understanding of her tool, and has started being able to use it*. Now *she has more of the skillsets that they want, and is more prepared*. For the most part she works on two different projects, time split equally between them. The other project pops in in random five, ten hour increments once a week.

Beyond that learning, she also had one day of what could be called an HR orientation, which *was helpful but not with the job, not for actual performing*. It was *helpful for describing benefits, who to talk to for specific problems like health insurance problems. Basic life stuff she hadn't had before*. From her internship she was *familiar with the working groups and positions, so they didn't feel a broad orientation would be beneficial*. Other than that she hasn't received training.

Even though there are some steep learning curves, she feels *well prepared. Her managers are aware of her capabilities, they give her things she feels she can do, and they give her enough time to learn how to do things* she doesn't immediately know how to do. *She also is very solid in the math, equations and engineering principles they use. So she wasn't completely unprepared*. The challenge was just

formidable. She occasionally has challenges of time management, “before I commit to this, do I actually have time to do it? Do I have to ask for a longer extension before I commit?” but she was prepared for those challenges.

One thing she notes about the job is that *they aren't actually designing anything. They're not supposed to. With the grants they win, they aren't supposed to design for one site, or with one industrial partner. If an industrial partner comes to them with a design, her group can help by commenting on it, and by telling them where to make improvements or whether it's practical. But because of the grants, the group has to generalize and create tools that people can use at multiple sites.* This is unlike her design experience in school, where she was *given one specific problem*.

Sometimes she feels like an engineer, but sometimes she *feels more like a researcher. When they are considering design specifics that hold for every site, different materials and whether they withstand certain stresses and strains, then she feels like she is engineering. But while the topics are all engineering related, the act of working on her tasks does not feel like engineering. She is not solving a problem, she is simply gathering information for other people to work on to see where there are still problems, where problems are being worked on and where they aren't. It's useful to engineering solutions down the road, but she is not necessarily involved in that.*

The parts that most overlap with capstone were the writing and reporting on the various projects. The projects often happen between five or six different parties, industry partners or other labs. The writing *has to be very clear. It seems that, every time something isn't clear in one of her papers it costs at least ten minutes of everyone's time in a meeting, or else an hours worth of email back and forth about that point of confusion. And all of their budgets for projects are time based. So that time comes out of a simple cost, and that cost comes at progress. You could have made a new project if you had used clear structure in your paper.* Right now, she is *one of the newbies. She isn't writing near the level that more*

experienced colleagues do, *but she feels she is able to hold her own and explain things clearly once an error is pointed out, before it goes out to the other parties.*

For the technical information that she didn't get from a textbook, she has relied on *lunch conversations*. The kinds of models *she was trying to build*, a senior colleague had 15 years of experience with. *She would snag him and say, "Hey can we have lunch? I need to ask about boundary conditions today. For the most part he was happy to talk and explain things. Having him as a resource was helpful. It was nice to have more than one "mentor," because they were willing, had different experiences, and it felt like she was nagging her official mentor less.*

Lunch conversations were not just for her to learn Sometimes a *legitimate concern* would be discussed between two people and *then brought back at the next team meeting*, where the whole team could weigh in.

Sometimes it was more efficient to let other people do tasks. At one point, *she attempted to do part of a project, and it went to the PI*. What *should have been taking her 40 to 50 seconds per task was taking her 5 or 6 minutes apiece*, because she wasn't *familiar* with the material. *She could do the tasks, but it would take her forever and ever, and they needed it delivered in three weeks. The PI went to another member of her team, who wasn't super busy. He had 25 years experience, so it was three or four seconds apiece instead of minutes. He took over that part of the project because she didn't have the experience.*

Regarding the ethics she was worried about coming into work, she wasn't worried anymore. For one, *because was a national lab they weren't worried about profits as much*. Instead they were worried about *publication*. *Some of the lab's work wouldn't be published any time soon, but other times it would be released*. She felt that things were *pushed more in an industry setting where profit was important*. *The setting didn't offer the necessity for people to make those choices*. Another reason was

that *they weren't doing anything design related*. Ethics didn't seem to *have any bearing in her position*. The lab was worried about delivering products to industry partners, but they weren't responsible for the profit margin. If their partners did something unsafe it was almost the lab's job to say, "Hey we don't like this design consideration and here's why."

Her advice to newcomers would be *not to enter a job thinking they know anything*. Graduating with an engineering degree was a big accomplishment, but they wouldn't know anything specific about the job, the people they work with, the environment of the company. She would caution them to go into their next job as they would a new semester in school. Go in to learn. She had assumed, because she was going to a national lab, that she would learn a massive amount. But the advice might have helped her pride. She was hoping that she would be doing more hard engineering, math and materials. She thought she could use *knowledge she already had*, that she wouldn't have to *feel like she was in school again*. But on her first day they handed her a textbook, and she has been feeling lost again. She wasn't expecting to feel that way after graduating. It was a shock to her system. She worked four years and it equated to her being good at a tenth of my job, maybe.

Her degree was still good for something. It was *good for a basis of knowledge*. She couldn't make design decisions without it, because her degree at least taught her how to think in a logical way, how to break larger problems and projects into smaller pieces. It also taught her how to write technically which has been very important for her.

D's 9-Month

D is working on different projects now, but her responsibilities are basically the same. She works on small parts of other people's projects such as helping edit grants, or proposals. One of her new projects is helping to model one some devices. The modeling has *ramped up* – she's been working more hours. She's also been *collaborating* more with other people. She's been able to participate in

major meetings with sponsors and other important people, which happened with two of her projects.

And she's been *assigned tasks* alongside members of those groups. *She's also been collaborating more with her own team, working through problems with the modeling,* and working on writing *grants, proposals and journal articles.*

She hasn't been climbing the ladder or improving her position, but she has been getting more of a *knowledge base which makes her more useful to the teams she is in.* She is more knowledgeable about the *background research, the technical background of the components* they use. In one instance, the group was working on a model, and she was able to ask a good question, one which made the entire group think for a second, which didn't have a clear answer. A good question makes the team take a step back and ensure what they're doing is valid. It also ensures that their sponsor gets a valid, *physically real,* result.

She also knows more of *what's expected of a sponsor interaction,* so she is *more free to interact with them without going through someone else.* *Most sponsors have detailed contracts about what the lab is doing for them, and who's spending money where. So those expectations are clearly laid out in the contract.* The *expectations of communication are to communicate professionally, communicate clearly, and don't say anything that you cannot do, in terms of hours, timelines, or legalities.* Lab members are *only allowed to work a certain number of hours on a given project.* So you shouldn't *promise or estimate more than you can do.* *She has slipped up a couple of times* in delivering tasks to her mentor, but *internally that is less of a problem than externally.* And dealing with external groups, she is knowledgeable *enough to know who to ask if she is unsure* about whether she can do something within those constraints.

It is a balance, though. She has *found that if she under promises too much, I'm not given enough to do.* *There has to be a balance of doing things in a reasonable amount of time,* which lies between agreeing

to too much and *underselling herself so much that she's bored. She has to keep myself busy, to keep myself learning, on my feet.*

When she thinks about the projects from capstone, *they were completely different.* In capstone, they worked on *prototypes.* They were given *specifications* and told to *go at it.* The work she does now doesn't provide specifications, she must *find them and then hand them off to someone else to work on.* It's *strange* to her that she feels *less personally responsible for what I do at work* than when she was in capstone. In capstone it was directly her responsibility to get things done, to communicate with the sponsors, to talk to machinists, to get my drawings done. But here, if she doesn't know something, she has a few people to go to, first and foremost, her mentor. She might be listed as an author on a couple of articles, but I'm not as responsible as the first author. The first author has the say as to what goes into that article. If I write something poorly worded or incorrect, it's his responsibility, in the end to catch it.

One instance where she felt unprepared, which was *silly, was taking notes at a big meeting with several sponsors. Afterwards I was asked to prepare a meeting summary and I had no idea what that was. I wasn't sure if they wanted a description of what happened, my cleaned up notes? Because my cleaned up notes were like 20 pages long. I had to ask several different people if there was a template for that. There was four different templates in between all the labs that had been there and so I eventually just contacted the person who asked me to take the notes and asked what they wanted. They didn't like any of them and they just asked me to give them a general product that didn't follow any of them. It was silly because she had spent at least spent four years of my life taking notes and figuring out how to summarize them to study for tests. It was something I should have been able to do, but I just wasn't sure.* If she were assigned the same task now, she could definitely do it again more easily. *The first conversation I'd have with them next time would be what format are you looking for?*

All of this is *the opposite of what she was expecting. She was expecting to get to the "real world", and your responsibilities increase not decrease. She also expected that at some point her job would be less*

dynamic. I expected to do the same thing again and again; to come in, learn a few tools, and then have to apply repetitiously, a CAD solver, a CFD solver, some kind of data analysis, some kind of post-processing. I expected to have all of those tools and then just apply them kind of repeatedly to different projects with the same kind of process. Instead she seems to be learning and or applying a new programming language every day. you may never use a given programming language again, but for this project it's important so you have to learn it now.

To her, an engineer is someone who finds a problem and works at solving it. Whether that's making something 5% more efficient, 5% cheaper, or 5% longer lasting. Or coming up with an entirely new idea. Engineers solved day-to-day life problems. At her lab, they have engineers working on everything from smart grid technology, to self-driving cars, to saving the biomedical world. And those are all things people face day to day, they use every day. And they work at solutions to make them better.

Thinking about the factors that affect engineering, economics is one of those factors. Some ideas get funded and some don't. You might have a brilliant idea, but if it's sounds outlandish and people don't think you can do it, you're not going to get funded. Also, she hasn't experienced it firsthand, but she knows that when her colleagues go to developing countries, they have to remember that they have different views on what's important as far as environmental sustainability, cost, even simple things like electricity. They have to remember that they can't just plop their system down, and have it work.

There are some days she feels like she is an engineer and there are other days where she feels more like a technical editor. She realizes that part of funding engineering is writing papers, but it doesn't feel like engineering to me as much as when she get to do modeling or result studies.

One of the things she's learning in the past few months is when familiarity is okay. letting herself be slightly more comfortable, slightly more informal, and yet still professional. Joking around "how was

your weekend” kind of conversations, sharing more personal details, asking more personal questions, being less wary of certain conversation topics. She can be familiar with her peers, the other post bachelor's, the other post masters who are also starting out. They have caught drinks together, had dinner together, hiking. So she figures if she is meeting people outside of work, being slightly less formal at work is probably okay.

She was still in training, and might always be. *It was hard because almost everyone she worked with had their PhD* She didn't have that kind of background. Everyone was *patient* when teaching her. Sometimes, *she was able to fill in when the PhD's were busy*, especially because *she had more flexible deadlines*. But for her, never being fully knowledgeable was *frustrating*. *It was something that she had to get used to*. She had to *accept that it was okay, that she didn't know everything, and as long as she stayed there she never would*.

She was applying to extend her one-year contract. If she got it, she would still have to *find something else* afterward. She hadn't yet heard back, but *she did seem to be doing well*. Both her supervisors had given her *good marks* at their weekly meetings.

D's 13-Month

Thirteen months in, D has gotten her first “*actual*” *engineering problem*, doing stress analysis of a component system. It let her *crack open textbooks that she hadn't touched in a while*. *It was the first problem that wasn't just reading or data analysis. It was an actual sit-down, pull out equations and figure out what you're doing, problem*. The equations were very familiar to her.

Her general technical knowledge has improved since the last interview. *There were still a couple of things she didn't have a deep understanding of*, but she understood 85-95% of her day-to-day tasks.

The other things, *she hadn't been working on as long, or it was a more complex topic*. The strategy was to *do it until you fail, and ask someone for help to understand your failure point*.

Even though her technical knowledge had increased, her level of responsibility had not changed much. The increased understanding just resulted in more efficiency, so she could be assigned more tasks. Rather than being given more authority to solve problems, she was getting more problems to solve. She did have some say in the tasks she did. She was doing specific programming tasks, partly because she showed interest. After she showed interest in doing the first one, they said "Hey, since you're decent at this you should do the next one." With the one after that, they roped in another teammate and split the work 50/50 so that they could develop skills for more people and maintain the capability of the group. The managers were cognizant that most members of the group were rotating to new areas, so the goal was to give everyone a varied skillset.

Her latest significant accomplishment, was one of the applications she helped develop. From when she started, she had been told, "This is your work child. Go figure out this project and teach yourself how to use it, and you'll teach the next person." It made multiple projects for her group easier. They realized that other groups might also be able to use it, so they had a "brown-bag" seminar, where you could attend over lunch on your own personal time, and around 90% of the groups showed up. It was cool to see that they were actually interested in what she was working on, and it was the first application that they developed.

The accomplishment required perseverance, to just keep trying until it worked. If something wasn't working, figure out a reason why, test to see if that was why it wasn't working, and try again. To her, Thomas Edison was a great example of perseverance. He found 999 ways to not make a light bulb, and he found one that worked. She was pretty sure there were days she ran her code 999 times trying to get it to work, before it finally did.

One challenge for her was writing a journal article. They didn't know where or how to start, and nobody had time to work on it, so she volunteered. But she still hadn't quite figured out what went into

a journal article, and which journal would be best. It could become a lengthy research project that was of questionable use to industry.

When thinking about capstone compared to work, she thought there were similarities. Both Capstone and work were about *being handed a large problem and figuring out where to start. But deadlines could shift more for Capstone, and that wasn't necessarily true for work - at least she didn't perceive any flexibility.* That said, there had never been a time she turned something in late, even if it meant *working right down to the last minute.* They had *good project managers who were very aware of what people were capable of, and they tended to err on the side of setting people too little to do. If she didn't have anything to do for the rest of the week, she would ask "Hey do you have anything else we can work on?"* And they would assign her new things. *The only thing she had been asked to do that she couldn't do in the timeframe they wanted was learn a new programming language in her fifth month. She had gotten good at finding the best starting point. She could call herself an engineer.*

The culture is very relaxed especially for her and her coworkers because they are technically in student positions. Her mentor has said that "as long as work gets done and you're here between the hours of six o'clock in the morning and seven o'clock at night and not after-hours, I don't care when you show up, be on time for meetings." Their purpose at the lab is to get research done, but also to learn to be young professionals. She is often asked, "What do you want to learn? Are you comfortable learning programming? Are you comfortable doing this? Are you comfortable writing a journal article, and if not can we get you there?" She was not always prepared to answer, "What do you mean what do I want to learn while I'm here?" Her final answer was "whatever I have the opportunity for I'm not going to say no to, because you never know what opportunities are going to pay off."

On a daily basis, the social interactions do affect her work, because her job is very much based on other people asking what she is interested in. Office politics do come into play, *not for her position, but she sees it happening around her all the time.* She has also heard that *politics* like the presidential

administration and the senate budget play a big role in which projects get funded and which do not.

Funding is politically motivated, and what loopholes you go through to get funding are very frustrating.

It's an extremely stressful job, because once every four years your program could be completely defunded.

Her advice to undergrads would be to always be open to learning. She and her *peers had the conception that they would graduate and get a job that they would know how to do. It would save people a lot of frustration if they accepted that any new job, and any new situation, was going to require a lot of learning.* She also heard the advice to *think of your career in two to four year segments, and tell yourself that you're going to be doing something new every two to four years.* If you did that, *you would never go stagnant, and you would always want to learn the next new thing. In four years you might be applying to new jobs. Graduating didn't mean you quit studying. In STEM the next big thing could be tomorrow, or it could be five years from now, and either way you had to be able to deal with it, and you still had to be competitive in the job market.*

To her it seems that early career probably *starts the last couple of years of college, with what internships you have, who you know, where you get a job. Building relationships is important right from the get-go. It would have been nice to know that in her junior or senior year of college, how to use LinkedIn and other professional tools.*

E's Narrative

E's Exit

E held leadership positions on both of his senior design teams. It wasn't a huge deal, *more of a communication thing. Being lead just meant taking control of making sure that everything sticks, that everything follows the schedule they made at the start of the semester. It meant putting the*

responsibility for project completion on your shoulders, but also making sure that everyone was doing their part. Much of it he learned from watching the senior students leading his junior year projects.

On his first team, he was forced into the lead position, he didn't have a choice because he was the only student returning to the project having worked on it junior year. It was difficult at first because he didn't understand the design as well as the previous lead had. His junior year, he *hadn't been plugged into the design or the controls*, so he had to spend *a lot of time learning and getting caught up, trying to get in contact with the old lead to ask questions*. After that, things were pretty much *the same*.

One challenge he had on the second project was team-members that *either wouldn't contribute or weren't willing to put in the amount of time that the more experienced students were putting in*. A lot of the work *he had to do himself*. On that project, it also wasn't very clear *what the team was supposed to be doing*. *In the beginning, the team was under the impression that they had to use a certain mechanism to make the design work*, but the *design clinic faculty wanted the team to do things in the most efficient way*. *There was clearly a problem, based on the feedback they were getting from their presentations*. *By the time he and his co-lead had called a meeting with their advisor and the design faculty to agree on what they wanted to do, it was halfway through the semester*.

One thing E made sure to do differently from his own junior year leads was to start papers and presentations earlier relative to their deadlines. Additionally, E's writing style had changed over the past year. He started *narrowing down what he needed to include, omitting useless information*. *He also became very particular about formatting – indents, page breaks – and it had started to frustrate him that his teammates didn't know these things*. *In his internships, everything was expected to be a certain way so that other people could work on it*. That's probably where he picked formatting up from.

Writing at his internship was mostly technical documents, for instance, making sure a program was producing *predictable output*. The writing there was different from capstone, because *at work he wrote the document by himself*, and then multiple people *reviewed his work*. In senior design, since everyone

worked on the document at the same time, *if there was a mistake* or miscommunication, it wasn't *caught until it was too late.*

E has secured a full time position at the company he had been interning for the past year and a half. *During his internship they didn't expect too much because they knew he was busy with school.* He knew that, going into work, he would be *writing calculations and reports*, somewhat related to what he had already been doing as an intern. *At some point he might be using programming*, but *at the start he wouldn't be taking over programming.* *There wouldn't be a whole lot of design work to do.* While there were people at the company that made suggestions about what *needed to be changed* or fixed, doing engineering, his job was more *"analysis."*

He also knew he would *be doing CAD modeling*, which he *regretted not learning more about.* He expected to be *teaching himself at work*, which he *didn't mind*, though he did understand *the company wouldn't have hours for him to be sitting around, working off overhead hours, trying to teach himself the software.*

For now, he would just be a general *resource*, although there was specific work on fire simulation that he might be able to specialize in. He was able to do some of that work during his internship. *It just happened to fall in his lap, and at the time he was the least expensive person to be doing the research for it.* He wasn't hired specifically for it (*they said they hired him because appreciated his work ethic*) but *no one else in the office* was able to do that kind of work, so he might fit into that role, and *master that job.*

Although the engineers at the company *didn't generally do presentations*, the fire research that he was doing for his internship required that he *effectively relay his information* to his small group of five engineers. They *weren't formal*, but he had only about an hour-long meeting to talk about a month's

worth of research. He used to be a *nervous presenter*, but the repeated presentations of capstone helped him get feedback. He didn't try to *stick to a script* anymore. It was more like *having a conversation*.

On the other hand, he was nervous about the *responsibility of no longer being an intern*. As a full time employee, he wouldn't always have someone checking his work. He was worried about making an early mistake and needing to re-do all of something.

But he was *excited to be narrowing things down and focusing on one thing*. School had such a broad focus; *it will be nice to learn one thing and try to become the best at that*. He also expected to *enjoy working in an office, to be working with a team*. At work, there wouldn't be team-members who didn't *pull their weight*. There might be less active team-members, *but not to the extent that they didn't do what they were supposed to*. *You couldn't not be a member of the team and keep your job*. *It felt like senior-design, but better because he knew it was more important*.

He felt fairly prepared. He would need to learn a lot of technical details, but *for the most part he knew the process of preparing documents, and he knew overall what the goals of the company and the office were*. *If someone were to sit down and train him on technical tasks, it wouldn't take long for him to take one over*.

Ideally in five years, he'd like to still be at this company, possibly in management once he had built up some *experience*. He would also hopefully have a PE license, which he had already started. A PE might be a little unusual, no-one in the office had one, *but it was a valuable thing to have, even if he didn't stay with the company*. He was going to try *not to let his work ethic take priorities away from other things*, but to a certain extent *you did want to become important and have job security at your company*.

E's 3-Month

When E *started out, they didn't really have a place for him*. He was given *little random jobs for the first month*. The second month, *he was overloaded with the work, because he was one of the only*

people in the office that could go on a site visit. It took about two weeks. He really enjoyed it. When he came back, he started writing a report for the visit, when the contract with that client was put up for renegotiation. He was completely separate from the contract process, but with that they had lost a lot of work in the office, and their office manager challenged all of them to look outside of the office and find other opportunities. That's how he ended up where he was now, by asking the fire specialist group if they had any work for him. The opportunity just happened to land on his plate, perfect timing.

He was working with a group that was completely separate from the rest of the office. His new responsibility was to write a report, which he would be doing for the next several months. His routine was to go into the office, sit down and type for the entire day. When he got stuck, he would go and have potentially hour-long conversations with the people he worked with, just them walking him through everything. He got stuck pretty frequently, not because he wasn't prepared for technical writing, but because each site had highly specific technical details to keep track of, and all the little technical details could add up. With these details, he didn't see a place in education for learning them, because they were so specific. Anywhere you went, the challenges were going to be primarily technical details, getting acquainted to the job that you were doing specifically. That said, the writing was pretty similar to what he learned in capstone, only that you wrote with a company-wide format that was more professional. Every single report that their company spat out looked the exact same – often writing reports involved looking at previous reports, copying things over and adjusting for the specifics of the site you were working on. And you wrote your reports for a client who probably had their own review team, rather than for one faculty reviewer.

He wasn't doing the typical work he would associate with engineering. He was just researching. And while engineers did sometimes do research, that was more on the business end: how to interact with clients and find information for them. What he did now was not hands-on at all. Even on the site visit, they were there to record information, to talk to people and get information from them. None of it was

as hands-on. It wasn't a lot of actual designing, 3D modeling, or any formal calculations. There were engineers that actually do design work within the company, but the area of specialization for the office led to them becoming mostly report and calculation writers rather than design workers. In design someone came to you with a problem, you went through all the processes of creating drawings and going through calculations, and then you got to a point where you were modeling that, and then you would collaborate with other people to finalize it. And then you eventually worked towards developing a prototype. He thought his work was "research" more than anything else.

For him, the biggest problem was starting out in a career and wondering if you were limiting yourself. He had gotten into the mindset that what he did now had to be what he did for the rest of his career. And he had been asking himself "Am I enjoying what I'm doing now, and was this what I want to continue to do?" He wasn't sure. He wished he was pushed more into pursuing a graduate education, as opposed to just starting to work. He realized it wasn't too late for him to do that, but it was definitely harder to transition back to school after starting a full-time position. Grad school would have also been helpful for his current job, especially with the technical details. He originally guessed that less than 20% of people at the company would have graduate degrees, but it turned out that many more people did. People looked at you differently if you only had a bachelors. And it seemed like many of the people he talked to valued their higher education.

Motivation had been a big problem too. It was easy to work on something when you were on a roll, when you were making progress, like on his current report. Yesterday, he was so motivated he stayed late, because he was making good progress on the report. Today, he was just not motivated at all.

Thinking about his future at the company, he saw opportunities, he was just trying to decide where he wanted to end up. His current area of work was an opportunity to be part of the group in the future, to get away from what his office was doing (and from mechanical engineering). That was the understanding when they gave him the work, that it could be training for a new group. He was using his

work on the report to gauge whether that was what he wanted to be doing, because you didn't want to limit yourself to just your company. He had also been asking more experienced engineers for their opinion. One senior engineer told him "you never get bored" of the specialist work, you were constantly doing something, you would still be scratching the surface after ten years. It was really helpful.

He had picked up networking from work, and it was something anyone should expect to gain over time, as they grew to know more people by working alongside them. And it got you connections at other locations when they went off into separate jobs. Without his own internship at this company as a foot in the door, he might still be job hunting right now, given how difficult it was to find an entry level job without a masters or experience. Internships also helped you get a feel for where a company wanted to put you and what they wanted to have you do.

It had also been especially important for him to maintain constant communication with everyone because after his site visits in the second month, he had been working with people outside of his direct office. Even if you were 90% sure about something, you wanted to call and get 100% sure about it because one little thing could mess it up for everyone. That was also how he was being trained with his new project, they threw him in and said, "Read over some stuff on your own and the moment you get stuck, let us know and we'll talk you through it."

E's 7-Month

Although the past few weeks had a lot of overtime, work had been incredibly slow for the past few months, because the office had lost some major contracts. They had recently received some work with a tight deadline, which was why E had been so busy, but it was going to slow down again. The work life balance was good, but E was very concerned about job security for himself and the whole office, which had lost even the work they specialized in. Ever since the office originally lost their big client, he

had been ramping up applying and interviewing for new jobs. For the time being it looked like he could keep his job until the end of the year, he was not desperate enough that he needed to quit now and chase one of those offers. He had been making sure that whatever job he took would put him in a better position in the long run.

This had been a problem for a while. Since he started, *ten employees from the office had left*, on top of two rounds of layoffs in the company in the past year. Another experienced employee would leave next week. A handful of employees were looking out for each other and looking for jobs that other people could apply to.

A big part of everyone's frustration was that things were being swept under the rug by upper management, even by their office manager. No one was addressing that there was a concern, they were just told not to worry. They didn't see changes being made in the company. And the current circumstances (Lack of work, lack of attention from other offices focused on this office) were very similar to the previous pattern that led to layoffs.

His fire work, separate from the office, was still going on, which was a source of pride. *It gave him good experience, but it also helped keep the office charging to billable projects at a time when no one else really could. For a three- or four-week period, he was one of the only ones from the office pulling in money from clients.* It was still a shock that he was able to get involved with the separate group, but it made sense. At the time they wanted to tap their newer resources because a) they wouldn't be pulled away for other work, and b) because it was a bit cheaper than sending experienced engineers. Either way, he was glad that he did that. *It was one of his best experiences working at the company so far.*

The office's difficulties were *not something that anyone could have predicted.* Their big client was struggling and had cut them out mid-project. Because he had interned there, he knew what he was getting into, but losing the contract had been a big surprise. Across the industry there were issues, some

of which you could see in the news. *They might have seen it coming as more of a long-term thing, that it wouldn't be sustainable for the office to stay focused on one area, but they couldn't have predicted it would happen as fast as It did.* Now the office was bidding on smaller contracts in a desperation move.

For him, the consequences of these issues were severe, because he was by far the least experienced engineer in the office. *He could see how long it was going to take him to find a new job without having experience or a graduate degree, about six months. Everyone else had higher degrees, and at least five years of experience. It might not be fair, but that was how he was looking at it.*

The interviews had all gone well. He had heard back from one job a few months ago that wanted a second interview, but he *didn't see that job as a good fit for him. Another one he was waiting to hear back on. He had been keeping his eyes open for opportunities, and networking to see if anyone had any viable positions in the meantime. Most of his networking came from past employees who had gone on to different jobs.* It wasn't really something you learned in school, more like something you learned in industry. *You had to go and work for a little bit, and learn not to burn any bridges with people.*

Everyone was going to be useful to you at some point.

As an intern, he *hadn't realized just how tedious writing could be.* Reflecting on his site visit months ago, he admitted that his opinions about working in an office had changed a little. *He enjoyed working in an office a lot of the time, but felt that sometimes you just had to do hands-on work.* Those two weeks of site visit were *entirely hands-on.* It might not have been a *popular opinion within his company, but to him that was the first time that he really felt like he was doing actual engineering work and not just sitting and writing reports all day. It was important for engineers to know how to write technically, but he felt that what he was writing about was not really the design work and engineering calculations that capstone had prepared him for. It was more looking through the design work and engineering calculations that someone else had done and writing about it.* To him, *and he had seen this in the jobs he was applying to as well, engineering work should have been more design based.*

Modeling, fabricating, *that was the way things were in industry*. His past eight months of experience wasn't very *relevant to any jobs he was applying to*. *He did want to get involved in design, more typical engineering work, it just wasn't going to happen at his current company*.

He had found that, as he was advised earlier, people in his field *tended to get bored very quickly*. *Within two to four years, they found out, "oh, this is incredibly boring work. I'm just doing the same thing over and over, every single day."* *He had seen people leave a year and a half after they had been hired, looking for more hands-on work, more actual design work. The people who didn't get bored with the work ended up becoming managers, and everyone else just cycled through*. He still had hopes for the other work he was involved in. *He hadn't seen it yet, because he had only been on one project, but once you knew how the analysis worked, you could start applying that process to all sorts of problems*. The other field *covered a whole lot*.

Another direction that he *wanted to pursue for a while was applying to law school*. At a job he took after freshman year, he was inspired by interacting with an *inventor who was having issues finding someone to legally represent him that understood both the legal and technical side of obtaining a patent*. His end goal was to become a patent attorney. *He knew if he didn't apply now then it would be harder in the future, there would be higher opportunity cost to leaving an engineering career*. *He didn't apply earlier because it was an extensive process of studying*. It might not be reasonable to expect it to work out, but at the same time, *having an eight hour a day job made it easy to schedule study time*. It would have been harder in school. *This had been his plan for a while, to work for a year while studying for the LSAT, then apply the following year*.

E had talked with former employees that had worked with the office, because they would write recommendation letters for him, but he hadn't talked with anyone else. In this job, *pursuing a law degree wouldn't be in the best interest of the company*. *Bringing it up would make them question whether they wanted to keep him around*.

E's 14-Month

E has gone through multiple job changes in the past few months. After he hadn't heard back from one job, *he accepted a job doing HVAC. After a couple of months, he heard back from the first job, which was a better fit, and he accepted that offer. Now, he's finally at a job where he feels able to continue growing, and they care about his professional development as far as pursuing a Master's degree.*

Since the last interview, he has also applied and been accepted to law school, but that was about as far as it went. He was accepted to both law school and his current job at around the same time, and the job offer opened up more doors for him. He decided to pursue a Master's in engineering instead of a law degree, based on what his company would support, and also kind of based on his changing interests over the past six months. But he still felt accomplishment in having applied and been accepted. He was happy he was able to go through the process. It was something he could cross off his list.

Thinking about his changing interest, law school was *his main interest* before *because he wasn't doing any work in the engineering field that he was interested in at the time. But that changed with his current job. He was at a big enough company to provide a lot of variety in this new job. He is able to stay busy without getting bored or feeling like he isn't going anywhere. He doesn't realistically expect to get bored.*

The job he is in now gets to *see everything that's going on in the organization. They get to work and support several different projects. And that's not typical for someone starting out - normally you are assigned to your one group and one project, and then when that finishes up, you move to the next one. Everyone says that you can have 20 careers at the same company by the time you retire. They expect you to move around and do different things every couple of years. They're very supportive of that.*

Another thing, the reason he left his first job was *because the work wasn't necessarily engineering-related. He had heard similar things from friends that graduated and went straight to work, that it's*

not engineering-related work, rather it was regulatory support, quality assurance work than engineering work. It didn't have to be a specific kind of work to be engineering, but there was a certain type of work that you learned in your undergrad or even graduate degree, and that's not what a lot of engineering jobs were like. His second position in HVAC was completely design-based engineering work, but there was no design creativity associated with it. It was very stick-to-the-template type design work, more of a CAD job than anything else. His current position is more engineering, but from a systems level. It's not really design work, but it's still traditional engineering work. It's been a year since he has gone over them, but they apply engineering principles that he learned in undergrad to various systems. They look at a lot of hazards, they're helping people. There are multiple kinds of engineering, chemical, mechanical, electrical, that fall under their group. He's able to actually apply something that he learned in school.

As a group their tasks vary. They never know what organization or projects they'll be supporting. Sometimes it requires him to go out and tour the facilities. They actually do modeling, not necessarily CFD modeling, but they're working up to that. The other half of the job is training, since he is still new. There are opportunities to take classes, different trainings. They really encourage professional growth. For instance, every week he has a two-hour course in solid mechanics, onsite. For two hours that's his job, to just go and learn something. He appreciates that. He doesn't see any direct applications yet, but in the long run, reinforcing those engineering principles will help him in his current job. And beyond that it will help him move to a different organization in the future, if that's what he decides.

The position is in a unique area, safety, identifying hazards that people won't necessarily think of themselves. It's a different way of looking at engineering, it isn't a huge topic for engineering undergrads. The majority of people in office are very experienced, and most of them are older, though they are working to change that. Right now the hazard analysis projects they do are being led by more

experienced people, but the intent is that in six months he'll be able to lead one of those himself. He just needs to come up to speed.

He thinks that safety should be implemented as a more relevant part of capstone. At his university, people are lucky that there haven't been any safety injuries so far. It should be looked at from the beginning of a project, though it's hard to do that on an accelerated project like the capstone project; most people are concerned with funding, scheduling, organizing subteams, it's rare that people develop a plan for how to go about things in the safest way.

When he started in this group, two other people were also starting. They were all put on one project, and given a tight deadline. *They had to learn quickly how to work with each other, each of them having different backgrounds, and not knowing each other before starting the project. The first thing they needed to do was establish a leader. That was the most important thing. No matter if it was a team of three people, or 12 people, you needed a leader, someone to be in that position so that everyone knew who to communicate to. The leader also had to make the most of meeting times so that it didn't turn into a two-hour-long discouragement session. That was reinforced with capstone, how to have an effective meeting.*

Right now, his approach is all about *communication, knowing when to ask for help on things, not being afraid to admit that you don't know something. Beyond that, he is trying to get involved in more trainings at an early stage. He is hoping that once he finds where his group fits into projects, it will be easier to either network with people and bring in new work, or start leading these hazard analysis by himself.*

It occurs to him that jobs are not always going to meet your expectations. *His expectation was that he was going to stick with his first job, for several years. And he was going to stay in one field, and that would be what he did. But there's a lot that goes into your expectations, and you have to worry about*

things like job security, and how an industry could be on a huge decline when you start. You start to realize “my expectations are going to have to change because I can’t stay in this job, and this isn’t a realistic option for me long-term.” He has expectations now, but you just never know what’s going to happen. Maybe the expectations are better described as goals. He wants to stay in this position for a while, do as much as he can, finish up his Master’s, network with other people, and use that to move to a different organization three or four years down the road. But you just don’t know what’s going to affect that.

For any job, even if you have a great manager that you get along with most of the time, you can’t say you’re never going to disagree with that manager. Part of it is learning the hierarchy. It varies from company to company, whether you have a hierarchy where you report to someone, and they report to someone else, or a flat organization where everyone’s expected to communicate with everyone.

Disagreement with management is still something that he’s working through. He hopes it’s something that comes with work experience. When you disagree strongly enough, you can try to make your case with whoever you’re working with, but at the end of the day they’re the manager, they’re the team lead, and it’s their call. You just have to make sure that you make a strong enough case. But if it’s an issue of not agreeing on how anything is being done, he doesn’t have an answer for that. Maybe it’s as simple as meaning you’re not a good fit for that management style, or that organization. Maybe that’s a warning sign that you need to get out.

The best advice he can give is to develop good relationships with the people that you work with. Because really you can go from job to job, and maybe some of your experience will be relevant in your next job, but what’s really important is the relationships that you have with people, and kind of the professional network that you build, and how people view you. Because that’s going to follow you around. You might think that you can leave your reputation at one job, but it doesn’t work like that. If you’re going to leave a job, leave it on a good note, because you just never know when you’re going to

need anyone to vouch for you in the future. He's had a couple of recommendation letters that he's had to get from previous coworkers. For background checks they wanted to get his coworkers' opinion of him. It's helped out to have a good relationship with them, and to be a hard worker, so that when someone asks what their opinion of him is, he has a good reputation.

F's Narrative

F's Exit

Over the course of F's junior and senior design projects, she had had mixed experiences. Her junior project *didn't make a whole lot of progress. And she blamed that a little bit on the materials team that her mechanical team was working alongside. They moved very slowly on their deliverables. It may have been because of the tons and tons of paperwork that was required by the other department.*

Regardless that group was a little more split, and three people on her team were responsible for most of the technical writing, *all of the status reports. It was frustrating that the seniors didn't review much of the writing.*

It was different for her senior project. Her team lead spent significant time splitting up the work, and *he assigned everybody a particular section of their writing tasks. The project also, for her, was not theoretical at all, it was very hands on which was what she wanted. Their team was small, and they changed roles all the time. If you had completed your task, it was up to you to look for your own new role, to volunteer for tasks based on what you were interested in, as long as it needed doing. In hindsight, she wished they were assigned tasks based on what they wanted to learn, not based on the requirement for the team to make progress. Maybe she would have learned more about the electronics then. She still didn't understand that 100%. That said, assigning tasks based on productivity is how it works in the real world, so it was fine.*

For her first role, she worked on a specific sub-system. She had looked into cutting-edge solutions for this sub-system, *but after consulting the project sponsor and after emailing the company specifically, they decided that it wasn't really ideal.* Both the sponsor and the company suggested a simpler solution, that *they go with what was quickest and easiest.* After working on that, she moved on to another task she thought was *interesting.* The task amounted to placing devices inside of a box the company had provided, and programming them once they were placed. It also involved research, *just looking up devices for their specifications.*

Another challenge with the senior project was working with their advisors. They weren't very communicative. They didn't tell the team anything. It seemed nobody knew when they were presenting until the week before. *It took too long to get important information, and the team needed to pay more attention to make up for it.*

Still, throughout her projects, there was *no challenge that she came across that she didn't overcome, nothing that she needed to understand that she didn't at this point.* Design Clinic helped her become more confident in her abilities to perform any sort of a task, *helped her know here to start.* Even her junior year project experiences helped her know how to work as a team effectively, even if only by showing her what not to do.

Speaking of “real world,” she had landed a job at a national lab, and she considered herself *lucky.* She hadn't interned there before, so she *wasn't sure why they had chosen her resume.* She was a little nervous, *hoping that she didn't make it sound like she knew too much.* She didn't want to disappoint. At this point she wasn't 100% sure what the job entailed, but she did know it was *a hands-on position,* which *she was excited for, to not sit in front of a computer all day.* She had some sense that it would be *very similar* to capstone. She liked the lab, already. She knew people who worked there, and they seemed to like it. It seemed like *a good learning community.* She was planning on staying there a little

while, for at least 5 years. Ideally by then she would be doing something different, would be *smarter*, and might even start a Master's degree.

F's 4-Month

At 4 months of work, F doesn't yet have any highly specific responsibilities. Right now, she mostly *does whatever anybody tells her to do, which can range anywhere from working on image editing or working on a report or attaching wires or testing some sort of a component. Most of her work is sitting in front of a computer, though. She hasn't had to learn a whole lot yet, and she feels completely prepared for everything she does.* Right now, she is a temporary employee, though she is *working on a transition to being permanent. Before that can happen, she needs to get the security clearance, though that's not something that she can control.*

She finds the company's design process is *about the same as capstone. You have meetings, you discuss it with your teammates, you guys come up with a plan, the plan changes, there's reports that need to be done. You come up with a design, you present this design, then you change the design, you have meetings, make a prototype or jot one down, or create a prototype in CAD.* From capstone, she learned *produce something quick so that you can get a better idea of the scope. The faster that you produce something, anything, not necessarily an end-product, the better your product is going to be.*

It's still *more involved* than capstone. *The project she's working on is very large, and the larger a project is the more there is to know, and the less she seems to know. She has been assigned to a smaller subteam, but she I has to attend meetings with all the sub-teams, and try to understand what's happening with the other groups, what they're having to go through.*

For the technical knowledge of the teams she hasn't received any in-depth training, although she has received short online trainings. *The first one they had was about how the general process for any of their group's projects. She's also had some hands-on training, such as boom and lift training. There*

have also been trainings about normal job type situations, like how you're supposed to get on the lab campus, what your requirements are.

Boredom is a new challenge, a big one for her. It's challenging finding something to do. At her job there is a lot that she wants to do, but she doesn't have the experience to do it. They're really good about getting her started on tasks, but she can see how that might be difficult to put her on some of the tasks if she doesn't already have experience with them.

Beyond the online trainings, she has had to research the components her team works with, either at the direction of her supervisor, or self-directed, looking things up on her own because she knows they are important. She does a lot of *preparing herself, googling*, mostly through reading *user manuals*, but she *doesn't think that's the best way to teach herself, even if it's working for her so far*. On the other hand she does know that *she can't just ask somebody in a meeting to explain things to her. She tries not to bug her supervisors too much*. In some cases, *she will go and find somebody who has worked on a topic before. But usually, she has to write down what she didn't understand and go back and research it on her own*. And, because things are interconnected, *if she doesn't understand one thing, she has to research the whole entire topic*.

It seems that the skill most necessary for her to do her job is communication: *responding to emails, creating meetings that work around other people's schedules*. She wishes that communication had been better with her capstone team, that the supervisors had done more than just *request to see the project, maybe asked for specific updates*.

The other thing that's been important is having her own *schedule laid out, knowing what is expected of you, communicating with her supervisors, to know what she should be doing, what needs to be done*.

Scheduling is also hard because you can't do whatever you want in the five minutes between tasks, like you could during school. *Managing a schedule is always a work in progress, especially as she tries to*

juggle the travel arrangements with her personal arrangements. It never clicked to her before that when she does travel, she's not going to be at home for a whole week. She advises newcomers to expect to be tired.

F's 11-Month

At 11 months, her team is getting farther into the design work, which still involves report writing. She has also been doing a lot of traveling. Whenever she is on travel, it's a lot more hands-on, where she might be doing programming or setting up equipment, the latter of which can make the fieldwork more physical labor.

More specifically, F has a unique position as the civil for these projects, which doesn't quite make sense to her because she is a mechanical engineer, but that's how it ended up. She had expressed that she was interested in civil work, and there was change of people, so an opportunity opened up. She does some CAD work, some writing, and Excel as part of that. That said, she isn't doing a whole lot of engineering. There are occasionally moments where there are problems to solve, where she will have to adjust components to fit the site, which requires some calculations and some talking to people. But for the most part, her work is typical office work. A lot of time is spend putting together reports and presentations for project leads to present to the customer. As the team goes farther into the design, she also has to spec out parts and call manufacturers, which she wasn't as prepared for.

On travel, she feels a lot less prepared. There's a lot of basic understanding she feels is missing. She understands how to use the tools, but she doesn't always know what she is supposed to use the tools on. She might be told to connect a device up, and even that is something she doesn't yet know how to do. The challenge also comes in part from the project transitioning from a 30% complete design to a 60% to a 90% design (at the 90% point there really should be no unknowns about the design).

But she is learning now through informal training. And unlike school, which would eventually test your knowledge and call your learning to an end, *in the real world, the problems are never really solved, you just learn a little bit more and more about them, and you come up with better solutions. Everything about a design can change as the design moves from 30% to 90%. You never learn something and then move on.*

To cope with the constant learning, F keeps a to-do list and sticky notes, as before, to look up things once meetings are over. She thinks any newcomer should expect the same lack of knowledge at their job. *You can't expect to go into any job knowing what you're doing, especially as an engineer, unless you've done it before. A newcomer might expect the people who run the business to provide training. That's what she expected, but it's not what happened.*

At this point, she *prefers* the hands on work, and she *loves* the group she works with. There is the possibility of moving groups if she wanted, but she isn't interested. She might want to get a masters in a few years, because she does want to *lead a project* in the future, but *not now*, not when she doesn't yet *know what she's doing*.

F's 16-Month

F's job hasn't changed significantly over the past months, but she is doing more traveling to do site surveys. *Site surveys are not easy.* They usually go as a group, and for a project this large it *takes anywhere from a week to three weeks of people walking around* gathering information about the location. *Everybody's looking at something different,* though sometimes you *need someone else there to help you verify* information, such as keeping track of how much wiring there is. This information is *more for the company's own verification,* and isn't necessarily made into a presentation. When they do collect enough, the team *combines it in one big meeting, to make sure that everybody has everything they need, and then they store it somewhere so that everybody has access.*

They do have templates for storing information, but *90% of the time the template isn't very helpful, except for just reminding the things that you need to look for*. She has found that a lot of the time it's better to make notes directly on the collected info like drawings or blueprints, though other people use the templates or use notebooks, whatever works for them.

As things go on, she is beginning to feel more comfortable. *On the first site survey she went on, she had an idea of what she wanted to look at, but when she got back, she realized that there was a lot she missed. In talking to some of the more advanced people, you begin to understand the things that you need to look for*. It's important to talk with these colleagues, to *see if they think what you have is good enough, to hold yourself to some kind of standard. You can't expect anybody above you to catch your mistakes, because they don't have the time or the resources to really fine comb your work, you have to fine comb things yourself. People care, they will care in the end, but you're not going to have someone checking on you every step of the way, so you have to seek out feedback. There are some companies that are more careful with new people's work, but eventually, no matter where you are, you're going to be in a position where your work is your work and nobody else's*.

Beyond feeling more comfortable, she also feels very close to being an engineer. *She has more of an understanding of how this system works. If there's a problem, or the customer has a concern, she is able to go through and explain, propose solutions. It seems like going from zero to a hundred percent design is what it's going take to be an engineer in her field. Maybe just in general*.

That said, the *design is supposedly at 60% right now, but she knows for a fact that something is missing. She can't tell exactly what, but she knows from capstone what a 60% design should look like, and the current project isn't up to that par*.

It's hard to tell about completion from deadlines because they are often flexible. *She has a deadline to her lead, and they have a deadline to the manager, and the manager has a deadline to the customer*.

Sometimes the deadlines set by *the person just above her is flexible and sometimes it's not. It depends on who is above you*, but often you can ask for more time. If you're going to miss a deadline, you let someone know, and they'll give you a new deadline for end of day, or end of week.

Either way, because their design is at 60% they have to work on a new set of documents to fill out. Again, the project leads will present those to the customer, but the lead can't know all the *nitty gritty of the design*, so when the team does present in a couple of months, she will also be present, *in case somebody has a technical question that they want* discuss about her part of the design.

F's 27-Month

At two years of work, things are good but busy. Thinking about the past two years, F feels *fortunate with the things that she is able to do. There is a lot of international travel*, which is nice. She's getting exposure to *managing the logistics for that international travel*. Better, *she gets to travel and get paid for it, which she didn't think could happen*. She didn't necessarily seek out the travel, but the opportunity arose, and with a *little effort*, she was able to cross this kind of travel off her *personal bucket list. It's a normal job whenever she is on travel, but it's still nice to see these places*.

At this point, she's still not really doing engineering. Her position is responsible for *things getting ordered, things getting submitted for review, things getting shipped and received. These things have to be accounted for when you're exporting them*, whether it's a metal or if it's a plastic, whether it's a safety or an electronic piece of equipment. *She was half and half, design and logistics, up until about three months ago*. Design work meant *wires, boxes, deciding where thing get placed, and whether or not that's going to work for the site, conversations back and forth with the site about what they need and whether the design is going to meet their requirements*, sometime calculations. *For a portion of time, she was doing both of them at the same time. Half of her day would be dedicated to the design project, and the other half of the day, she would spend doing logistics. But the design project has*

ramped down, and the logistics role has ramped up. She's just not doing design much now, and in her mind, engineering is design work, primarily.

That doesn't necessarily mean that it's not important or not beneficial to her, as an engineer. She's learning how the world works, either way. She has experience now with how logistics work, how things get fit, what information you use to ship things, who you should talk to, the kind of terms you should use, the people and the things you can expect to receive. This is something that they needed, though she was unaware of it, until she became interested in playing that part, gaining that experience, being able to do it in the future. That said, it's a lot of the same thing over and over and over, so it's probably not something she will continue to do, in the future. She'll do it here and there, but it's not something that she wants to do as a career.

In this position, her engineering background helps with knowing what the majority of tools and parts they ship are. She knows what these things are purely because of her engineering background, whereas if you call some of the shipping departments, they need to ask, wouldn't necessarily know what something is.

From a more personal perspective, she really likes what she does. She tells everybody that it's not her dream job, but she does enjoy it. Again, the traveling makes her feel fortunate. There is also a good mix of hands-on design work in the position, and she loves all her co-workers. She gets paid well. There's a lot of opportunity at work, so she is not pigeon-holed into a particular role - she can easily move on to something new if she gets bored or if she is interested in something else.

The reason the company isn't her dream job, however, is because they're typically involved in defense projects, and it's not really what she want to do with herself. Anything that has to do with weapons or military is not something that she's interested in, in the long run. She doesn't think that we should be spending quite as much money as we do on these kinds of things. She wants to put her efforts into

saving the planet, saving animals, and making sure there's enough food for all the people, and all the people who are on the planet are well cared for. She want to see things thrive, not see them be destroyed. She cares that our country is safe, but she think there are other ways to make that happen. That's not one of the bigger threats right now.

Being fresh out of college, there wasn't really any reason to turn the job down, because it wasn't her dream job, but she wasn't expecting her dream job fresh out of college. She had heard from everyone that it was a great place to work, and it really was. And she figured the experience she would get at a well known place like her workplace would only help her find my dream job.

She would like to do something more on the lines of sustainability. There are some opportunities to do *renewal energy type research at her job, and that would be interesting. But she hesitates a little bit. It seems like there's a lot of red tape, which could make progress in that area very difficult.* For example, *safety. They overdo it with safety. There are so many barriers they build up. They overdo it with paperwork in general. If you want to get rubbing alcohol, you have to fill out multiple forms, and it has to go through a vendor. Then they have to fill out a form to get to you. It's very complicated to get simple things done.*

As it stands, even with obstacles, her team recent turned in the 90% design which they have been working on. And she is proud to say she contributed. *Everything she needed to get done, got done. The customer didn't have anything serious that they were concerned about, so that's and accomplishment. It's also an accomplishment in her logistical role to make sure that everything, all of the export control information is accounted for and all the variables are accounted for and correct, and that things get picked up on time and get delivered on time, and everyone is aware of what's happening. That's nice, too, very complicated things being delivered on time.*

The one skill she thinks every engineer needs to learn is spec'ing out things. Picking a part based on the requirements of the customer, and being able to prove it meets those requirements. Everybody learns it eventually. To her, engineering is still designing something based on requirements. You take in the customer, and typically you take in the end user. Not all engineers get to do this, but in an ideal world, and in her particular group, you get to build and implement and troubleshoot that particular thing, then maintain it, and plan for end of life. Engineers do more than just design and install, part of being an engineer is considering the future and purpose of something. How much should you spend? How important is this thing? Do we really something need this high quality? It all comes down to money, that's part of engineering as well. If her understanding of engineering is unique it's because the work that she does is a higher level, with higher expectations of what is accounted for. Most engineers just do the job and move on.

One challenge that she and others in her group have is trouble with saying no to work. A lot of them are overworked because so much work comes in, and they don't say no to it. She might only be able to enjoy her job because she has learned to say no to work over the past year and a half. When she first started, she was overwhelmed and confused. Since then, she has been able to recognize when it is too much for her to handle, when she cannot take on a project. It feels like less a big deal to say no to a request, even when she knows that it will make things very difficult for that project lead.

Sometimes she also has a challenge with the physical labor. The job is good about it, but there are things that she knows are too heavy for her to lift. She doesn't view it as being treated differently, just as something she acknowledges. They treat her differently as a woman, but it's for a good reason. On the other hand, she notices that as a woman, when you get upset, people assume that you're overreacting. She feels like she has to maintain her emotions because if she reacts, people try to hug her and calm her down, and she doesn't don't understand why. She does feel like she is treated differently in those cases, one of which happened recently. She just wants people to listen to her and

work on what is *frustrating her*. She thinks it could be *because she is seen as a little sister, they immediately try calm her down and make her feel better, and that's not what she wants. She just wants to tell them why she is upset. "Why can't we just have that conversation?"* she asks.

For any new engineer, her advice would be *to speak up. People tend to hesitate because they think that their inexperience will make them look bad, but she thinks becoming comfortable with bringing up issues is what you actually gain with experience. Knowing how to ask questions properly is something that you learn. If you think it might be important, just say it.*

Thinking about the future, she feels very *secure* in her job. The amount of work does fluctuate with the seasons, in which case she would need to switch sub-groups, but at the moment there's so much work in her department, they are overloaded. She could stay in this position for the *rest of her career if she wanted.*

G's Narrative

G's Exit

G's Senior Design *project was working with the City's office of planning and sustainability. At the very beginning they were trying to wrap their minds around the project as it had been proposed, until they were inspired by a side project, something that engineering students could take in a unique direction. But they still had no idea what was happening with their team and the project. Everyone was blank. No one knew what they wanted out of it. They had two students from architecture, who came in thinking they would have more set instructions. The team needed to figure out the process for themselves. In senior design, you had to have confidence in where you wanted to bring the project. But, in the end, the engineers were left to make the decisions. It was a nightmare for G figure out the schedule with the Gantt chart, the steps they were going to take that week, that month.*

Collaboration was a challenge. They didn't know each other very well. One of the architecture students described the team dynamic as unwelcoming. They weren't engineering students, and they didn't understand the intensity of the course. G and the rest of the engineers worked their butts off. They had done projects together in the past, and they always worked well together, they had a good flow. But G never felt the team got that back once they had architects on the team. She and the engineers would work together, and the architecture students would work on their own, in their own little worlds. And they couldn't ever find times to meet. The engineers would spend long nights in the engineering lab. And every Friday, after design class, they would have "snack" as a team, as a whole class. It was very cute. The architects didn't understand "snack." They would come to meetings, but they wouldn't do work sessions together. They would come with their backpacks on, and plan to leave for another workspace soon after. G didn't know why. But she didn't want to force anyone to work in the lab.

The project worked out in the end. Or it ended, at least. Who knows how much better it could have been if they worked well together? They had planned on getting gifts for their liaisons as a team at the end of the semester, but they couldn't even get the team together for that. The disconnection had been tricky to deal with, and she probably hadn't dealt with it in the best way. She was bad at confronting things. But work had been getting done, the project had been moving. Was it really an issue or was it that she wished that the team was more together? She didn't know. Maybe the architecture students weren't used to working in groups as much, or in the way the engineers did.

Beyond setting schedules and managing, G also did the CAD modeling for the project, which was a killer. She was a perfectionist. She had to get all the dimensions correct. When she started the CAD modeling, she was doing it alone, and she ran into so many problems. But it ended up working out. Things actually fit together in the end, it was cool.

She felt much more prepared than she had been a year ago, and the project manager role she took on played a big role in that. She knew now not to have meetings for no reason, how to close meetings

before she wasted people's time. *Having the responsibility of setting up meetings with people outside the team was also good preparation.*

For work, she was *going to be doing HVAC design, as entry-level person. she was all very mysterious to her. She didn't know on a day-to-day basis what she was going to be doing or who she was going to be working with.* It was kind of scary. *She was excited. She thought she would love it.* For one, she was *going to be living at home,* but it would still *be a change of pace, going from school to work.* Another thing she was excited for was *working under a professional engineer and seeing what that life was like. She had been a student her whole life, never really worked in a professional setting.* She had previously *worked at a summer camp for five years, where she was basically paid to be a kid. She didn't want to lose her childness.*

She was also excited about the people she was going to meet there. She didn't have other companies to compare it to, *but the first interview she did there, they gave presentations about the company that really sold her. The company was really sustainable, they worked on really cool projects,* but they also *had a philosophy she wanted in a company. They paid attention to work-life balance. The employees did activities together outside of work, like hiking trips and baseball. Everything they were doing, she would do.*

She was excited about the projects she'd be working on, because she didn't know what she would be doing. Was she going to be using CAD all day? Was she going to be in a lot of meetings? What if she didn't have the technical skills she needed?

There was one *thing she was most nervous about.* Other people were *coming in as mechanical engineers, and she had a general engineering degree. It was a hard thing to explain to people. And maybe she didn't know as much as they did. She had a lot of technical background, but she didn't know what it was going to be like working as an engineer. They had learned about sustainable design, fluids,*

thermodynamics, there were so many topics. She just didn't like feeling unprepared. She knew she would be working in teams. With her general engineering degree, she felt prepared to work on multidisciplinary teams. If a problem like the one in senior design arose, she would just discuss it, as a team, like they never had in senior design. It was such a simple fix, you just had to do it. She also knew the CAD program they used. She had been watching tutorials on it. She was trying to study up on what she should. She emailed her boss and asked, "Is there anything she should be knowing?" She just wanted to come in prepared. But everything they needed to know, the company would teach when they got there. She knew that.

On a grander scale, she had a plan, an idea of what she wanted to do. She wanted to work for this company for a few years, see if she liked it. If she did like it, she would transfer to one of the company's offices abroad, if she could, though she didn't know what it would be like for a newcomer. Then she would take time off to travel after she made some money. Then eventually go to grad school, though she wasn't sure for what. She did want her PE at some point. She also wanted to go into renewable energy. That's where she saw herself as an engineer. She had always been fascinated by wind turbines. She would like to go into that, especially because she knew it was a really good form of renewable energy. But ultimately, she didn't know what a job in renewable energy would look like.

G's 4-Month

G's manager was allowing her to take on more leadership responsibilities. It was nice because he trusted her to communicate, take the lead, and come to him when she has questions. For one project, right now she was the one exchanging emails and phone calls with the other office. And she was now a part of meetings where they made design decisions. They needed help from G's office, and she was in charge of adding another person onto the project, getting them up to speed. Her manager knew that

she had spent so much time in the model, she knew where everything was. It was cool to feel like she was starting to understand the work she was doing.

Her day to day was a lot of CAD modeling, and emailing back and forth to coordinate with the architects. They were handing off their drawings to them, and the architects would hand them back. They were updating their model. And the engineers were updating theirs. This was how the company did it. Normally it was up to the engineers to carry out the architects vision without back-and-forth.

The only thing she was having trouble with were specific to the CAD program, though she knew how to deal with every issue, who to go to for help. Design clinic never taught her all of the specifics of programming she needed, but it helped her to know what questions to ask, when to ask them, and how much research to do on her own before asking. Mostly it was avoiding using up other people's time. In senior design, their main client contact, his time was always short, he was hard to meet with. Then she had realized the value of other people's time. Some of the architects at work with were similar.

When she first started, they had a graduate induction, to get to know and network with everyone who had just started working, from across the Americas. They were all “graduate” level, not yet mechanical engineers. They did a bunch of design challenges together. It didn't help her with anything specifically related to work like she had hoped. But at the same time, there were panels with senior engineers who shared their experiences, and how they started at the company, how they worked their way up, which was helpful. Sometimes she got so caught up in gaining technical experience that she forgot she was also trying to build her career out of this, trying to figure out what direction to take it in.

The company was paying for her and others to do a CAD training at another office, next week. So far she had been disappointed to get so little training. It was a lot of online modules she did her first week, like harassment videos and safety. In any and all of the spare time she had when she started working, the company had a page with videos and tutorials about CAD, energy modeling, load calculations. She

took those. But it was so much harder learning from those, than from a personal setting with someone who was training you on specific things related to work. She hadn't been given any sit down training sessions with people. But now she understood how to get that learning. It was all self-perpetuated. If there was a training your office, they would send out an email to the team looking for anyone interested.

Even though the skills she learned from senior design helped her get hired at the company, she wished her senior design project was more related to HVAC. She didn't get those specific technical skills. It was a field that she never thought that much about. She felt really intimidated the first few weeks.

Getting to know the people in the office made her relax. She realized that no one was expecting that much of her right now. She was willing to exceed their expectations as much as she could, but they never expected the grads to be professionals right off the bat, because no one was. Her challenge was that she wanted to push herself in all these directions, faster than the company was pushing her. She wanted to figure out how she could make herself an important asset, instead of being someone who could do anything that was asked of her. It was hard for her to figure out how to do that when she didn't understand their project process. She had always been put on a project in the middle of it, after it had already gone through the first few design phases. If no one was telling her the next steps, she wasn't sure what to do next, even if she had ideas of what would help.

She was trying to focus on was making herself an important piece of the mechanical team. One coworker was good at CAD modeling. Another was good at doing controls. She wanted to become an asset like that. She could sit back and do easy modeling every day, which is what she was doing now. But she wanted to find ways to personally progress projects forward. She felt that if no one was asking her to do it, it must not be the right next step. Earlier today she had started an energy model, but someone stopped her, "we're actually not gonna do it. The budget's too tight, and we don't need to, it was just a garage." Only one person per project did an energy model. She had done a bunch of tutorials in the software. And she was realizing that everyone on the team seemed to only have done it

once or twice. That's something she was interested in, so she was hoping to start doing energy modeling. She didn't need to be the expert at anything yet. But she didn't want to be seen as someone who was left with CAD work. As much as she liked that, it was easy and mindless, and she wanted to be valued. She wanted to be the go to person for something. She hadn't had the opportunity for that yet. It was more of a long term goal, but why not start now?

There is a question of whether what she is doing is engineering. When her manager comes to get her opinion on things, he is relying on G's *engineering expertise*. That's engineering, her opinions and knowledge become *part of designs and decisions*. *The CAD stuff isn't engineering*, or maybe it is. *She does make a lot of decisions* about where parts go, or which need to be used to avoid failure, and it does require her *knowledge*. But it also *seems like mindless work, it was many small tedious things. It doesn't seem like anything significant, but it was important* because it was needed for others to do specific calculations. *She did consider herself an expert at it now*, at least for this specific building.

There was a lot she liked about the company. *Company morale was more based around sustainability and quality design*. She also liked the *flat structure, you didn't feel like there were people who were too important to talk to. It was like a family. Everyone was friends. They did things together on weekends, planned trips, pumpkin carving. It was all of the company, all over the world. She loved that. They also had a good focus on work life balance. People could decide to work part-time if they needed*, as in the case with one coworker who was a professional athlete. *They didn't just talk a big game, they actually did care about your wellness. People cared about you as an employee and as a person. They had a wellness room where you could take naps if you needed. It felt like a really good work environment.*

Her advice to newcomers was to get prepared with skills early, like she had with tutorials before coming to work. *That way you would at least know that you tried to make yourself as prepared as you could be. It was also helpful to have connections. Asking whoever you could for information, or informational interviews, that would get you so many steps ahead.*

G's 7-Month

G's leadership responsibilities were still growing. Right now, she was on a team *split* between two offices. *She was the graduate engineer working the most on the project, so she had become the go to person for a lot of questions from the electrical and the fire protection team. Two weeks ago, both the engineers had gone on vacation, so she ended up being in charge for a short time. It was stressful but she was able to set up all the meetings and keep track of progress. She was actually participating in projects now and being asked questions. She was also taking on little projects within the bigger project, figuring out configurations of parts. She was surprised that she hadn't written any reports yet, but she was sure she would in the future. She was still doing a lot of meetings, emails and calls.*

She didn't always feel prepared for questions, for being put on the spot, but overall, she felt prepared for the meetings, and coordination that the job required. A lot of it came from being a project manager on her senior design project. Constantly having to keep up, email exchanges, people asking questions back and forth. It was very similar.

In the past few months, she had joined a mentoring circle within the company. They had a few senior people from the office, most of them engineers, but also people from marketing. *It was cool, because she could get other perspectives from different roles within the office and hear about career paths. At a recent meeting, they had been talking about grander ideas of the future, where they wanted to lead their careers. G had been working with local climate change groups, and she was thinking about how she could have those things together. Somehow, she wanted to connect her work more to sustainability or renewable energy. One of the mentors in the circle brought up that he had been looking for people that would be interested in that kind of thing. A week later her supervisor said that someone wanted to put her on a project focused on sustainable energy at multiple sites. Last week she spent time working with [green energy] systems. It was interesting to just speak up like that and have it instantly change her work within my job. It was a really empowering thing, and it made her feel like*

she had a lot of say in what she was working on. And as she grew in the company, she would be able to bring those types of projects in, and have other people work on them.

They had been doing cross disciplinary team lunches, which was helpful, but with the mentorship circle, she got more chances to talk to people outside of the mechanical team. Most people seemed to understand what the other disciplines were doing. She also was planning on staying at the company for a long time, at least the next three to five years, so she was still figuring out how to be the best employee possible, and how she could change the company in the future. Her climate change group had been trying to partner with an engineering firm, and this company seemed pretty interested. She had one foot in that door and one foot in the other. Hopefully in the future she would act as a liaison between the two.

She was getting a sense of how she could carve out a career path that would be what she wanted to do and also beneficial to the company. It was hard to know in the shorter term what it would look like.

The most she could possibly do right now was to broaden her knowledge about every mechanical system she could see. She was studying all the time, outside of work. She was starting to struggle with work/life balance, partially because of the tutorials she was doing outside work, partially because she was getting so much work so quickly and she could stay until 8PM if there was something she felt she needed to finish. She knew it was going to happen – it was part of the reason she joined the mentorship circle. When she talked to her supervisor about it, she reminded her that she only had eight hours a day for work, and if she couldn't get it done or there was information she needed that she didn't have yet, she didn't have to worry. It was better to do it correctly and thoroughly than to just get information out of people. If she was doing her work efficiently, that's the best she could do. Since talking about it she had not been as stressed, staying as late. It didn't need to be perfect. She was used to working on things until they were perfect. It wasn't reasonable to do that all the time.

She still had the goal of *being an energy modeling person. But she was realizing there was only one person* who did the energy model for any given project. There weren't any openings for that right now. *She wasn't going to be able to experience everything as soon as she decided to. It was a lot of waiting, waiting to be put on the right project, or for the right time.*

She was doing engineering in the meantime. *She did a lot of calculations. She used her best judgment to make decisions* with limited information. Thinking back to before she knew what she would be working on, *she was pretty happy with what she was doing. More than anything else she was hoping that people would be asking for her input, and she did feel like her opinion was taken seriously.*

Coming into work, you should hope *not to feel like you are just one in a crowd, to feel like you have a unique perspective and experiences that could help with any problem. You should expect to work really hard. Just because you graduated school doesn't mean that you can slack off now that you have a job. But you can expect to feel good if you're working as hard as you should be. Having a grasp on how to professionally communicate, how to present yourself, how to be confident, would be huge. Those were the bread and butter of being a professional, no matter what you were doing. Confidence allowed her to gain access to all the resources she had. Accessing your network took being able to put yourself out there.*

G's 13-Month

Work was *going really well*, though things were slow. *She was working on a skyscraper project so she was kind of annoyed. She would've wanted to work on something else, but it happened to be the next opportunity that presented itself. She was only a year in, she had plenty of years ahead to work on other things. But she was kind of getting "skyscraper-ed out."* The product manager on her project was *"the skyscraper guy"* and when she asked, he said that he earned the title after being *"put on one project after the other, and now here she am."* *She didn't want that to be her.*

Other than that, everything was fine. She had hit the point where she was comfortable, she didn't get presented with many new things on a day-to-day basis. Maybe she wasn't skyscraper-ed out. It was more that she wanted to learn how other buildings operated. But it was also really cool working on skyscrapers. It gave her perks when navigating the buildings, she gain access to places by saying "Listen, I'm an engineer." That and she was working on a local project.

She had gone to a few training sessions, one about the energy modeling software the company used. She still hadn't done an energy model, but she was going to be one of the next people. A lot of times the one engineer responsible was someone on the sustainability team or someone from another office. She would probably do that within the next year or so. She also went to a training on more baseline knowledge, where they presented all the different systems and everything they needed to know. She got useful knowledge from her day-to-day, but from that she only learned the specifics of those projects. There was a lot of custom equipment you could choose, and, of course, buildings were all different, you couldn't just select any old piece of equipment. So, that training was helpful.

She hadn't used the knowledge yet, but it was helpful knowing that it was something that you could do. She was realizing that there were no black and white rules to engineering. In some cases, when she had tried to place a part, she realized that all the things the part depended on weren't there. One of the senior engineers reminded her, "Yeah, that's not set in stone, that's going to change. We have to tell the architects what we need and they tell us what they need." They were working together to get the building in the best layout possible for the systems in it. So it was a reminder that until it was built, and even then, you could always change things around.

Her mentorship circle was still active. The project that she was introduced to last time through the circle, she was acting as an extra person. But after some time, as other people got busier, she became the person putting the reports together. She was modeling [alternative energy] systems on buildings, which was exactly what she wanted to be doing as an engineer, though it wasn't her job at the moment.

She was proud of the work she had done. She learned how to code in excel, which she didn't even know was possible. She was getting a lot of praise from the senior engineer who she was working under, and at one point he went to her supervisor to talk about how hard she was working. They put together the necessary reports really quickly, which was hard. Afterward, the other engineer sent G an email showing her a new way to do the financials, "this would've been a really cool way." They had been using a simple payback method, which wasn't the best way because it left out a lot of factors, and it ended up looking really bad. A lot of times the best recommendation they could make was CHP over [alternative energy], which wasn't really green, and not what they wanted. Maybe they could pursue the new way in the future. Even though they didn't have huge success on their project, she felt really good. She felt her work was appreciated, and working on renewable energy or sustainability was why she went to engineering in the first place.

After that, she had been looking for more opportunities, and last minute the other engineer invited her to a meeting. She realized it was the first time that she had met with a client like that. Now they were extending the contract, and they would identify positive and negative attributes of different energy sources. As they were walking back, her partner made a comment, "Isn't it funny how you can just speak up and things will just work out for you? It's almost like the most satisfied people at this company are the people who say what they want to do."

At the time she was on the [alternative energy] project, she was doing other projects, including skyscraper work. The [alternative energy] project was different as it was outside of the mechanical team. The lead mechanical engineer for the skyscraper was kind of upset. He didn't think she had time for the [alternative energy] work, it might affect the skyscraper project, make her miss deadlines. G said, "I definitely do have time and this is actually what I want to be doing." She had to stand up for herself and say, "I know you don't want me to work on this project, but I am going to because it is my decision and I will still get the work done for the skyscraper" And that's what she ended up doing. He

wasn't actually mad, he was joking about other people stealing his employees. There was conflict, no one got mad. Most people in the office were very understanding. Maybe if she had spent all her time on [alternative energy], he would have gotten upset, but it didn't really change how much she got done, because she was also working a lot of overtime.

That's what she had been told at the beginning of being in the engineering industry, you had times where you were twiddling your thumbs, you did trainings online, you asked people on your team if they had work or needed help. And there were times where you worked 80 hour weeks. That was the nature of it, which was fine with her. She was fine because she got paid for it. It only made sense when there was a deadline. People didn't say so, but they expected you to stay if there was a deadline coming up. She probably wouldn't be as okay with it now that she was dating someone. Under previous deadlines, when she was just gonna go home and watch TV anyway, she might as well be there making money. They made it easy. They would reimburse you for dinner, and for a taxi home. They gave them laptops to take home. She found herself thinking, "there's no reason not to." She could just listen to a podcast, which she would be doing anyway, and work on modeling a little bit. And she liked the feeling of saying, "Sorry, got ordered late today, really need to finish this deadline." She felt so valued.

The expectation came from seeing other people do it. Before she ever worked overtime, she saw it happening to people. They would turn down after work activities. Some people would eat lunch at their desks or get in early, stay late. A lot of people were very devoted to finishing projects. She wouldn't expect it from anyone who had a family, though she was sure they would take their computers home and do it too. The head of the marketing team gave her a book that really helped her. It talked about how work-life balance wasn't a real thing, you'd probably never get there, but work-life satisfaction was something you should look for. What did you really care about doing right now and how? G was a huge climate activist so she spent a lot of time going to actions. She was taking tomorrow off for a sit in, that was more important to her. It was high on her priority list. She spent time

thinking about that and it made her feel really nice. No one expected work to be your highest priority, no one was going to bat an eye if you needed to leave. There was a little pressure, but not enough to make you feel bad. You were only expected to work 40 hours, really.

*She hopefully would end up making her own path, some combination of disciplines, but it would take time. She was only a grad right now. She didn't have much power over what she did. But she was still planning on staying. It was a really great company, she had zero complaints. There were times when she thought, "I f***ing love this place.", and times she thought, "I'm getting a little bored of doing the same kind of work." But that was to be expected out of almost any job, let alone an engineering job. She felt lucky to be where she was.*

G's 25-Month

Work had been good and bad. She was feeling particularly good right now because she just went through a bad period, but she had her head in the game again. She had a lot going on outside of her work life, and it sometimes got in the way of work. She was a leader in her climate change activism organization, so she was volunteering full-time outside of her full-time job. She was expected to always be available, so it had been hard to balance. It was a lot of responsibility. They were asking her questions all the time. She had to lead meetings, often. But she loved it. It was so hard seeing all these things she could be doing that she loved, that were also benefiting the world, and then there was the other actual work you had to do. She found her hours started blurring, she would do activism stuff while she was at work, and she would do work stuff when she was at home to try to catch up. She was focusing on too many things. The other part of it was that she was hitting that time after two years where you were so used to the routine of working that everything blurred together. It had been hard.

At work she had been put on lots of projects at the same time. She just wasn't used to that balance, especially because she wanted to please everybody. She had been struggling for a long time

with understanding how she should prioritize things, when everybody thought their requests were really important and time sensitive. She also needed to know when to ask for information that people weren't communicating with her. She had assumed that if someone hadn't communicated something with me, it was not something that she should do, but now she had to anticipate.

She had been given a lot of work. One kind of project was great for junior engineers, because they happened fast, and they could go through the entire design process from beginning to end in the span of two months. It was great for learning, but extremely stressful for her. 100% of the construction documents had to be done in two weeks. It was hard for a lot of people. Even though it was a good learning process, she didn't know how anybody could balance that workload with things outside of work. Other people could accept working late every single day for the next few weeks. She couldn't do that, not when she was leading meetings after work. She had been really frustrated with that.

On another project, the communication had been really bad because the project got turned over to someone new after an employee left. The lead mechanical engineer sat next to a girl G's age. And there was a competitive edge between that girl and G. She and the lead mechanical engineer would talk about everything without communicating with G what was going on. And she made G feel like she didn't know anything, because she was not on the emails. G was being made to represent the mechanical team at meetings, but she didn't know what was going on because they didn't communicate with her. She had been trying to fix that, but it was hard. She couldn't ask to be in on every conversation they had in person. It was annoying and stressful. It had been making work suck.

Then an energy modeling project was happening. It was a cool opportunity because the client was considering geothermal energy. Heck yeah. Renewable energy, more energy efficient building. She was excited, and it was her first energy model. There were two or three mechanical engineers at the office who knew how to do energy modeling, and they didn't want to be doing every energy model for every project in the office, so they had been leading sessions. None of the older mechanical engineers

knew how to use the software, because it was new, and because it was too expensive for the company to pay for their time to learn the software. So, a bunch of junior engineers were learning the software, while working under senior engineers who got frustrated because the juniors were trying to learn the process and couldn't get results as fast as they needed. And the juniors were getting frustrated because the seniors were expecting things without knowing the software. It was frustrating to be given deadlines when the person above you didn't know how long it took.

In the end she was supposed to turn in an energy model and she delivered it late. Partially because she was feeling very stressed and partially because she didn't know how long it was going to take. She should have asked for help sooner, but she was used to figuring things out on her own. There was a miscommunication between her and the senior engineer. She got him results on Friday, but he wanted the results earlier, and he didn't tell her, and she didn't ask. When she sent the results late, he got really mad, talked to her supervisor, and sent her a lot of rude emails. She was worried. Was she going to get fired? Would people trust her as an engineer? No one was thinking that but her, but it was scary because it was her first huge mistake. But it actually was really good. It put her head back in the game.

Luckily, soon after, G had a mid-year check in with her supervisor who wanted to address this. She suggested that G have a sit down with him. So she did, earlier this week, go through what she thought happened, what the miscommunication was, and where she was wrong. He had made her feel dumb, like she wasn't capable of doing the work, which made her feel like she couldn't do it, like she was going to fail. Creating a line of communication with him was good. It made her feel better. He saw how he didn't let her know what the expectations were. When she got back to her desk, she decided that she needed to focus again. She stopped doing activism at work. She started to work really hard again, and she started doing more trainings. After that, she felt so good, like she understood what she was doing.

The mentorship circle of last year *was a temporary thing. It only happened for about six months. She mentioned it to her supervisor, that maybe they should do it again* because it was so great. Her supervisor agreed, but she reminded her that *anybody could be her mentor. You didn't have to do it in such a structured way.* G thought to herself that *maybe she should spend more time connecting with people in the office.* She was part of an LGBT+ group which *connected all the office – they had recently become more active, and this year the company had hired their first black employee, as an intern,* and due to some other efforts, a reorganization had placed a lot more women in leadership. So, she was at least part of those communities. But outside of work, *a lot of her friendships had gotten tenuous because she was just so busy, and some people didn't understand that. But she was also choosing to do this, and she wouldn't be coordinator for the activism group next year, so she would have more time next year. For now, she was going to ride this roller coaster until the end of her term,* until the winter.

She also had a conversation with a co-worker who was also having difficulty with people not communicating with her. *'Okay, I'm not crazy,'* she thought. *'There are people who, for some reason, don't think that communication is important.'* It was striking how different engineering was from her activism work. In activism, *everything they did was about supporting people, making sure people feel uplifted with their work,* and in engineering, *it was all about getting work done on time.*

Some coworkers had been *laid off,* including the professional athlete. *Not because he worked part-time, but because the company had lost a big project, and with it a lot of money. Afterwards a few people got fired. It was weird, so random and unexpected. He might have been chosen because he worked part-time, and that made her scared to work part-time. But it was unclear. Not communicated to anybody.*

Office life was hard. In capstone, no one had ever said, “hey you can't take a nap right now.”

While earlier she had thought you could take naps in the wellness room, *you weren't supposed to. It*

was more for women breastfeeding. She was still struggling. Was she just a slow worker, or were other people just rushing through the work they were doing? Every time she took her time to really understand the work she was doing, and do it well, she felt she was taking double the time compared to what people were expecting of her. She had never been on such a time budget before.

She thought it was better now that she was fully focused all the time. Before she would get distracted by an interesting podcast. Focus has been helping her with time allocation. Maybe it would have helped to keep track of time in capstone. At work, everything was on a budget, and budget was related to time. You found yourself trying to do things fast at the expense of your work. Learning how to be efficient with your time, especially in engineering, was important, because there were so many things that could take you hours and hours, that you could possibly automate to get done quicker.

H's Narrative

H's Exit

H's senior design was a software engineering project. They used Scrum, which made the project very structured and it gave the team a good framework, but right off that bat, there was the challenge of trying to incorporate Scrum into a college framework, in Scrum you meet every single day. The team didn't have the time for that because they had other classes, so they met four times a week.

As part of Scrum, they would start the week by outlining what they wanted to do for the whole sprint. They each had a project backlog, where they put the stuff they needed to do. As they grew to know more about the project, they listed down things they needed to do and pulled up the most important stuff from the backlog into the weekly sprint. The reason they did things that way was because their sponsor company did it that way. The team wanted to incorporate it as much as possible into their work flow.

In H's program, they rotate team roles, and at a *crucial point* in the semester, H was the *Scrum Master* for her team's software senior design project. *Scrum master would facilitate the discussion of what needs to be **done**, what was a priority, helped assign tasks to people, and made sure there was an even distribution of work among people. She was supposed to do all the tasks that helped alleviate or unblock loose tasks blocked development of the project. It was a crucial time because they were trying to figure out what on earth their project was, and they figured out it was a data architecture project.*

The biggest challenge was team members coming from different backgrounds. It was challenging to distribute the workload. H liked things to be very structured, but most of the team did things very organically, without a set plan, people took jobs and no one was really assigned. Sometimes she felt that team members were not taking as much work as they should be, but she wasn't particularly disturbed by that because it all evened out.

Another challenge was differing communication style. H was more on the frank side, very direct, because she believed in clear, direct communication. Rather than assuming what people were feeling, it was always better to ask. But some people were not going to be as responsive online. As Scrum master, she needed regular updates on the progress of tasks. One team member was totally fine. If you asked her the ETA on a task, she would just tell you. Another team member would say that it wasn't done, but H wanted a time estimate. If H just asked "what's the ETA?" she felt it was perceived as being very strong and direct, because it put a lot pressure on a teammate.

So, the goal was to create a safe space for people to be open. She realized that not everybody was direct like she was, and she couldn't change everybody. That wasn't her role. So she would try to accommodate to how people work. She also slowly tried to be direct in person, so people would feel more comfortable with her directness. If she asked the same kind of direct questions over text, she hoped they would realize she wasn't trying to be personal, just trying to get things done. If she said it in person, then when she said it in text, it would be less scary.

Some of the trouble was that *it was difficult to know how long a task would take. A lot of problems came up on the way, and took longer than expected. They had to be always readjusting their schedules.* For instance, they had never tested code before, and late into the project, they realized that *testing takes a lot of time, sometimes times more time than actually writing code.* But despite that problem, like most other of their problems, they managed to *make things work.*

It's not something she would have admitted right away, but now she would describe herself as the glue behind the team. She had talked with their advisor because she felt like she wasn't producing enough code compared to her teammates, but her advisor reminded her not to overlook her strength - she really defined the team. She paid a lot of attention to small things, which were very important to the team's success, especially when they came from different backgrounds. She was the glue even when she wasn't technically the Scrum master. The project allowed everybody to try the Scrum Master role, but she felt that some people were better at the role than others. People would try the role out, but at the same time you wanted the project to move forward. You had to group people together, and lead discretely. If a teammate asked for help in the group chat, it was technically the Scrum Master's job to respond, but she would step up if the Scrum Master didn't.

Another challenge was that she thought the team had a mindset of believing in a right and wrong answer, though that was expected after being in school for so long, where there had to be a correct solution. It was always her thought to push forward and just build something, despite the ambiguity. They should start building to get a better sense of possible solutions and mistakes. Despite the advisors telling the team that there was no right or wrong answer, she didn't manage to convince them. That was one of things she might not have handled as well, she tried and failed. It was something she would have to learn when she got to the workplace.

Soon she was going to start work at the company that sponsored her senior design project. *Her role was going to be project manager, working with cross-functional teams to release their software. She had*

been reading about what the project manager role entails. It had bits and pieces of the Scrum master role. Gaining trust from your team members would be very important. Naturally people would give you more credibility if she had more experience, if she had done more software internships. In the work place she would have to start building credibility. One of the ways that project managers convince people, especially senior people with 20 years more experience, is through data. She will try to find a way to quantify why things need to be done. She will use that approach as her guideline and amend it as time goes on. Other approaches which will come in handy will be speaking both non-technically, and with engineering language, bridging that gap. She is also very curious as a person - whatever job you give her, she will do what it takes to make it work. That's her philosophy.

One thing she was worried about was that there were currently no people in her position (project manager) in the company, according to her to-be manager. She was concerned because she wanted a mentor in the company if she had questions. But she was an independent person. If she was really struggling, she would seek help from people, and she felt they would be willing to help.

Working on the senior design project, being able to see how software is developed, for her, was very eye opening. On their site visits they got to see how the team functions, with everybody building their own code, seeing how people do code reviews and conduct meetings. It gave her a sense of what to expect in the work force and would help her in her job. She was looking forward to working with people who have a passion for work, who felt strong about their projects – not all her teammates had that.

Her project was an intersect of many of her interests, and it helped her realize her strengths. She had always thought she was someone who wanted to engineer and build. She took many classes and didn't have a cohesive picture about herself and what she wanted to do. It was challenging, with the liberal arts, to create the story of what you were interested in. But now she was confident that she wanted to work in healthcare, but also tech and software, and that her skills were more in the area of

management – not that she couldn't build software, but she knew her strengths. And she was excited to be part of this company, excited about its mission.

H's 4-Month

A lot of things had popped up in the past few months, and she had been doing things beyond her job scope, which she did not expect. She thought it was in part because, the company trusted her enough to give her additional responsibility. It was pretty nice, so far. She was learning constantly.

Right now she is managing software releases. She is having meetings, putting together documentation, and coordinating teams with each other to ensure that they were regulation compliant. Her manager had been pushing for her to become the "process expert," who does things like writing code, testing, or actually deploying software. It isn't just focused on the releases, but on the whole software development process and ways to improve their workflow, or increase their efficiency. That is all within her job scope. It is a lot of her talking to people, trying to understand where they were coming from and how she could help improve and streamline the process.

She feels like she knows how to ask the right questions. The work is nebulous, but then design clinic was also nebulous and she was able to ask the right questions to their stakeholders and liaisons to get answers she needed. The trickier part for her is to get the technical knowledge, and building a trust relationship with developers.

Working with people who are more senior is a challenge. Or it might be in her head. As project manager, she has to get people to do things on time, or needs to follow up with people. Sometimes it's hard to get information out of people. She tries to not to only talk to people when she need things from them. Sometimes in the break room, she will strike up conversations with people; One difficult person really liked coffee, and she shared the same interest, so they bonded over coffee. They went for a coffee

meeting downtown. And after some bonding they were more willing to explain to her in layman's language why things weren't working.

On paper she knew what she was supposed to do, but she didn't really know. So, she went in with an open mind. Right now, she is the single point person in the company. If people have any questions, they come to her for answers. If she doesn't know, she needs to know who to ask. She didn't expect this at all, but at the same time it's something she can manage.

She was the only project manager at the company, so they didn't have a standardized process of training. Her manager trained her with a checklist - she had to ensure the checklist was complete, which it was after the first week. She also kept in close touch with her manager. It was a lot of self-initiative. Any questions about the process, even the tiny details, she felt comfortable going to her about. She let H know who did what at the company. Now H was less dependent on her.

The other responsibility, besides being the process expert, was managing a recently formed team. One of the challenges she was facing with the team was similar to what she experienced in capstone: there was a person who had different ideas from the rest of the team. She preferred to work solo, she had been working solo most of her time at the company. Extending help to her was a challenge, and H was still in the process of trying to unify this team. Unlike in capstone, this person was actually blocking the team's progress, and did not want help at all. H felt that everyone there should be able to talk freely with one another, even though they were in different roles, because you couldn't have the teams not talking with each other, they were building the things that other teams were going to use. The team was not used to that. They had always been working separately. The challenges was to break down those roles and try to see how people could connect. Her explanation was that there was a sudden shift for this person, which made them more resistant to change. That's what her gut feeling was. They also weren't doing a product, which made priorities and motivations difficult to determine.

She didn't feel comfortable talking about it with the team because she was new. In senior design, she knew people. They were her friends and it was different to talk about it openly. At the company, she didn't want to create unnecessary tension by bringing it up directly. She didn't know if that was the best way. Even her manager agreed that she shouldn't be the one handling this alone. Her manager would talk to the resistant person's manager and think of ways around it. The team was quite new, so they should give it time before they took action.

One change for her is not having to know technical details. In meetings there is a lot of technical discussion and she has to make herself settle for a summary of the main points. She doesn't have the time, and there is too much information, to ingest and understand every single thing in detail. And she doesn't think she should be, in order to be effective in her job. She used to ask her manager for technical details, it was in her nature to be curious, but it wasn't possible for her here. It was letting go and knowing that she didn't have to know everything and that was fine. It helped to know, but the more important skill was to be able to adapt easily and learn things quickly. The most important thing was to be able to know how to get that information. Also, establishing good connections with your coworkers.

Still, in the beginning, it was hard for her to speak up in meetings and say what she really felt. It was kind of scary voicing her opinion in front of vice presidents. But at the same time she was slowly trying to do it when she thought it was necessary. And she was relying less on her manager, trying to do as much of it by herself as she could. Being put in that situation, being forced to lean on herself, made her more comfortable.

In the end, she feels her work is firmly on the management side, rather than engineering. She wasn't writing code. She wasn't building anything new. She did a lot of coordination, planning, and making sure she or the team could execute. But she could see herself writing scripts in the future to help automate certain processes. A engineering background in software did help her do her job a little better.

H's 8-Month

Work can be pretty crazy sometimes. When things get crazy, it's either because the team finds new bugs, or they realize there's a new risk that they didn't account for, so they have to do additional tests. There are lots of moving pieces, and she needs to check them. If something breaks the team has to fix it right away. H is getting a lot better at anticipating what needs to get done, and planning and accounting for things that might be unforeseen. When something comes up, they do get off schedule, but only for one or two weeks, a reasonable amount of time.

H is still facilitating the work for the newly formed team, which is trying to serve the company's needs. Bringing the team together to have common goal has been challenging because of their different backgrounds, which range from engineering to customer success. They were originally put together because a manager thought the people would make a good team. They aren't treated like a typical Scrum team. There are pushes for them to become a Scrum team, to be more other teams in the company. And they want to be a scrum team, but at the same time, they don't want to be bound by all the product related processes, like documentation. Right now they do a lot of ad hoc requests, serving the company and other teams in ways which other teams don't have to do. That needs to be factored into their planning, and makes it harder to predict. They also don't necessarily have an end goal to unite the team, though she has been talking with people to come up with initiative goals, so the team can start prioritizing.

Being scrum master for the team is like being football coach. She doesn't run the show, she helps facilitate the show. It's her job to know what people are doing each day, and trying to [unblock] interdependencies among members within the team or outside of the team. Sometimes, they need engineering to help them out. She makes sure those things get done, so the team members can focus on doing their work. People think a scrum master is a manager, you want to enforce that Scrum master's not really about that. She might have a good idea about what is wrong with the team, and she can give

suggestions, but she has to try and get the team to bring that out, as opposed to her bringing it out, because it's not her place to do so. The team has lots of team dynamic issues, but they have managed to solve them by having a war-room session - getting everybody on the team to work on the same thing together for four days. They've seen good results, people making inside jokes, it's all very healthy. Even though it's very frustrating at times, it's important to keep a clear head, and look at things objectively, and try to understand another person's point of view. How you come across is very important, and she thinks she has been better at doing that now than in capstone. There she was more vocal initially - when someone said something, disagree or agree, very vocal instantly. She tried to encourage team members to speak up. Sometimes people don't have any ideas or don't make comments. Then, when they were silent, she would rush in, but she shouldn't do that. Doing better is not only a matter of letting someone finish what they're saying, but actively listening. She knew coming into work, her first reaction would be to be vocal and not to listen. So she has been telling herself to keep calm and just listen first. In part this comes from a common human need to feel liked. Of course, she wants to do well in the project, but she also wants to be liked by her team members. She wants the team to have a good project and work well with each other. So she thinks about her actions, tries to be very aware. It might be more natural for her to self-reflect like that. It's important to self-reflect. She's also very invested in the team. She cares about what she says and how that impacts the team. How could she not think about that in the moment?

The investment helps. Though, in school, it consumed her whole life. Right now, when she works, she has her work life. She also has things outside work. She has some separation, but the level of intensity is still the same.

Thinking about investment, there's another leader on the team, the product owner, and sometimes she feels that he is not as invested in this team, it's almost like an afterthought. Things like setting up priorities for the team, technically, by the book, are not the scrum master's duty. They are the product

owner's duty. But at the same time, she feels like she can take initiative and do those things. At the same time, she is aware that she really shouldn't, because if she continuously does that, the product owner won't learn how to do it, and will never do it. The other reason she shouldn't take that initiative is because it's rude to take over someone's work. But her habit, especially in school, has been to pick up the work, as long as it's done, because it's for the best. If it gets done, it's done, it doesn't matter who did it. But she realizes that she probably shouldn't have that mindset, because it does actually matter. Eventually, you have a million things to do, and you need to let that other person know how to do it. She has been restraining her need to do things for other people, and she is trying to figure out ways to help someone do their job without her doing it for them.

H's 13-Month

Since her last interview, *the company has undergone a huge reorg, shifting her roles, her managers. The company is trying to scale up, they're hiring a bunch of engineers, and they need people to help manage those teams.* And she is helping with that transition.

Her official title is project manager, but she is also now officially also Scrum master, she was just certified. As Scrum master she facilitates the Scrum process to enable teams to work better and more effectively. She sets up many meetings, unblocks the team whenever necessary, and helps the teams plan out their sprints. But if a team has a release scheduled, she also has to oversee that process, and make sure they get all the things done in time.

She is now on three Scrum teams, her old team which did support and ad hoc tasks, and two program development teams, Program 1 and Program 2. Program 1, that team works very well. It's one of the best teams she has been given; they work very well together. That team already had a lot of trust and good communication, so H didn't have to teach them much besides the Scrum process, and how the company does things. The second team needed more help.

Her being the first project manager at the company, she has an eye for the process, and she brought up a lot of issues and events to avoid delaying the process or impacting other teams in a negative way. So she does cross-functional team communication, and she has been conducting the weekly release meetings since day one.

The company was looking to have her only take on two teams. She would be phasing out of her old team, in the upcoming months, and they were hiring another person to fill her role, which scared her. She had gone into the team as Scrum master - her job was to facilitate, she should be a service leader, enabling them, empowering them. I didn't know how much pushing they needed. It was hard, because the feedback that she received about the team from her new manager was that "the team really sucks" and that she had to do better, without giving her clear guidance on what to do besides "whip them into shape." It was frustrating on multiple levels. It was her personal belief that being stern and forcing people to do things, whipping them into shape, would not have a long-lasting effect. It had been hard for her to do something she didn't personally believe in. It was also frustrating that the improvements to the team were not being recognized. Even though they weren't people who would self-start or take initiative, they could produce with the right pushing and guidance. She was really happy with the team's performance after they met a recent deadline. Since being told that "the team sucks" they had met all their milestones, done all of their testing on time. They showed good progress.

A lot of the progress was made by over-communicating. Their sprint goals, for instance, what their goal or mission for the week was. Communicating every day about what the team should be focused on created an urgency that they didn't have before. If they were not keeping up, she would question them about it. If she couldn't see important conversations happening, she would ask to be included in them. And she also was supposed to shield the team from external requests which could distract them.

She had a choice to decide which teams she wanted to be on. It was a really, really hard decision, but she chose two new teams, rather than one new with her one old. Her biggest reason for not continuing

was because she felt that the mindset of the team sucking had already been built into management, despite their progress, and they would eventually associate her with the team. Even if they kept improving, she didn't know how much it would take for her to leave a good impression.

Program 3 was where all the machine learning algorithms were. She spent lots of time talking to the team members, going to their meetings, seeing how the team operated. The machine learning tended to be a lot more work, so if she took on that role, she would have to be really good at helping the team break down all their projects into milestones and tasks, into all the small chunks that they can work on and ship, piece by piece. She decided not to do that, not because she was not up for the challenge, but she wanted to learn most about the company. Program 1 could provide that. She was most unfamiliar with that technology right now, so she decided to move to that team. They had a good reputation. They were very easygoing, easy to work with. She was pretty comfortable with the team, and knew them really well. The program also released faster compared to program 3, which was good for visibility within the company.

The second team hadn't formed yet. So she had no thoughts about it. The teammates used to be on the quiet side, not really wanting to contribute, but she did have experience with her old team being the same way.

In management between the teams, she doesn't talk as much to her old manager anymore, they have a new mid-manager; she reports to him now. The weird part is there's very little communication. If there are issues or a meeting needs to be called, it's up to people on her level to bring it up or ask questions. Sometimes she feels like managers don't communicate downstream as much as they should. She suspects she should be training someone who is joining Program 1, but she has been given no training or expectation on what to tell this person. Even phasing out her old team, nobody told the team that this was coming. As far as she knows, it was just her who told them that they might be getting a new Scrum master. Easing them into it is important, and she can't imagine what it would be like if she didn't say

anything. It would be a total shock, and they would be left with an email saying “someone new is going to start on Monday.”

People before profit was important, because teams needed to have psychological safety. They needed to be safe in expressing themselves within the team, and they had to be able to work well with one another.

If there was too much process, those things can be inhibited, and it doesn't benefit the team and their productivity. There are many parts to psychological safety, but one is asking people for how they feel.

No one asked the team for their opinion. Things like that can slowly build.

She doesn't know if her new manager has noticed these things, but she sees a lot to improve. They did all these trainings, and at the end of the day, the takeaway message is that all these Scrum frameworks were just one example of a way you could do things. A way you can put team to work, efficiently and better. Not the only way. This issue came up when executive management attended one of her meetings.

They saw that she was used a tool to track the teams progress other than the one that prescribed. They looked at it and said, "Oh my gosh." He made such a big deal out of it. If it was a problem, it's something that should have been brought up earlier, something they should have known about early on.

But there isn't any dialogue around that. She could say something, but she doesn't feel she would be heard. When they were hiring the new manager, her feedback was included, and she felt he was lacking in communication skills. She told her manager that someone could be very experienced, but if they didn't have good communication skills to motivate, sync up, and unify a team, there was no point.

Maybe she would be heard, but whether there would be any impact, she didn't know. That was fine, because sometimes things took a while to roll out, and some things were easier fixes. She had seen changes before, which is why she liked her old manager. Some problems were cultural they took time.

But as far as she knew, her old manager was working on it, or had plans to work on it.

This week had also been rough because her friend, Jennifer, had been thinking of leaving the company. She and H had been there since day one, but her friend was leaving for two reasons. One was compensation. Jennifer felt like she wasn't being compensated enough. Second was that Jennifer felt like she couldn't grow in the company. She wanted a mentoring position, but their manager felt like she was not ready for that, and the company didn't have the bandwidth, because there were other needs in the company right now, like supporting all the documentation. Until they hired more people, which is what they were doing, then maybe she would consider doing some of the more busywork. Their manager told H that Jennifer wasn't being specific enough about her wants. So H didn't know how well the company's predicament was communicated by their manager to Jennifer, nor how much Jennifer had communicated what she really wanted. H didn't know what was really happening. But it seemed like Jennifer felt like she wasn't being heard. But she might not have been very explicit about what she wanted.

H was worried because they were hiring a lot, and hiring people wasn't necessarily the solution. They needed to fix their problems and then scale up, because if they don't fix their own problems and then scaled, they were only going to scale their problems. Maybe it wasn't as bad as it seemed. But that's how she felt where they needed to be. She has been most demotivated this quarter, more than she had been before at the company. She had been at her lowest point. She has times where she stresses; she doesn't know why she's doing what she's doing. She didn't know if she was making impact now, of the kind she used to. It seems like she has had less responsibility, but at the same time more. The things she liked doing, she was doing less of. She was doing more of things she didn't want to do. But she didn't necessarily have a choice.

J's Narrative

J's Exit

J's capstone project involved a lot of CAD. When the project started out, only half of the four-person team knew CAD, including her, and it was up to them to teach the other half. The project also involved close contact with their liaison, multiple meetings per week and ongoing email exchanges, to get more information about the technical aspects of the project - *missing dimensions* in drawings or ranges of acceptable movement for the product. While they were originally supposed to turn in a 3D model of their final concept, by the end the team *didn't see the point in it*, so they decided not to do it. *Their liaison agreed: "Yeah I don't think you're time would be best spent with this."* Instead *they gave them the full report of what they did, any FEA results and drawings of the concepts they generated.* In the end, the project turned out well. *They did the best they could with the resources they had. And their liaison didn't seem to have a problem with it*

At J's university, the practice for Capstone was to rotate who the team leader was with each season. J *was the guinea pig and was the leader for the first quarter.* She *didn't consider herself a natural born leader*, and it was out of *her comfort zone* to do so, but she *was learning to step up for the team*, and *none of her team-members wanted to be first, either.* Her time in the role did help her gain some leadership skills, being clear about specific tasks and their deadlines, and delegating those tasks. But reflecting on her experiences, she felt she was *a little too much of a pushover.*

If she could have changed something about the beginning of the project, she would have been more *stern and assertive about certain deadlines the team needed to meet.* She was the kind of person to *give people the benefit of the doubt - everyone who gave her a reason to push back deadlines had a legitimate reason.* On the other hand, there was other team behaviors that *frustrated* her – people didn't seem to consider meetings to be a *good use of time* while she was leading, and they would cut meetings

short. In one instance, she stepped out to go to the bathroom and came back to half her team gone.

They had decided to end the meeting without including her. She felt that more work could have been done with their time. Later in the semester, after coming back late from a site visit, the team got into a conflict when she insisted that the team had to work, but everyone was tired. She *let it be, didn't hold her ground, and they came to the consensus that it was better for everyone to get some sleep and be productive the next day.*

At the same time, she did think *her group worked well together*. They would resolve their conflicts *quickly and without jeopardizing our relationship as a group*. *Most of them were introverted, and just one of the four was extroverted, so they were often on the same page each other member worked and they were transparent with each other*. *If someone was overwhelmed with homework and was stressed out, they were all mindful of that person and what they were going through*. *And even if they did get into arguments, those were more because of the project and not because of individual conflict*.

Thinking about work, she knows she is going to need to be more *vocal and assertive about her presence*. Beside her capstone experiences, her internship the summer prior had also given her that feedback. *She I knew that she was a shy person, and it took her a lot to take up space, but she also knew that that was what the reality of work was going to be like, especially because she wanted to do mechanical engineering*. She knew that she was going to have to be *assertive in order to be recognized as a valued member of a team, especially if it was male-dominated* and the workplace would be *not as open to her being there*.

She felt like her capstone experience provided some help in that regard. She was now *able to pretend like she was comfortable in situations* like presentations. When her friends came to her class presentations, they would comment on how *poised and confident she sounded*, while she would admit that her *knees were shaking the whole time*. She also was starting to address her *speech quirk* of

“upspeak,” *ending sentences like she was asking a question*. Her professor made her more aware of it, so that she could sound more *confident and credible*.

Thinking about work, she is *nervous about being able to fit in with her group, given her experiences with her last internship*. She was with the mechanical engineers, and they were not open her being there. Even though the cubicles and floor plans were open, she was isolated. Being excluded from the entire team was hard, compared to her university experiences, where even if she was not close with someone she knew she could talk to them, and they would be more than happy to talk to her and make her feel included. And in part that asking for help is how she learned to survive at college. She had to get over that pride of needing to do things on her own. At the same time, employers like people who are self-sufficient and can teach themselves, but also not be arrogant about their skills. These things together, she felt it was important that you be willing to ask for help when you needed help, and people would recognize when you were trying to improve yourself.

She realized that it was not always going to be the case that she would have that help, especially because she is a woman and a woman of color. Isolation might happen more often than not. Finding those relationships and those mentorships within that company, whether or not they were directly in her area, would be important.

She had applied to a few jobs so far. One of her criteria, she was concerned with project variation. In her previous internship experience, the job was *repetitive*, and she was stuck with a lot of *paperwork*. She knows that if she gets bored within six months or so, that's not a job that she wants to be at. And her other criteria: she wanted to go back to the West Coast (where she was from), or at least somewhere sunnier. The cold weather had it's effect on you.

J's 4-Month

At her new company, J's job is more of a process manager position. She works very closely with the sales team. When they get a sales opportunity, *her and her team are the ones who design and provide customers with prototypes based on whatever they want. The turnaround time is quick. Her primary job is managing projects, making sure team members are doing things that progress the projects, making sure that the team is meeting deadlines, and making sure that everything is fully documented within the process.* More recently, her boss has been putting her in charge of scheduling projects and coordinating with other departments, *making sure that they're well fed with information so that they can also do their job.*

When she decided to study engineering, she had a certain idea of what a career would be like, and she told her professors that she didn't want to be a project manager. But here she was doing that very thing, which she did not consider engineering. She had had a hard time finding a job after graduation, and she had secured the position through networking hoping to gain knowledge and grow as an individual that same way she did when she led in capstone.

In her first three months she hadn't had anything she would call training beyond an orientation. She didn't have much prior knowledge on the technical subjects. *Her boss would occasionally pull her aside to show her how he calculated various things, and he also had been very patient with her in her slow progression of figuring things out. She usually would try looking things up on the internet, though there weren't many resources for the specific work they were doing.*

While people on her team have been helpful, lately she has been experiencing a *tension* of needing to deal with people from other departments, and their *territory, more diplomatically.* She was frustrated because, while these other parties probably *understood what her position* was about, *they don't seem to know what her group does* as a whole, nor do they *know the value they add to the company.* The team has had miscellaneous and *random work dumped on them* that they aren't *responsible for.* They were

given work that *was not a priority*, and people would get *upset that it wasn't getting done*. She has been the *face of that frustration* in communicating with other departments, but she also *doesn't necessarily have the authority to handle these issues*, and often defers to her executive to find a win-win solution between multiple departments.

These situations sometimes upset her. Usually she will *step away and try to compose herself and then respond in a more diplomatic way*. *There's no reason for things to escalate because it's not helpful for anyone*. She has needed to make sure that their communication was inciting progress instead of placing blame.

In a recent situation, she was trying to help a different team ship a product, and because she had experience with the customer they were dealing with, she knew they should include coupons with the products to keep the customer happy. She intervened and made sure they were included, but she had a dispute with coworker who was reluctant in sending out the parts. In the end they needed to ship it out the way she suggested, regardless. She considered the situation a win because, even though there was still a little *tension* between her and the reluctant coworker, the company had a *positive interaction with the customer*, and it *benefited the company*.

To her it is *ironic, but she finds that assertiveness doesn't necessarily work* as an approach to dealing with people here. The *passive approach, being more open to negotiation*, is something she has carried over from capstone, *and people seem to appreciate that more, as opposed to forcing things on them*.

It's very different working with teams of mostly male engineers. She expects that *they were more used to people forcing things on them, and they appreciate* someone who will actually understand what their other obligations are. She remembers one instance where she needed a part made by the one engineer who knew how to build it. He was frustrated because he wasn't getting support from other departments. She asked him *"Have you received the help that you need?"* He told her how frustrated he was, and she said *"I'm sorry that neither I nor anyone else have been able to provide the help you need. I'm going to*

make sure that you get what you need and that this can be done. I understand that you've been putting a lot of work into it and I appreciate the work that you've been doing." He seemed to appreciate that compassion and understand that she was there to help. *She had always been taught to be compassionate, and it might be that women are expected to be more compassionate, and men are expected to be more authoritative. Compassion might be so appreciated because there aren't very many female engineers. And being of the youngest people in the company might also have helped people react to her differently.*

Her advice to newcomer engineers is to *not lose yourself because of the environment that you're in. Make sure that you stay genuine to yourself even if there are external factors that are trying to mold you into something else.* It's hard to balance with her *willingness to learn and receive feedback*, but as she deals with so many conflicts, she is *making sure she maintains the compassion that she came in with and doesn't become a bitter person. That's not who she is.* She's also been getting a little burnt out, *working at a startup company*, so she *recommends prioritizing and taking care of yourself* as well.

J's 7-Month

Work has shifted in a few ways in the past 3 months. *J's already small team has gotten smaller, because one of her team-members quit*, and that increased her work a little bit, as the team has had to make up for that. J also has been doing more technical work, like data analysis, in addition to her managerial work.

Her *team members don't have enough confidence in her to let her actually build yet*, but she reviews their work. Before it was through looking at drawings and schematics, but now it is occasionally through physical tests, for instance making sure a part is connected to the right pins. She has been learning a lot more about how the systems work, she has needed to in order to analyze the data, and *it's been nice.* She has also been doing more technical documentation, and presentations for customers, and those tasks also require technical knowledge of the system - *genuine understanding*, rather than

regurgitation. Other teams even seem to be following the example that she set by being a *stickler* for technical documentation.

With an even smaller team, she and her team members have needed to be versatile in what their roles and tasks are. There are two team members with higher positions, so that leaves her and one other engineer to do the bills and data analysis. In this position, it's important for her to be able to do some of what her peer does in the event that he is temporarily out of work. Her boss also has been grooming them to understand the systems well enough to be self-sufficient, to not rely on other teams.

Other departments also seem to be relying more on her knowledge for their own work. She has had multiple people ask for her help navigating some of the systems. *It seems as though the departments are so ingrained into what they're doing, where the structural team will only know how to do structures, and so on. They're so closed off into their own little world, that they don't understand how everything's put together.*

Even though they rely on her, there are still *heated arguments*, and misinterpreted emails. Her boss has told her to *document everything*, so that *words aren't twisted*, so that it's not a "*he said, she said*" *situation*. Other departments seem to be struggling to understand what her team does, and they *don't value their work*. *People didn't understand that the prototypes the team builds are revenue – clients pay for them, the team doesn't give them out for free. It becomes frustrating, demoralizing, when you have to constantly validate your existence. She thinks there are still a lot of people who don't understand and question the existence of her team, but now that there are people who are involved with production of the prototype, they do seem to understand the knowledge the team has, and the work it takes to produce the prototypes in a short amount of time.*

Her and her team members are all a little *burnt out*. *Some of the team tries to leave work at a reasonable time, and if they don't leave at a reasonable time, it's for a justified reason.* She also feels

that some of the burn out *is her fault, she has vacation time that she should be using, but she doesn't*. It might be because she is *still in the college mentality, where she expects breaks to align themselves*. And if a team member is out for something like paternity leave, *she feels obligated to stay so that her other team members don't suffer extra work for a couple days. She still needs to work on allowing herself time for herself*, and she might take a couple of days off once her teammate comes back from leave.

Another thing, her coworkers are definitely not “PC.” Certain topics might not be appropriate for work, but she is aware of how political climates impact her *coworkers*, and how her college experience has impacted her. *She has had to address herself in order to fit the company culture*. In college, *her and her friends were more conscious of how certain jokes affected people in her communities*. At work, she occasionally hears racist jokes, and recently a coworker called her “sensitive” after a debate over her wanting to be referred to as Latina rather than Hispanic.

She wishes she learned better how to be an *advocate for herself*. *There's one other Latina engineer at the company*, and there are *a lot of women in traditional roles*, but *there are few women in the actual science and nitty gritty part of building their systems*. She has been encouraging the company to recruit more women. When she tells friends about the situation, they are *shocked to hear it*. Maybe they could have used a *dose of reality*, in school, rather than *sugar coating* things. Because the reality is, even with *more diverse people*, there are still *issues to iron out*, and *it can be difficult to work in a predominately white and male workforce*. She could have benefitted from learning how to advocate for herself and for others.

Her advice for newcomers has shifted slightly; *be true to who you are as an individual, and prioritize yourself over the company you work with. If something is impacting you negatively, address it and be proactive about changing that*. For example, if you have a *bad work life balance*, *communicate that with your boss and be proactive about making sure that balance is met. You can also give yourself*

positive affirmations – even if people are not verbalizing what they appreciate about you and your work, if you're putting out good work, if you're showing progression, people do recognize that.

In part the advice about prioritizing yourself over the company comes from seeing her coworkers. A lot of her coworkers come from “big name” tech companies, and they display a *blind loyalty to those companies, prioritize the company before themselves, when that loyalty may not be reciprocated. It's important to not follow a company in a cultish manner.* Many of her coworkers suggest that engineers should do things the Elon Musk way, *which means absolutely nothing to her.* Sometimes it might be appropriate to use another company as a model, but *sometimes that model should be questioned. There's an unquestioned devotion for a company that they don't necessarily work with but they still admire.* One of her coworkers who agreed with J put it in a harsh way, *“loyalty doesn't necessarily pay the bills, and loyalty doesn't necessarily take care of you.”*

J's 12-Month

J's boss is going to leave the company at the end of this week. They have already hired someone to fill in and help the *flow within the team*, so the work will be *manageable.* Her *biggest concern about her boss leaving was that he was good at communicating within her team, keeping them aware of what was going on at the company.* She is *worried* that without him, *information won't trickle down to the team.*

Her boss gave a few reasons for leaving. For one, there are *still work balance issues*, and he has been *sacrificing his life* for work. Another reason is that the decisions the company is making are *contradicting his morality.* The CEO of the company is a *go-getter*, who *promises customers the world* without *thinking about whether or not projects are actually feasible.* They often make these promises, such as short production times, to customers *without having conversations* with the other company members in the room. And these promises have put a *strain on the actual employees*, especially as the company *hasn't been doing very well*, and is *having difficulty purchasing materials.* Ultimately it looks

poorly on her team if something is promised and the team must admit they cannot fulfil the promise.

They come out looking like the bad guy in the whole situation

The false promises also extend to the mission of the company. J was *motivated* to her work by the company's environmentally related mission, and its philanthropic work. She was committed to the *bigger picture*, but now *she doesn't know if it is true anymore*, and she's not sure if the philanthropic work *is still happening*. The company is starting to *stretch itself thin*, and *dabble* in projects outside of that bigger picture, and it *makes her uncomfortable*. To her, *that lack of focus will create projects that the company is not prepared for, stretching people beyond their limits*. The company *should at least focus on what they say they are good at*. It is ultimately an issue of *honesty*.

She would like to see the focus of the company change, but she unfortunately doesn't have that power to change it. It seems *the only way to influence that change of focus would be through the sales team, because her team are worker bees for the sales team, who does all the client interactions*.

These difficulties aside, *her boss and her supervisor are pleased with her work*. It seems the *initiative she has been putting into creating documentation and organization processes* has paid off, because other teams don't have that kind of documentation. Especially for her team, they go through so many projects, and when someone asks them for intimate details about the project, it is hard for them to remember. *It's nice to have a page of information to refer them to. It's also nice to be able to direct people to information while they continue to work on their own projects*.

Another accomplishment of hers is that she has a better *understanding of their systems technically*. *She can have conversations with the other engineering teams and understand what they're talking about*.

This is partly because her supervisor has given her more data analysis and test plan creation tasks. She has been put in the position where she needed to understand the systems deeply. She now considers herself an engineer. And she is also *aware of things that she needs to improve on*.

Even if her boss and supervisor recognize her efforts, *a lot of people don't take her requests very seriously, because she is one of the younger employees and also a female.* Sending out emails, talking to people, putting up signs not to take certain equipment, people seem to brush her aside. Since she doesn't have the power to enforce her requests, she has to lean on her boss in order to have her concerns taken seriously. She was *frustrated for a while*, and has taken to *reassuring herself that she does deserve to be heard - just because other people don't listen doesn't make her less valuable as a person.*

It's trying to advocate for herself. Her boss was one of her biggest advocates, and now he is leaving. She still feels like she needs to work on being *assertive, figure out a way to make sure things are done and her concerns are listened to without him being here.* And in the case of her upcoming promotion or raise, her supervisor and boss handed the decision over to HR, keeping her out of the loop. She doesn't *know if it's a promotion or if it's a salary compensation.* And it's harder for her to negotiate for something better. She has heard a lot of issues of people getting unfair raises. *The company does try to create a better work environment by having potlucks and trying to keep up rapport but in terms of treating their employees fairly, the conversations that she's had about raises doesn't give that impression.*

What it would take for her to quit would be if her supervisor also quit, because even though she personally feels like the company's in disarray, her supervisor and her current boss have been good at keeping their team grounded and watching things. They are the naysayers - if their CEO makes unreasonable promises, her boss and her supervisor have always been the ones to point out how ridiculous it is, and to suggest changing timelines. If both of them were gone she and her team would be at the disposal of those requests, which would be unhealthy and overwhelming for her to take on, even if her team was kept together, and that's a big if. If her team was dispersed, she would also be unsure about how she would mesh with other teams.

J's 21-Month

A few weeks ago, there was an incident demonstrating a prototype that put her *immediate co-workers lives at risk*, and *broke* the prototype which had taken them almost a year to build.

The customer had been putting pressure on the company to do destructive testing of the prototype. She and her team kept pushing back on the customer interfacing employee, advising them to explain to the customer why they didn't want to run those tests. That input was completely ignored. Right before shipping, someone made the executive decision to change the test without any prior planning. The device immediately failed, and her team members put their lives at risk to deescalate the situation, which was overwhelming and upsetting. And it could have been worse, and it's quite possible that she and her team were exposed to substances that were hazardous to their health.

It's hard to assist in remedying this issue when it wasn't an issue, it wasn't a problem that her team created. Big egos had gotten in the way. Decisions were being made by people who may have not had the knowledge to make those decisions, because they were hoping to bring in revenue to the company. This is something she has been trying to grapple with. In her mind they are supposed to be working as a team, but it is clear to her that that isn't how the company sees them. The incident has made her weary of trusting my other coworkers and their teams. It has changed her perspective and her trust for the rest of the company.

The other thing that *broke her trust*: there was a *huge layoff* a few months ago that *included the majority of the engineers*. It was *traumatic* – one *Sunday morning* her coworkers got a call letting them know that they were no longer working at the company. *It has ruined morale at the company and made everyone feel like they are dispensable, not valued. Those people were working diligently in order to provide a viable product, and they were easily disposed of. And that doesn't sit well with her.*

It seems that *it's still about money*. The company is constantly trying to pursue money, that is what causes costly mistakes like the prototype failure. And she understands the reason for the pursuit of money, the company blows through money as if were candy. As if they have money. They are desperately trying to use that money because the company doesn't have any. The company has been incurring a net negative because its products haven't been selling well. And so they have been pursuing all these opportunities and at the cost of their own company, in order to gain opportunities that they've never closed out. They just got some money through a partnership, and they immediately blew through it paying off debts to suppliers that don't trust the company. She understands the logic, but at the same time, she thinks there still needs to be diligence about doing our work well, not out of desperation. Things haven't gotten better over time, unfortunately.

She has also had more confrontations with coworkers and they were not pleasant. There was a lot of throwing each other under the bus. She thinks of herself as someone who will admit it if she has done something wrong. And if she doesn't know how to fix it, she will ask for help as she tries to fix it. A lot of people at the company resort to pointing fingers instead of trying to resolve the issue at hand. She receives a lot of the "feedback" that people have for her team, whether it's helpful or not – including the snarky comments from other teams. There is a lot of anger. She feels that anger is fine, it just needs to be productive, and it's not productive. It's in her nature to try to give people the benefit of the doubt, but if they don't want to work with her in resolving an issue, then there's nothing she can do.

Having to deal with all these company politics has become draining. And with the recent incident she had started looking for a new job. That was the straw that broke the camel's back. Her morale was completely gone, and her trust was broken. She didn't think there was a future at the company anymore. Their team still works well together, and she is grateful for that because they are still able to all laugh about their frustrating situation later. She still has her team, and they still have a strong bond with each other. That said, she does suspect that her boss is not going to be at the company very long. He

has given some signs that he is going to leave, and he's getting less involved in projects. Her concern is knowing that she no longer trusts her other coworkers, doesn't know how their teams operate, she wouldn't feel comfortable being put on another team. She doesn't want to become basically a glorified secretary, which is what a lot of other people think she is.

After almost two years of working here, it's frustrating that she still has to explain to others what she does, how much work she and her team does. She has had to explain to them that she has been building the prototype, coordinating between multiple departments, and creating documents to track everything. And they think that she just writes notes, attends meetings, essentially sits around and does nothing. She often heard how people are surprised hear that she does all the work she does. She doesn't need recognition, she just wants people to understand that what she does is a contribution to the company. It sucks to not be valued, especially when she might be one of the only sources of revenue for the company.

In line with that lack of recognition, there are many instances of mansplaining. A lot of people don't realize she has an engineering degree. In one instance, her coworker wouldn't take her at her word that she understood very basic thermodynamics. They assume she doesn't know anything. Sometimes she is assigned the task of taking notes that never get followed up on. It is frustrating and degrading, because she wants to do so much more, but she isn't given that opportunity because people don't realize that she has a technical background. They push her aside. She has reverted back to helping her team only.

Having a degree shouldn't be relevant – she has met employees in the sales department who are technically well versed, but don't have a technical background. She believes that you shouldn't assume that people don't know anything just because they don't have a technical background. But if people knew that she had a degree, they wouldn't talk to her the ways that they usually do. She thinks to herself "Had I been a male coworker, he probably wouldn't have been talking to me the same

way." And she asks, *why can't she be treated as an equal here? Why can't they think that she is capable of understanding these things?*

People seem to *see her as a child. Everyone else is older than she is, and they're males.* In the lunchroom she *talks to the people who work as technicians. The people who work in the cleaning staff, those are the people she talks to because they look like her. And they understand her. She feels like they're proud of her for being a representative of their people in a higher position. When she talks to the other male engineers there are no similarities. It's usually a very short conversation, or it's always about work, and she tries not to talk about work when she's on break. She has to seek out people to talk to, because not everyone here is that friendly as they appear to be. She misses her college, being surrounded by women, or at least a couple of women. She misses being around people that in some ways look like her.*

K's Narrative

K's Exit

In picking his senior design project, K *wanted to work on something related to automotive.* Then he learned about the project he ended up picking. *It was everything he wanted to do – mechatronics, autonomous systems. It was supposed to be a mechanical engineering project, but there was a heavy focus on software,* as he found out.

Being able to get the software to work the way they wanted it to sometimes hindered the team. The Sponsors for the project wanted them to come up with procedures, as well as hardware and software necessary to accomplish the ultimate goal. They ended up building software to be able to control their machines, and came up with some hardware to support the project. They came up with an operations document which outlined everything about their system, and they described their journey, how they got

to where they did, how they arrived at their design decisions, what worked well for them and what didn't.

Things didn't go exactly the way they wanted, but the clients were happy. They were a little bit disappointed when the teams demo didn't work, but they were satisfied with how far the team got with their operations document, and everything they had found, and all the information they had to present.

K was officially the communications manager, his second preference, but most people seemed to have a first preference of project manager (including him), and no-one was vying for the communications role, and he thought he could help. In his role, he was supposed to handle all of their communication with the clients, directors, and the instructors of the course. He sent a lot of emails, did a lot of logistics. He organized meeting rooms. He just made sure that the teams had all the resources that they needed.

In addition, he did a lot of coding himself. He was one of the people on the team that had a computer science minor, so he was familiar with software, and he had just taken a class in algorithms. He ended up implementing one of those algorithms during this project.

He learned from the project that over communication was actually just enough communication. You had to make sure everyone's in the loop. You also had to acknowledge that everyone has different form of communication, or referred communication method, and they had different quirks and preferences in the type of information that they want to communicate, media, but also the content of what was said.

Communication also meant understanding other people's motivations and other people's wants and needs in communicating.

The most valuable thing was communication. In a variety of media, with a variety of people, at different levels, was useful both in your professional and in your personal life, whether it was engineering or business or law. Communication was one of the key elements to success in any industry. It meant being collaborative, making sure you didn't hurt anyone's feelings, that you acknowledged people and made

them feel heard. When the team was demoralized, both he and the project manager had to encourage the team to have a positive attitude and remind them of the aspects of their project that were going well.

He also learned that you had to start early in your design process, and expect to fail fast. With their project, since there was such a heavy focus on software, they should have probably applied a software design methodology as opposed to a mechanical design methodology. With a mechanical design, you do a whole lot of planning in the first semester, come up with deliverables, prototypes, and have a refined design. Then you start manufacturing, and then building, and then come up with more solidified prototypes and have your final design at the end. But, with software, you should probably have a two-week turnaround, where you try and get everything done, or at least one portion of the project done, then see what works and what doesn't.

The biggest challenge was figuring out what to do. At the beginning of the year, their clients gave the team a vague idea of what they wanted, and left the rest is up to them. They had to come up with their own specifications and requirements. If they wanted to implement the design in the real world, what were the metrics that it should meet? What should it live up to? They had to not only design the hardware and software, they had to design the requirements of the project to take on.

He would have liked some guidance on how to navigate conflict with managers. They had some disagreement about the strategies being used by their faculty director, and the design decisions that he was pushing for. The way they resolved it was by informing other parties, like the client, and having them deal with their manager. He would like to have had more experience being firm with a manager or someone at a higher level.

In two weeks he'll be starting work at a large automotive company as a software developer. It's not his major. It's not mechanical engineering. It's a lot of business support. He's not exactly sure what team he'll be on, but he has a feeling it's CRM, Customer Relations Management, how to provide the support

needed for the customer to have a good experience once they have bought a car. He thinks it will involve maintenance...but he doesn't know very many details of the job. His expectations are shaped by one of his previous internships, where he sifted through data, generated reports based on that data, and automated it so the higher ups could make more decisions about what they wanted to do with the data. The skills would be software development, having a technical mindset, and being able to efficiently work in the software design lifecycle: having a two-week turnaround. He's heard the word "agile" used a lot. He doesn't know all of the details about that, but they will want him to work in that agile environment and collaborate with others to be able to produce efficient code. The interviewer for the job didn't ask him anything about them, but it would have been nice to know the agile software development design methodologies for his project, since his project was focused on software development, and since he would be using those methodologies at work.

He was excited about the opportunities available to him in the job. It was a big company and he was going into software. It was exactly what he wanted to do, because he would get a lot of real world experience with software, coding. It would open up the whole career path of software development for him, officially, so he could probably go the software development route. He could also move around in the company and go the mechanical engineering route. And of course, there was the business sector and management. Maybe in 10 years he might want to move into management. The company also did work with autonomous vehicles, which was appealing to him. There were a lot of opportunities and he was ready.

He was nervous about workplace etiquette and fitting in, watching the way he spoke. The course had been helpful in practicing communication and interacting with clients, and the instructors had presented the class with professionalism and workplace etiquette tips, but he was still nervous about fitting in, saying things he wasn't supposed to and making people feel uncomfortable. He wanted to make sure he did it right.

K's 3-Month

K's first two weeks of work were a little tedious. There was computer-based training he had to take care of. Those courses brushed over agile software development and object-oriented design, things he would have learned in school if he had taken those classes. The classes were useful, but internalizing the information based on computer training, without a project to work on, was hard. There wasn't a lot of work to do, so he had to show some initiative and come up his own tasks. He kept in communication with his managers about his struggles of not being able to do anything, until the work did come. His official training period ended only 3-months in.

Coming in to work, there were some things he didn't know. For instance, his video trainings discussed the format of meetings, which left specific technical questions for the end of the meeting, in the "parking lot," but in one meeting he went into a lot of detail with a question, and took up meeting time. Afterward, someone told him he could save that question for later. He didn't learn the details of meeting format until he put it into practice. Doing things hands on gave him the most helpful experiences. Reflecting on that, what was important for work was to be prepared to learn, not necessarily through videos or classes, but through working, learning from mistakes and experiences.

Compared to his design course, where they came up with their own design requirements, at work you couldn't. At work, there was more back and forth if something went wrong, or if something deviated from the original intention. They would have to meet and figure out what the desired result was and compare that to what they had. Having rigid requirements would have helped in school. Nine times out of ten, a new college hire wasn't going to be working on some innovative technology. They would gradually be introduced to that level. A newcomer would probably be given rigid requirements to design their work around. The requirements were more unchanging than in senior design. They were business driven and user driven - the clients gave you requirements, and the only feedback you gave was what was possible and what was not possible.

He was on a temporary project which would eventually lead to his main project, the one he was hired for. The team he was on was located mostly in another city, so working involved constant video and phone calls. It was challenging because he was the only one in his office performing a role crucial to the team, there was a steep learning curve, but it was a good experience. He had just come back from an in person visit from their office, which was vastly different from a phone call interaction. You could be less formal and communicate through body language. You didn't have to think as hard about your words. You could focus more on your tone and facial expressions to cater to other people's feelings. Capstone had helped him with professional courtesies and etiquette, and at work it was commonplace. Thinking about his team he thought of himself as people oriented as opposed to task oriented. He noticed there were people who could come off as rude, mean or combative. But capstone made him realize that they might not be doing it on purpose. That was just their inclination. They were task oriented, and not necessarily people oriented.

His first two weeks he sat next to two new college hires on his team. They had slacked off. They would watch Bob Ross videos if they had nothing to do. They had just started video based training, but they would skip all the videos and take the test at the end, so they were done in two or three days, whereas he watched the videos and took a week to finish, though he was still on time.

He took more initiative than they did. He was more available, proactive and curious. He asked lots of questions, talked to people about his work. He was increasing his visibility. That was something he had done naturally, just following his interests and asking people. He also took a lot more notes. He had notebooks and whiteboards, and he took full use of the resources available to him. Compared to him, the other college hires weren't as visible and they weren't as proactive, and he could feel his other team members making comparisons in their heads between him and the other college hires.

There was a *sensitive* college hire, who didn't receive feedback well. When he was *confused* about something, a requirement he had been given, he didn't ask, wasn't proactive about clarifying what it meant. There was a situation where he heard two different things from two different people about a question he had, so he added his own thing, what he thought was right. He didn't do what either of the senior employees had said. When it funneled through K, he was confused, because the college hire had developed it one way and the requirement said something else. K talked to him about it. He had made a third option that made it even harder. He didn't try to bridge the gap and get everyone talking to come to a joint conclusion. That particular new college hire wasn't used to laying the groundwork for team success, so K sent out an email to everyone that had stakes in that piece of software. When he sent out that joint email, everyone became aware of the problem and eventually they got it sorted.

Another new college hire he was working with was doing a lot more work too, he had increased his visibility also. It was good. It was fun working with them. It was good to be around people your age with a similar mindset. They were at similar stages in their lives, fresh out of college. They had a lot of similarities, so they worked better together on teams.

His division of the business was small and new, only a few years old, so it felt like a startup and there were a lot of young people working there. K could relate to people a lot more, and it was good environment to be in. Compared to other jobs, he had had situations where the senior employees were strict and conservative, a traditional professional environment. He also had experiences where the senior employees were very open and fun. On one hand, where it was too conservative you didn't have a lot of opportunity to thrive and have fun or enjoy working. On the other hand, where it was too fun loving, you didn't have enough opportunity to grow. What he liked about this environment was that there were young people that were laid back, they were down to earth, and they were also focused on growth. Work was laid back but people wouldn't dial back their expectations for you, and so you were expected to perform.

His advice to newcomers: *be ready to learn. To give it your all and be available as much as you can. Be able to do what was expected of you, and try to go beyond what was expected, because that would get you ahead, but also set you up for growth. People weren't there to help. The primary goal of people interacting with you in college was to help you grow and be ready for the future, whereas the primary goal of people interacting with each other in corporate America was to create value and generate revenue. Growth for college hires in the working world was second to creating value. The only reason you grew in the working world was because you were trying to create value, and you were expected to create value. That's why people were invested in you, because you had a lot of potential value to them. They were flexible and lenient, but they also had high expectations for you, and you had to be able to not take things personally. Don't be sensitive when someone tells you your work is wrong, it was all about creating value and putting feelings aside a little bit.*

It was also about being able to defend your position. It was easy to mention an idea you thought was kind of right, but you weren't 100% sure, but objectively speaking it was the right way to go. No one was going to act on that idea or implement it until you were confident in it.

And finally it was also important to take care of yourself outside of work, especially if you moved to new city like he did, and you didn't know anyone from that city. It was important to find things you could do, find friends and take care of your health, your emotional well being, and improve your performance at work. Going to sleep on time was important.

K's 7-Month

At work, things have been going well, and they have been ramping up. He has a few more responsibilities, and bigger challenges. He has been getting used to all the intricacies of communication on the job, even though he's not where he wants to be yet. There's some stress, which comes with the expectation that he deliver everything on time with the resources that he's given. Some

of these challenges he's never encountered before. He is still separated from his team members in another city. That group is where all the knowledge is, all of the expertise that he needs to do his job successfully. It's challenging to keep up the pace.

His main role has started, developing new software. There's no real blueprint or schematic for it. The goal is to do things the same way as it was before, but doing it in a new way, in-house, from scratch. That involves using software that isn't very common. Unlike before, the rest of his team are the testers of his code, and he is all by himself trying to explain it. Communicating over web conferencing or instant messaging is probably 80% of his day. It would be easier if they were face to face. He would have a constant stream of communication about why things were going wrong, as opposed to them having to ping him over text. He tries to put his inflection of voice into messages to convey his mood. He wants them to see it as positivity, but they could take it as something else. He has a lot of dry humor that doesn't necessarily translate over messages. His best bet has been sending gifs, though there isn't a seamless way to do that in the messages they send. He can tell that it is not only frustrating for him, it's also frustrating for other people, which is also frustrating for him. Sometimes a code will work on his systems after multiple tests, but will fail for his colleagues in the other city.

Originally he had the option to pick from four cities, and he chose his current one because it was closest to his family. He also didn't know that he would be on a team almost exclusively in another city. He didn't know what working would be like at all. He had assumed he would be working exclusively with people in his office, they made it sound like different locations were responsible for different aspects of the business, that it was more siloed, but it didn't turn out that way. He knew people were trying to move away from that.

The team in the other city were also mostly college hires, too, but they were close to experts they could interact with. That would be nice to have. But, looking back, he would probably not have chosen a different city, because despite the challenges, he saw it as a learning experience that helped him grow.

It was the time for him to learn, anyway, the beginning of his career. Plus, he was in a pretty nice city, and he did appreciate having his family nearby.

If he kept going this route, kept using his own proactiveness long enough to learn everything he needed by himself, and kept a positive attitude, he would become an expert. He was taking on more challenging projects, more challenging tasks. There was one a week ago: the team was planning their work for the next sprint of software development. The tasks were categorized as easy, medium, and challenging – the challenging tasks would lead the volunteer into uncharted waters. A manager had made templates of code, and all the developers had to customize the template to match a set of requirements depending on the task, with the hardest tasks being given the most stringent requirements. When he came to a task that he said was very challenging, K volunteered for that one. He chose that one subconsciously. He wanted to learn and he also wanted to impress his boss. Now he was having difficulties with that task and he was in over his head. He couldn't get the code to work. It was still a little bit beyond him, so he had to go to one of the experts. Ultimately, it was expected that you do that, at least sometimes. A lot of people on his team were doing it, too, going to the expert.

Still, he had grown in technical aptitude, as opposed to just understanding business processes. Instead of using a website to log how many hours he worked on a task he could write the code for it himself. He could create something new, innovate, take an undefined problem and bring a solution to it in a unique way. That was his technical aptitude. Responding to a problem was basically a matter of Googling things, trying to leverage your resources to be able to accomplish the task. In creating something unique or developing new code to solve a problem, there was a learning curve no matter what, which could be addressed with Googling.

He had more pressure on him to perform. Before his motivation was to get an A. Getting feedback at work was more implicit. You had to read people's signals, to figure out whether they approved of your work, or if they enjoyed working with you. And there was more at stake – you were expected to grow,

but you were also expected to perform well, and there were more consequences if you didn't. Now he was creating code that had to meet many requirements so people could market it to all of North America. That also included vehicle recalls, which were dangerous if they were left unchecked. That could potentially be a life-or-death situation, so that motivated him to dig deeper into the code and use more of his mind, his potential to learn what he was doing, as opposed to just taking it as was. The work could be innovative, and it could have a bigger impact, touching a lot of people. It could make a lot of lives easier, make things safer. Having a bigger impact was good in and of itself, but it also helped him achieve more.

One challenge he *encountered at work was disgruntled employees, people who were super negative all the time, who would ask "Why are we even here? Why are we working for corporate America? We're just a cog in the wheel."* That was different from anything that capstone prepared them for. *If there was an aspect of your company culture, where people were disillusioned, or they didn't agree with the policy or if they didn't feel valued as employees, that's a challenge he wasn't prepared for, dealing with those teammates.*

Some things *that could be detrimental to new college grads was that either they didn't understand the expectations of people about how much they should work, so they didn't show enough initiative or work enough, or they wouldn't communicate their needs or the work they had done well. Showing initiative and a positive attitude working, trying to go above and beyond, showing that you care, that was all important. Communicating well, showing what you know, not taking up loads of time, not confusing people, helping them understand you and what your goals were, what your strengths are, what your areas of growth would be, and trying to solve technical problem - communicating that was huge.*

It was also important for new college grads to know how to network, how to put themselves out there, be engaging, and cultivate relationships so that you could help yourself and others move forward.

People liked to help new college grads, at least if you were in the right environment.

K's 13-Month

Work was going okay. It was slowing down a little. He was getting to the point where it was becoming a little bit repetitive. The repetition came from the nature of his work. It was a lot of looking at code that other people had written, figuring out what it did, making sure it worked, and passing it along to the next people in the pipeline. All the code was similar, but he didn't think it was the type of work he could expect at the company as a whole. There was a learning curve, and learning curves slowed down as you went further. He had learned a lot technically, and he had been able to practice communication and other skills, but not as much as he would have liked.

What he wanted to do was write his own code. If was presented with a unique problem, not clearly defined, he would like to be able to write his own code and come up with his own solution. He'd also like to explain why his decisions saying why it worked, why it was valuable, why it was better than other solutions that he thought of, presenting that. Right now, he was looking at other people's solutions that they had already developed. It was code he didn't like looking at, because it didn't work very well. It wasn't his, so he didn't take pride in it. People had a very uniformed approach to problems, and they repeated it hundreds of times.

He wasn't getting as many formal presentations, or leadership opportunities. He wasn't in any decision making processes. He was just in meetings that were pretty much technical. He asked his manager a few weeks ago, if there were more opportunities to learn, and it came off like he was asking for more advanced leadership position, which didn't fit into the timeline for the college hire programs he was a part of. His manager said that it might be a better idea for him to wait, once you were promoted, the raises wouldn't happen as often. It wasn't really what he was looking for. He was looking for opportunities to grow, learn, and practice his skills. He wasn't being given those opportunities, so he was trying to create his own.

A lot of the people he was hired with, over the last year they had been in the same roles working on the same technologies. They hadn't been able to grow as much. K didn't know if that was unique to his company, or applied to the workforce in general. He was expecting that you'd be exposed to a lot of different stuff, you would be able to lead your own projects. Not yet, it seemed. The project he was hired to work on was still going after a year, and there were about six months left. Once that project was done, then he would have the opportunity to work on another project, and develop other skills. He could move iteratively from there, working on different technologies, exploring what he liked to do, and hopefully that would help develop his career development plan, whether he would find a specific technology that he really liked, become an expert and seek projects again and again, or he went into leadership. He could find out how he wanted to progress his career.

As he explored and got deeper into projects, he felt there was bigger decision making, more business-related, process-related decision making, that he wasn't part of. He had a very small sphere of control to make decisions. At a team level, he had the ability to make decisions, or at least provide input on some of the things that they should focus on. But a while ago someone else made a bigger decision that everybody would work on deliverable A first and then everybody would work on deliverable B. But he disagreed with that – He knew it was important to fail early and fast. The most amount of time on a project was given towards integration. Working on deliverables A, B and C at the same time was how he thought they should work. Ultimately, it would be more desirable for him to make some of those bigger decisions, guiding more people. maybe he wasn't quite ready for that yet, but being a leader might be part of the direction he wanted to go.

Aside from that, there were also decisions about what was worth the company's time to accomplish. He was practicing making those decisions with a separate but company sponsored organization that tackled innovation challenges. They would assess how viable different projects were and work on them. They had only just gotten started. What he expected was to see results after working on a project,

seeing how successful it was, how it might be integrated with the tools the company was already using, and then how much it saved cost, how valuable it was to the company. He was trying to lead those initiatives because the feelings he had were shared among people in his office, not that they were not satisfied with work, but they wanted more opportunities to learn, to grow, to practice their technical and presentation skills.

After school, society's expectation was for you to go into the working world. The expectation was that he had done all his learning. Now the nature of his life was to make money instead of pay money to develop himself. It was more about making money and doing what he wanted. Growth was not something that you focus on. He knew that he would have to grow, but he didn't think about how it would happen. It was something you didn't practice in school, creating your own career development structure, your own learning development plan.

His main goals were to learn new technologies. He felt good looking at code. He hadn't ever worked developing a website, so he would like to know that project structure, and how the technology worked. That was the same for any project, developing websites, developing apps, or whatever else.

The other thing was practicing his leadership, his soft skills. This was something the employee program involved, could help him with.

Those were the things he asked his manager, when he would have those opportunities. It was creating his own opportunities. He had noticed there were opportunities to automate some of the repetitive work he was doing. His idea was make that work faster. Those opportunities for automation came up once in a while. It wasn't assigned to him. It was just something he asked to do. It was probably his third opportunity to do it over last year.

He is hopeful for the future. He's glad to have those opportunities. Now that he works for a big company and his work is more monotonous, he's in the position to consider what he wants to do in five

years, ten years. Initiative is what you need to properly execute those plans. You need to initiate you opportunities.

He needs to work on following routine and staying committed to habits. He wants to learn a new language, take up new skills, floss every day. It strengthens who you are, your personality, because you set a goal for yourself and you want to achieve it. He has been learning more about what kind of person he is, now that he is on his own making on his own adult decisions, whether it's like talking to people or approaching his finances. He does wish that he was a more mature and more determined when he graduated college. He wishes that he had had more of an ability to define his life goals, and execute them, working around obstacles that might come up. He has noticed that other people are also similarly philosophical. Before, he didn't really get it, he thought, "Man, you are in such a great company and you just have to keep a positive attitude and always work as hard as you can, and you will be rewarded." Now he is in their shoes after a year, and he thinks it's okay to question where you are, and look at what you want out of life, if that helps you plan for the future. It's a skeptical attitude as opposed to a I'll-do-it-no-matter-what attitude.

He has been thinking about a job change. The primary reason was for moving closer to family, but it's also finding that environment where he can grow, where he can explore more, a more dynamic entry level position as opposed to working on one role, working on one thing, one technology.

L's Narrative

L's Exit

L had a *stressful* capstone experience, for a few reasons. For one, she was the communications director for the team of eight people, plus the capstone director, client, and multiple instructors. *That was a lot of people the team had to maneuver around. She wouldn't want to be project manager again – she'd*

probably *pick a smaller engineering role* next time. *She understands why they get paid more now. She thought it would be easy, just tell people what to do, but it was the hardest thing ever.* The whole team was inexperienced with project management, not to mention programming, so they were not good at *estimating the time for tasks. Things got pushed back, and then more things would get pushed back,* and a teammate might still be working on a task the team wasn't sure they needed. *Writing a pseudocode Managing her own time was okay takes maybe an hour, typing it out takes maybe two to three hours. Debugging takes three weeks, apparently. Who knew?*

It might *have been so hard because none of them were getting paid. There was no sense of respect for the project manager, because he was technically their colleague. Sometimes she would think "She was smarter than him. Why is he project manager?"* That said, she is unsure, the problem *might be even worse in the workplace.*

The other thing that made her experience stressful, being on the team *was an accident.* She initially intended on going for an architecture or civil project, but personal reasons and the logistics of the class forced her to be reassigned to another team that wasn't even *in her top five. Her team all had minor programming experiences from classes,* but besides one team member she didn't think any of them, including her, were actually interested in doing programming. *She didn't want this project,* but at least it was *over.*

They didn't have good cohesive teamwork that some other teams had. She was not too sure how they had handled the project. In the first semester, she was really stressed out, trying to fix her teammates mistakes, trying to follow their tasks. Towards the end, she changed her approach to *"I can't fix everything."* *She learned to either let it go, just let her teammate talk. She was the kind of person to say, "this is wrong but if you try to tell me it's not, well, okay, whatever."*

Looking back on the experience, *she knows that you don't have to be buddies with your teammates*, but you still need to *learn to be both respectful and professional with other people. It would be better if you were friends - if you like working with them, you'll get better results. But if you just hate the guts out of them, you can still learn to treat them like another individual and just 5 o'clock you clock out and then you don't talk to them ever again.*

She is looking forward to work, though. She really likes the field. *Working on buildings and getting to work with the architect themselves sounds exciting. It feels like the work actually makes a difference.* Creating energy audits could save the client *thousands of dollars*. What's *cool is getting the feedback* from the client showing whether or not their effort did decrease their energy bill and save them money. They could see if their bill was decreased by 10 or 20 percent – or they could see if their effort didn't really work, *and then they would have to go back and see why it only decreased that little amount.* It's one long project *that doesn't have a formal closing*. The client can keep asking for more of their work. Before she starts, she might be missing technical experience, especially regarding the CAD program they use. On the other hand, she does identify as someone who really likes theoretical stuff: heat transfer, fluids, and thermodynamics.

In general, although she is looking forward to the work, she sees her job as a steppingstone to a specific larger company that she is aiming for. This larger company has a history of complex *architectural designs and projects* that she is a fan of. *And they do a lot with acoustics and lighting. With an apartment, it's easy, you take the second level and you copy and paste for higher levels, but with these more complex buildings, everything has to be creative.* She doesn't see herself there even in five years, but that is eventually where she wants to end up.

L's 3-Month

L started in the middle of two-projects; they had already met the client, already laid some ground work. She didn't do any communication with the client, because she was as confused as the they were. She didn't know all of the inner workings of the company, yet. When she came in, she was drinking from a fire hose. There was a lot of common knowledge that she hadn't picked up in school, because she had been indecisive in her first two years and hadn't left room to take the specific civil or architectural classes. There were simple words and acronyms she didn't know, but her coworkers were accommodating. Like a lot of people hired as mechanical engineers, they didn't expect her to know all of these things, but they were patient in teaching her them. It was head-first, she would have questions, they would answer them, and then she would have more questions. Whenever she had time, or if it was lunchtime, she would go over drawings with co-workers, and come away from the hang outs with terms to look up on her own.

Her supervisor was accommodating too, he would tell her what to do, what to work on, and then if he saw that she was confused, wanting more information, if he had the time he would go in depth, maybe talking for an hour, even two hours.

That said, work is a lot more boring than L expected. While she liked doing energy engineering at her previous internship, she has figured out she likes the design aspect of the work more. In participating in these projects that have been going on for years, her current responsibilities involve auditing, fact-checking, making sure the client is satisfied and that they deliver on savings. Generally, that involves calculating the month-by-month energy costs for the buildings they are working on. She's also accompanied a few senior engineers on trips to interview building managers. The work also dealt a lot with the client. But as an entry-level engineer, she didn't deal with them at all. It would probably be very bad if a young engineer up-start pissed off a client.

During internships, her experience with energy engineering was very high-level, just barely brushing the surface, and as she got deeper, more detailed, it started getting tedious. When she started she was enthusiastic, but months later she was saying to herself, "This sucks. I just want to finish." At the beginning of work, she didn't feel like she was doing "engineering" work. She felt like she was an accountant, because it was a lot of Excel spreadsheets, and looking at the big picture, and looking at bar graphs. And it felt like she had the title "engineer," but nothing else.

Design engineering was more what people would think of as "engineering," looking at CAD drawings, designing things. It just felt more engineering-y. She would take her giant handbook, go through each appendix, looking at data points, or qualifications. "This kind of defuser defuses this much CFM, and this type of space at what speed. It ideally operates in this kind of area. And this is the price!" You compare it to five or six other ones. You have to do it for each individual room. It was detailed. It felt something more like an engineering class would do. Your client wants something cheap. But he wants something pretty, and he wants something for human comfort -- now optimize it - that made more sense to her. That felt like more of an engineer's work than looking at trend data over the last three years, and chugging out a report for the client. The things she was interested in didn't really apply to those reports.

But the company has been nice about letting her jump around for work, at least. They understand she is just starting out. She was not 100% certain with her career, so they even got her into commissioning, into construction, all different parts of the company. Around week seven, they finally said "Oh, wait! She likes design." Once she told them she didn't quite like the whole energy engineering experience, they hooked her up with one of the design engineers. That week she started talking with the energy engineering supervisor about how to design heat exchangers. They pulled out a handbook and went through the whole thing. She's been getting quite a bit of work from the design engineer, looking at

plans, measuring the duct size and the length of the duct for an HVAC system to get a feel for how big the pump should be.

In this work it was important to be able to handle ambiguity, *because nothing was going to be the way you want it, or the way you expect it to be. When you're working on a building, you want the most recent drawings in an up to date zip file for the whole building, no issues, and everything that's in the drawing is perfectly reflected in this building. But that was bullshit! She had gotten drawings with multiple floors missing, where the team would have to chase the drawings down, calling 5 different other people through archives to find the drawing themselves. It was out of their control - the sheets just weren't in the packet they found. They weren't given, and the team couldn't find them. But they had to make their best engineering assumptions, and move on.* Before senior design she was so hesitant to make those kinds of assumptions.

Even though she has been getting new tasks, and her supervisors have been teaching her more design things, *there aren't any open positions at the company for a design engineer. She is sick of doing energy engineering, and so she has been looking around at other companies. But she does like this company enough that, if given the option, she would go back to her current company if something was open.* She might go off to another company, get as much experience as she can from them, and then come back with a shiny PE and five years of experience. She feels this way in part because they have been so patient with her, and would regularly ask her how she her experience at the company was going. Another reason was because everyone seems genuinely just happy and relaxed there. *Her dad had told her to look at the break room. Because if the break room is just in a dark corner full of cockroaches, the company that you're working for doesn't care about employee breaks. And this one is really nice, everyone's invited to just take an hour off, go to the break room, have a coffee, talk to other people who are hanging out there. Go back to your work feeling a bit more refreshed.*

Another reason was that this company, especially for construction, is very strict about safety. Their commitments to safety was reflected in their work; *over the last few years, they've gotten less and less accidents, they inspect us and the sub-contractors. If they're being unsafe, we're not going to hire them again. Sometimes it was even a little annoying, because we would need a picture of this equipment, and She was saying, "Oh, why can't I just stand on this little box right here?" And they're like, "No, no, no! That's not a safe step ladder, because you can see it's deteriorating. Or you can see it's a little bit rusty, and we don't want you to fall face-first into this box, into this giant equipment." So sometimes, She was just like, "But ... okay, I guess, we're just going to come back tomorrow?" But she was glad to be at a company with those values.*

Comparing her experiences to capstone helped her recognize the *warning signs* of team dysfunction. How, before, on her capstone team, *no one was willing to communicate. It wasn't that you had to hold hands and skip in the valley, sunshine and rainbows. But if you were unwilling to even just grab a beer with your coworker when you weren't busy, something was up.*

Another difference between capstone and work was that *she felt less pressure at work to get things perfect the first time*, though that *may have just been because she was entry-level*. She didn't feel a time crunch compared to capstone. But she did see her superiors scrambling to get things finished, pulling 70-hour work weeks just to get something in. It wasn't very often, but they've commented that it does get stressful; it's not always this relaxed. I came during a period where everything's starting to ... the beginning-ish of a project, where you still think everything's going to go your way. So it was possible that the relaxedness would change. But she was the kind of person *who valued her free time more than she valued a lot of money and a great position*. *If the company was trying to pull 70-hour work weeks for her every single week, she'd probably quit.*

L's 7-Month

L had been looking for new positions at the company, and there weren't any open for a design engineer. When they transferred her to a new position, she wasn't too happy. Their justification was that she could work under a PE who worked there, which *would help her become a design engineer*. To get her own PE meant *she had to work in that position for multiple years*, which she hadn't committed to, and *they were discussing giving her more tasks*. She had thought the new position would be *more calculations and engineering*, but it *turned out to be a lot more chasing down people, and bugging them for documentation, documentation, documentation, pictures, graphs, data, signatures*.

After two months in the new position, L was going to be leaving for another job in a few weeks. She had been talking to the owner of the company she been working at part-time, who offered her a *new position as a full-time design engineer*. *L decided she would rather work for her than try to back-door her way into becoming a PE*. This was a little more direct, because the owner was a PE as well. She might have been *a little faster at swapping around than her peers, but she didn't think it was too abnormal*. This kind of thing would probably happen to anyone. *She just happened to have an opportunity to do it faster rather than in two or three years*.

She had been working part time at the new company *for about two years*. *It was a small company*, it used to just be L and the owner, now it was three people. *She worked from home, that's how she was able to do both of them at the same time*. *She didn't have an office, because it was so small*. What they did instead was communicate through email or phone, and shared files over email or software.

She was really excited. She would be working from home the entire time, so *she didn't have to commute every day*. *She was also excited about getting into modeling, like she wanted from the very beginning*. *She was actually interested in the new projects*. *She was also excited to talk to the architects themselves, though some of them she did want to throw rocks at because they made things harder*. *But she wanted to see what their thought process was*. She was even excited to talk to their contract-givers,

just to see the whole industry from a higher level. As engineer you worked your way up, and then you could look down, and say, "Oh this is what's going on." But at such a small company, she could already see the whole thing.

Documentation was really important. She didn't understand that in capstone, but now she thought it might be the most critical thing in any industry. But while tracking people down was a really good skill to have, and she didn't regret the past two months, it wasn't something she could do for that long. It took a special type of person. Someone attentive to detail, and persistent in dealing with other people. Someone who was maybe a little psychotic. It was just a headache, because you had to keep track of your own schedule and stay under a very small budget, so you couldn't spend a lot of time on it, so you had to keep bugging and pinging other people. It was a little boring, not very challenging, but it was very time consuming. You pretty much took a template, and then pasted it across several projects.

The boredom was the most pressing issue, because she *did* really love working for her previous workplace. It was one of the most friendly work environments, and very flexible. But of course, working from home was even more flexible. You couldn't ever beat that. It was probably going to be a slight pay bump, but not enjoying the role was the main issue, and she felt it was easier to change roles now rather than five, ten years down the line.

Her view of what an engineer was had changed over the past few months. She used to have the idea that engineering was going in and drawing graphs, then everyone would say, "Oh man, that's so smart, we should totally use this design." But that was maybe 10% of the work, the other 90% was dealing with other people, double checking your work, looking at vendors.

For her new job she felt very prepared. She knew her employer very well, and she was going to be working with her one on one. They had been dealing with each other for so long, and she liked L. L was going to be talking to clients more, going to meetings, talking with architects, so that was going to

be exciting. A little more project managing, as well. With a company so small she could do anything from talking to clients to sweeping the floors.

The main challenge would be taking on the manager positions. She was going to make mistakes. Her previous team members were more forgiving when she made mistakes, but with a small company, if she made a mistake close to the deadline, it was either her or her employer who had to fix it (their third team member was only part-time), and the clients might be less forgiving, she didn't know.

She wishes she knew how to better ask for help. It still felt awkward whenever she came up with an issue, and they gave her a contact to call. She still thought, "am I supposed to ask her that? Is it appropriate for me to ask? Am I going to bother her?" This might have been a personal issue – some of her friends had mentioned that she had such difficulty asking for any kind of assistance from anyone. That said, telling an employer that you couldn't get something done was different from capstone. At work they had the attitude of "Okay. We can pick it up next week. There's always a safety net." With Capstone they had no safety net, no plan B In college, you had to wait in line for resources, so for efficiency, you assigned one person who was most skilled to a given resource. In capstone she would ask "Why am I wasting my team's time trying to figure out what to do, rather than pushing it to a guy who has done this a little longer, so we can move on to the next thing."

Her advice for newcomers was "you don't know shit, be prepared to learn." She has learned a lot at her job the past six months, and she was still learning a lot every day. It was a bit of a headache at times. She was a little tired. It felt like you should know something after graduating college, but you probably didn't, and that was okay, everyone feels the same way. She realized she didn't know shit probably after week two of her transfer position at the old company. She was shoved in head-first. She was overwhelmed, and bummed out, and felt like she should know it, but she didn't. But hey, that's the way it was.

L's 13-Month

Work has *been a little bit of a struggle*. She was *learning a lot every day, it felt like she was still in training*. At least she felt more like an engineer. There was a lot more analysis, and you had to make more assumptions, although there were *some things you couldn't assume*.

One time recently, *she made an HVAC model*, but she didn't know what kind of heating system it was. She assumed a particular kind was being used, because it was *popular*, and *she added it to the loop*. *But that was not the case. It resulted in one really late night*. She felt like an engineer because of the responsibility. *She hadn't thought about it until now, a responsibility to make sure that something was accurate. It was stressful*.

She still made mistakes. She was still trying to figure out what was going on. She didn't understand all of the "lingo." Her boss told her *that the learning never really stops, even though her boss had been in the industry for 10-15 years*. Still, *it was difficult to ask about things she didn't know, she was worried that she would look like an idiot. She didn't have a lot of confidence for making decisions. Small assumptions would turn out to be really big issues*.

She wasn't *on the verge of being fired*, and *she didn't want to say "everything's hard, life sucks."* She *just felt that the more she learned, the more she realized she didn't know what she didn't know*. At first she thought *she was in deep trouble*, but they had been talking, and were able to figure out that the talking-over-the-computer training sessions *weren't quite working out. They were fleshing out the details*. her employer was new to the role as well.

They were going to try to meet in person once a week. Whenever they could. Especially since it was summer, their kids were at home, and it gave them an excuse to leave the house. L supposed that they were all kind of strangers, kind of not strangers. But *she did know them, did know how they acted*. Meeting in person would *ease up the formality. When you texted and emailed, some things came out*

harsher or nicer than they were supposed to. Sometimes when L thought she was in deep trouble, her boss was intending to give friendly feedback. That's why L was anxious for the first couple of months. After meeting in person and hearing that feedback in person, L realized, "Oh, she doesn't hate me, got it."

One of the issues they all ran into involved the software they were using. When her employer ran into issues, she would ask the developers themselves, sometimes to no avail, in which case they had to figure it out on their own. You had to learn to swim or drown. And right now it felt like she was standing in waist deep water.

She was doing everything, and she was stressed out. It was just small company blues. She could wax poetic about the great parts, but the downside was that there wasn't really a good backup plan. If two people were sick, or if one person went on vacation and the other person was sick, that was two thirds of your company. There was no one else. No one to push the responsibility onto, no one to ask. All of this said, being part of everything was also awesome. She was struggling because it was a lot, because it wasn't just an engineering position. When you had such a small company, you were both an engineer, a manager, and a secretary at the same time.

Most of her significant contributions were fixing spreadsheets. She didn't know why she became the spreadsheet wizard, but she did. Most of her accomplishments involved figuring out the formula, streamline the process. It was her last job that prepared her for that, as it was more management related. She still didn't quite know what she was doing, and she definitely didn't think she was the fastest or most brilliant, but she hoped she was showing a willingness to learn. She used to think that all engineers were brilliant people, but now her perspective is that there are some engineers that aren't smart, there are some engineers that are smart, and at the end of the day they just get the work done and then go home and be happy, and that works out for her.

At her last job, she had been given a *performance review*. It wasn't too detailed, possibly a little bit rushed. At this job, they just talk a lot more, even for casual conversation, and she contacts her at any time. There hasn't been a formal performance review, because they all know each other, her boss doesn't need documentation. And the regular contact was working out well. When they had quick questions it was easier to text a picture, rather than the formality of an email. It made it a lot quicker. They were adjusting to each other, and for her, adjusting to an engineering work environment.

L's 25-Month

L was tired and stressed out. She didn't know if it was just her, if she should be liking work more than she was. It wasn't a bad job, and she felt like she was doing something. But she couldn't turn her brain off when she was not working. And since she was working from home all the time, she didn't have an office, it was even harder for her to not work. She was on vacation, but she would get an E-mail and think, "Oh, I guess my vacation is over. I guess I'm going back to my desk now." There wasn't an actual obligation, but take, for example, someone busy and hard to pin down finally emailing you, it was hard to ignore. Why was she not at her desk helping him out? She had met him before, she knew he had three kids. She herself didn't have children, she had no obligations except to work and do basic chores. Why wasn't she working? Maybe she felt she didn't have job security. She always felt she was going to get replaced by someone better. It wasn't reflective of her work performance now, it might just be stress she was putting on herself. She was a mess.

Just asking for vacation time had given her more anxiety than anything else. Her boss liked to emphasize, if you were taking time off, you were not obligated to do any work. But L didn't know if she could do that, though going to another country in another time zone might help her miss some meetings.

About the technical details of work, she felt that the more she learned about it, the less she knew about its intricacies. It might just be a confidence issue. Her fiancé had reassured her that she knew more and

worked more than she thought, but *her own confidence issues were getting in the way*. The details were difficult. *Every single city with a project had its own rules and regulations*. She thought *she barely understood the cities in her state*, until they moved on to a city in another state. Then she really didn't know anything, and there was so much to memorize.

She didn't feel like she had accomplished much. Maybe someone outside looking in might think she had accomplished a lot, but *she was so negative nowadays*. *Some days it just felt like one step forward, two steps back*. She would *feel like she nailed a code*, but then her boss would E-mail her and correct an assumption, and she *needed to spend another four hours fixing it*.

She wasn't a very negative person, before. Maybe that's why people talked about college days as their glory days, maybe they just had more confidence back then. And she *couldn't be burning out yet*, she was only 24. *She was supposed to burn out when she was 50*.

Something that was *annoying*, she had been getting more clients who were looking to do the *bare minimum*. Rather than maximizing energy savings, most clients wanted to get a minimum level of energy savings. She didn't know whether *something was going on*, but that's why one of their projects didn't *get the funding they needed*, *the political winds had been shifting towards not energy conscious decisions*.

Working at a small company was still kind of stressful. *If the job wasn't so convenient* and working from home wasn't so *nice*, *she would definitely be thinking about switching to a larger company*, where *she might get more support or not feel as much pressure to do really, really well*. She was missing a safety net. Though *maybe that wasn't the case*. *Maybe big companies also had those issues* and she didn't know it.

At this point her definition of engineering had changed again. *If she had to be frank? Engineers were just the first person*, maybe the second person, *you tried to find and yell at for any sort of bullshit that*

went on. *The first person you talked to was the manager, then the manager talked to the engineer, and then the engineer had to figure out whatever bullshit went wrong. That's what engineering meant. An engineer was pretty much the same as an accountant or anything else. It was a general responsibility, "Hey, you should probably know this. If you don't, I'm going to yell at you for it, and if you do, why didn't you fix it before." First person in line, cannon fodder to the potentially angry client, or at least she felt like she got yelled at a lot. For example, a typical thing that went wrong was finding out they didn't have the funding for better HVC equipment, but they still had to meet code. They needed to fix that. They had half the budget, but they didn't meet code. That's when she would look through old projects to figure out if they had encountered a similar issue before, then hopefully apply those strategies if they existed. If not, throw solutions at it and test until something works, then she went back to the client, "Here's what you can do with half the budget."*

If the engineer couldn't solve a problem, she didn't know what to do. This might be *where a bigger company would be nice. She would talk to someone who hopefully knew more than her and work together to figure it out. With her job, it felt like there wasn't much help because her boss was so busy with other projects, and because she was the manager. Otherwise, worst case scenario she would say, "Look, we can't do anything for you for half, and I'm sure as hell not going to lie to the code compliance people for you to build an illegal building. So you're just going to find more funds," and toss it back to them.*

If she were to review her own performance, her *positive feedback* would be that *she was responsive and willing to do work. Negative feedback: really shit at detail.* If she was her boss, she would say just to *focus a little more on quality assurance, quality control. Just double, triple check more closely.*

Reflecting on the impacts of race or gender, there really weren't any. She knows that *if she were ever to start a family, that was an issue some women had to face, whether she or her partner would quit work to take care of kids. But either way, she was going to take a couple of weeks off for maternity, so that*

was always going to be a little annoying to deal with. As for now, it didn't affect her that much. At her 3-person company, her coworker and her boss were both women. And race wasn't a big deal. Age maybe, because she was still learning, but that might be an experience thing. She didn't think race, gender, or age should affect her definition of engineering, however vague it was.

She didn't have much advice. "Good luck, have fun." It was hard to say because, engineering had a super wide spectrum of all types of engineers, and every person was different. Just "good luck and have fun," that was it.

M's Narrative

M's Exit

M was proud of how his capstone project had turned out. The team was able to be part of patenting a product, and helped create something that *had never been done before*, and improved upon a design that has been around for at least a *hundred years*, which he *didn't expect, going into the project*. The high-level *overarching goal*, now, would be to take the prototype to a world expo to show it off, and *hopefully a company would want to pick it up and use it*. These kinds of inventions *start high up and trickle down*, so it is possible that the patent might become common in *10 or 20 years* – though he *doesn't expect that*. His team members will not be receiving royalties, but their *names were on the patent*, and was exciting to think about.

Aside from that, he was grateful for the class focus on *professionalism*. What he took away from the course was that *getting a job was not that hard, but keeping the job might be where more attention was needed*. He felt that through capstone he *developed little skills* here and there, *writing emails, keeping in touch with people, communicating, networking*.

Reflecting on the past year, he realized that he had developed a broader understanding of what engineers could do. *Sure, engineers do R&D, research, designing, and prototyping, but the defining characteristic of engineers might be a certain way of thinking. One of the main things he took away from his education was learning how to learn. Engineers can do anything from design work to business. They know how to problem-solve, and they can be put in almost any situation to succeed or do well.*

Thinking about jobs, he *originally thought he wanted to be in an aerospace job, working on satellites, like in his first internship. But things changed with his HVAC internship in his sophomore year, and really opened his eyes to other possibilities. Considering that, he had applied to 30, maybe 35 positions over the past semester. He had heard back from a few companies, but none of them really caught his eye. One company he applied to was in telecom, something he knew little about, but he figured he could try it out, see if he liked it. He went to the interview and told himself that if they impressed him, he would think about it. They impressed him. He talked to his friends, and his parents about it. It was just an overall good feeling, and he was glad he accepted it.*

For the job, *he felt prepared, because he would be using CAD software at work – he had taken a CAD class in his last semester to prepare. He was excited to move beyond homework and tests – though those were things he was used to. On the other hand, he was nervous that he wasn't going to know anything specific. In the interview they used words like "operations" and "equipment," which he was not at all prepared to understand. Even when he was applying to jobs, he often found that he didn't have all of the desired skills listed on the job ads.*

But he got the impression *that people don't really look at those specific skills, that if he knew how to learn and how to apply himself, he would be fine. He had friends that are naturally smarter than him when it comes to engineering, he had needed to work a little bit harder to understand things, study more, practice more. He was more comfortable going into a lower role, maybe not the role he wanted,*

but going into a role that taught him the industry and how things work, moving up from there. That's how he saw himself, as one who learns the basics and then to continues to go up the ladder.

He expects to be working with more experienced people than he is used to. In school, everyone is at the same level. He'll have to learn how to communicate with people will all *different kinds of experience*, because *he doesn't want to waste someone's time*. In previous work, not capstone, he's *had the experience with asking too many questions*, so he's trying to anticipate and avoid that.

M's 3-month

M was enjoying work at 3 months in, but *it was a little iffy at first*. He started off in a graphics technician role. *His first month he didn't feel like an engineer at all, rather felt like a technician who was doing dirty work for an engineer. And it really unsettled him.* The job was *just graphics, almost like drafting*; technicians like him used the *provided CAD program* to put all the technical information into drawings that construction workers use. He was hired as part of a large group, and at first *it sounded like they would only keep the people that they like on board*. He was a little nervous, early on, and he sought to turn in tasks earlier than the deadline, and to keep track of a schedule filled with information he didn't learn in school. *He didn't want to be the guy that was cut because he wasn't doing good enough work or he was losing the company work.*

But *the more he did his tasks, the more confident and comfortable he got*. The job wasn't the hardest thing; he used his *engineering mindset to learn things quickly and to understand all of the information*. And *this led to him being noticeable*. He would get a task every week, and *turn the results in early and under-budget, saving the company money*. *He found himself pointing out the design engineers' mistakes, catching things before they went out. The more he saw that he was helping the company avoid mistakes, and save money, the more he felt like an engineer. Thankfully, it looked and sounded to*

him *like he was meeting their goals and standards. He was in a groove, and at 3 months he was going to be promoted to a management position.*

He found the new role because he *was in the right place at the right time.* He was looking for leadership roles, given *that the engineering wasn't really there,* and some higher up people had just left and transferred – those roles were filled, but that left *some lower managerial roles vacant, and it just so happened that they trusted him and they liked what he was doing. Eventually one of the leads appointed him as her number two person.*

It was *always his goal, to start off in the weeds, doing all the hard work that the engineers don't want to do. And if he did want to go into a new position, he would be more well-versed in the subject and the components involved.* Now he knows *what to expect from technicians and what the work looks like, firsthand.* In two weeks, he will be *pulled out of production to start training technicians, as well as reviewing and assigning their work.* One of the challenges was working with technicians on the other side of the world - he was planning on managing technicians that work *around the clock.* He was also going to be at meetings where management talked about technicians who were not meeting standards, and made *game plans for them to be better.*

He is *glad that he has met the standards for being in his position.* He feels he has done well by correcting his own mistakes so that he would not repeat them, and he *asks questions all the time* about components that are new to him. To do something wrong once, that was one instance, but habitually doing something wrong it might be more obvious. He had also been viewing the path to promotion as a *challenge see if he could be as good as other people.* While *he hated comparing himself to others,* he felt that *sometimes he had to.*

He wishes school had forced every student to deal with financial information. It was easier in school for everyone to trust one person with financial decisions, and to not develop a sense of financials

yourself. He realizes now that *money is really what drives everything and any work. It's cut and dry. If you're not doing design work that meets the client's needs, specifically financial needs, no-one is going to go with it.* For technicians, mistakes cost time and money. Even with reviews, catching and fixing mistakes takes time. And *if the mistakes don't get caught in the review process, which is a worst-case scenario, they order the wrong components. Learning from his mistakes and helping the process along makes him feel great. It keeps him going.*

The advice he would give to new graduates? *Stick it out for the first month, because things change, a better opportunity may come up, or people may pay more attention to your work once things settle down.* That said, he wouldn't have expected the changes, because job descriptions always describe specific plans and expectations for newcomers.

Right now, he knows there is design work that goes into the company processes, and he is *communicating with management that he wants to go in that direction. Thankfully, they understand that.*

M's 8-month

M is enjoying project management work, *the dynamic of each day, and all the people he works with and communicates with.* Right now, he coordinates with the lead design engineer in his office to assign tasks to technicians and review their progress. The team meets every other day to set responsibilities and deadlines and to make sure that the *quality of the technician's work is consistent and is living up to standards.* He *tracks their quality each week to see if they do better, do worse, or are about the same, to try to identify where their weaknesses are and tackle them.* For instance, one technician was taking a long time, four hours, to review certain forms, and *M was doing it in half that time.* M challenged him to be faster and to get his reviews done quicker - and the technician *listened and successfully did that.*

M also attends weekly meetings with all the other leads in the same division. *They help each other succeed as one large team.*

With his smaller team, they plan things out week-by-week, multiple months ahead. The holiday season has slowed things down, but *the goal is to beat all the other teams every single week.* Each team is supposed to get 4-5 tasks sent out for review – they shoot for 5-6, and often reach that level. *Week in, week out, they have been more successful than the other teams.* The accomplishment brings him extra pride knowing that *their team has the least experience*, including the technicians and himself.

The work is *fast-paced*, and he *doesn't have time to delay.* *The technicians are expected to work 40 hours a week and they do. Their performance is measured hourly, so if they don't have a new project, their score is affected – because they're really doing nothing. It trickles down from there.* The team is not *approved for over-time*, so his management must stay pretty strictly *within 40 hours a week.* *He can have something continually worked on at almost all times during the day*, given that some of the technicians are in another country. *He has to coordinate with them while they are almost half a day ahead.* His first week in the position was *pretty stressful.* Every 15-30 mins he was *contacting people to find work for his technicians.* Now he uses a software to *divvy up sections of work*, which is quicker. There are many steps to the whole process of an individual job, and each of the steps has a column in the spreadsheet, which can be assigned to a technician.

Some of his approaches have helped the team be *successful.* In the beginning, *the team had one technician who was familiar with the market standards, and everyone else wasn't*, including himself. He had that person lead him and everyone else in a *training session* to catch everyone up. He also has allowed technicians, not just him and the design lead, to assign work to each-other. That *strategy might not have worked for every team, but it worked for their dynamic.* M also imposed *time limits on reviews.*

Coming into the job, he had two goals. He wanted to go from technician to an *engineering position*, and he *was curious about project management*. Now he has had some of that project management experience. It has *opened his eyes to the fact that engineering is not just numbers and math*.

Engineering is *being able to communicate what you're working on to someone else, so they can either improve on that or take that work to someone else. It's being able to get results and being able to communicate them within a team and to the client. He realized that he couldn't have gotten to the lead position without being as knowledgeable as the other engineers (with degrees) in those positions. He supposes that he was only able to become a lead because he was a technician, and because he did well in that position, enough to impress the lead who recommended him. Now he wants to go to the design department and be that design engineer, again by taking a position and going up from there.*

He has been communicating with his design lead and describing his plans and desires for getting to the design department in a year's time. He still doesn't yet feel like an engineer, maybe only 60%, because he is a project manager. He is more of the technical side, making sure everything looks good, whereas engineers make decisions, and approach looser problems. There are many aspects of the process he doesn't have to figure out in his current position, and he is looking forward to the engineering position where he would get to.

There are a few other things on his mind. *The company recently downsized a lot, and let go of many contingent employees of the past three months. M was hired with a group of 9 other people, and now only he and one other coworker from that group remains. It's not because they were doing bad work, it's just that his company didn't give them enough work to keep the team size they had, and the contingent employees were easier to let go. He is still a little scared of that, because he hasn't been converted to a core employee. He is confident that he is doing everything he needs to, to impress the people that need to be impressed. They should be able to see that he is really interested, and his quality should be up to where they need to be.*

The other thing he's given some thought is about the impact of his work. Recently when he went home for Christmas, an extended family member asked him a few questions about the work he is a part of.

"What's the benefit of the work? What's the bigger picture? Can you use renewable energy to accomplish those tasks? Are you sure you're providing this to literally everyone so no one is left out?" *It raised a lot of big questions. Ones which are hard to answer, and he doesn't often think about unless asked. A lot of it is lost, because it's all about getting what the client wants, and the client wants the cheapest thing done in the quickest amount of time. Not only for him, but for anyone, they are given a job to do, and they're going to do it. And sometimes they totally forget about consequences. It is something to think about.*

Thinking about engineers coming onto the job market, *his advice is not to search for the one job that you want. Because although his job might pay less than average, he is gaining experience quickly. At a big company, they will take time to train you. It might not be your first choice, but it might turn out to be what you want to do. Because everything that's new is uncomfortable and going into an uncomfortable situation makes you a stronger, better, more experienced individual.*

M's 14-Month

A little after 8 months into work, M was laid off. Although it seemed *obvious* to him that it was going to happen, it still *didn't feel good*. But he went back to the job market. It was different from the first time around. For one, his old company offered to set him up with an interview at a similar company, but he knew that wasn't something he wanted to do. He still thought it was a *worthwhile experience to at least go through the interview process, just talk to people, get better at talking about himself*. He did interviews with many tech companies, but they *were always looking for someone with less skill or were too far away – they never worked out*.

He reached out to a project manager he knew at a second telecom company, and landed a job there, after one and a half months of looking. *It was a nice company and a nice office, but the feeling just wasn't right.* And during the second week of his job at the second company, he got a call back from a third company for a phone interview. He eventually got another offer and left the second company for the third. In part he chose his current company because *he would be helping the environment in some way, shape, or form. He was caught by that aspect.*

In the course of his new work, he's *often on the phone with subcontractors explaining scopes of work, and in the end he decides which subcontractor's bid to go with. It is usually the one with the cheapest price.* Once a bid is chosen, he coordinates the employees that work on site, and manages other little projects on the side. He may be on the management route in his current position, but it also seems like there are opportunities to do design work as well. He expects that he will be specialized in either design work or project management in another two or three years at the company.

Things had been picking up in the past couple of months. One day, while he was writing a scope of work, he realized he was managing a \$450,000 project – which he wasn't ready for. As he kept doing calculations, the cost kept rising until it reached \$550,000. Maybe to the company it wasn't that much money, but to him it was a lot. *Was he going to mess this up? It took him a little while but he wasn't afraid to ask questions and get his work reviewed multiple times,* Now he is taking on bigger and bigger projects.

Things were going well until about a week or two ago. He had been striving to be a *yes man*, picking up any order he could. *He felt he was doing his job quickly and efficiently, and he could make the most profit margin if he spent the least amount of time per project - every hour that he puts into a project is an hour in his salary taken away from what the job is worth, because of the company's rates. He was feeling good, although his coworkers warned him that he was going to be overwhelmed. They kept saying that, but he never got overwhelmed and he thought he was fine.* What he wasn't keeping track of,

350

was the second half of projects, ordering and tracking parts once the scope of work was approved. *Now he has 20 to 30 projects on his plate*, some of them are developing into their second stage and *he is getting a little overwhelmed. It's not his limit, but it's been challenging to juggle all the projects at once.* He might need to pass projects along to his coworkers, because he hasn't touched a few of them in weeks.

He sees himself as an engineer in this position, because problems come to him and he's supposed to fix them. He may not be *the one coming up with the solution, because usually the subcontract it out to other people who figure the problem out and do all the work. But without him, they wouldn't know that there was a problem, what the constraints of the problem were. He sees himself in the very forefront of that process of identifying the problem and the constraints, and laying all the information out for someone else who can then fix it.*

He also feels like the *good guy* at his job, because he is *preventing environmentally hazardous situations*. But on the other hand, the systems he is maintaining are military technologies, *used to kill people*. So, there's a balance there. He recalls one of his coworkers bringing up the *indirect* but supportive *connection* between his work and military technology. *It's not easy to think about. He wouldn't quit his job because of his realizations. But he wouldn't know how to react if this country went into all out war.* He could react by recognizing that his work would be more necessary in that situation, but still he would be connected to the military technology.

Compared to before, he feels like his thinking on the matter *has evolved*. Before, *he never thought about these issues because all he did all day was write or draw lines on a program. He didn't really think about environmental impacts. Before, that wouldn't have been a decision factor in what kind of career he did*, he would just do whatever work was assigned to him. But now that he has been in various industries for a year, that leads him to makes decisions based on *what kind of work he will be*

doing. He likes being in an environmental engineering company because the company is trying to help people.

His final piece of advice for future engineers: There are so many things to do in this world - it's important to live a little. Go work for an environmental engineering company helping environmental situations when you're a mechanical engineer.

REFERENCES

- Abes, E. S., Jones, S. R., & McEwen, M. K. (2007). Reconceptualizing the model of multiple dimensions of identity: The role of meaning-making capacity in the construction of multiple identities. *Journal of College Student Development*, 48(1), 1–22. <https://doi.org/10.1353/csd.2007.0000>
- Aguirre, A. (2000). Academic Storytelling: A Critical Race Theory Story of Affirmative Action. *Sociological Perspectives*, 43(2), 319–339. doi:10.2307/1389799
- Allen, R. E. S., & Wiles, J. L. (2016). A rose by any other name: participants choosing research pseudonyms. *Qualitative Research in Psychology*, 13(2), 149–165. <https://doi.org/10.1080/14780887.2015.1133746>
- Allie, S., Armien, M. N., Burgoyne, N., Case, J. M., Collier-Reed, B. I., Craig, T. S., ... Wolmarans, N. (2010). Learning as acquiring a discursive identity through participation in a community: Improving student learning in engineering education. *African Journal of Research in Mathematics, Science and Technology Education*, 14(2), 6–14. <https://doi.org/10.1080/10288457.2010.10740678>
- Antunes, P. (2012). Weak vs. Strong sustainability. Retrieved from <http://www.envjustice.org/2012/11/weak-vs-strong-sustainability/>
- Apple, M. W. (2011). Democratic education in neoliberal and neoconservative times. *International Studies in Sociology of Education*, 21(1), 21–31. <https://doi.org/10.1080/09620214.2011.543850>
- Archer, M. (1996). *Culture and Agency: The Place of Culture in Social Theory*. Cambridge: Cambridge University Press. doi:10.1017/CBO9780511557668
- Archer, M. (2007). *Making our Way through the World: Human Reflexivity and Social Mobility*. Cambridge: Cambridge University Press. doi:10.1017/CBO9780511618932
- Archer, M. S. (2014). Structural Conditioning and Personal Reflexivity. In *Distant Markets, Distant Harms: Economic Complicity and Christian Ethics* (pp. 359–379). <https://doi.org/10.1093/acprof>
- Archer, M. S., Decoteau, C., Gorski, P., Little, D., & Porpora, D. (2016). What is Critical Realism. Retrieved from <http://www.asatheory.org/current-newsletter-online/what-is-critical-realism>
- ASEE. (1955). Summary of the Report on Evaluation of Engineering Education. *Journal of Engineering Education*. Retrieved from <https://www.asee.org/papers-and-publications/publications/The-Grinter-Report-PDF.pdf>
- Augustine, N. (2013). One Cannot Live By Equations Alone. *Liberal Education*, 99(2). Retrieved from <https://www.aacu.org/publications-research/periodicals/one-cannot-live-equations-alone-education-life-and-work-twenty>
- Australian Competition and Consumer Commission. (2011). *Misleading Job and Business Opportunity Ads: How to Handle Them*. Canberra. Retrieved from [https://www.accc.gov.au/system/files/Misleading job and business opportunity ads.pdf](https://www.accc.gov.au/system/files/Misleading%20job%20and%20business%20opportunity%20ads.pdf)
- Bamberg, M. (2002). Narrative Analysis. *APA Handbook of Research Methods in Psychology*. <http://dx.doi.org/10.1037/13620-006>
- Bamberg, M., & Demuth, C. (2016). Interview Narrative Inquiry : An Interview With Michael Bamberg. *Europe's Journal of Psychology*, 12(1). <https://doi.org/10.5964/ejop.v12i1.1128>
- Barrera, O. P. A. (2014). Individuating Collective Responsibility. In *Distant Markets, Distant Harms: Economic Complicity and Christian Ethics*. <https://doi.org/10.1093/acprof>
- Baxter Magolda, M. B. (2008). Three elements of self-authorship. *Journal of College Student Development*, 49(4), 269–284. <https://doi.org/10.1353/csd.0.0016>
- Baxter Magolda, M. B. (2012). Building Learning Partnerships. *Change*, (February), 32–38.

- Berman, E. P. (2014). Neoliberalism : Science and Technology Policy, *39*(3), 397–431.
- Bhaskar, R. (2016). *Enlightened Common Sense*. London And New York: Routledge.
- Braa, D. (2016). Critical realism, neomarxist theory and critical pedagogy. *Radical Pedagogy*, *13*(2), 1–21.
- Brescia, R. M. (2018). DOMINANCE AND DISINTERMEDIATION: SUBVERSIVE STORIES AND COUNTER- NARRATIVES OF COOPERATION. *Southern California Interdisciplinary Law Journal*, *27*.
- Brunhaver, S. R., Korte, R. F., Barley, S. R., & Sheppard, S. D. (2017). Bridging the Gaps between Engineering Education and Practice. In R. B. Freeman & H. Salzman (Eds.), *U.S. Engineering in a Global Economy*. University of Chicago Press.
- Bucciarelli, L. L., & Drew, D. E. (2015). Liberal studies in engineering – a design plan. *Engineering Studies*, *7*(2–3), 103–122. <https://doi.org/10.1080/19378629.2015.1077253>
- Buch, A. (2016). Ideas of holistic engineering meet engineering work practices. *Engineering Studies*, *8*(2), 140–161. <https://doi.org/10.1080/19378629.2016.1197227>
- Case, J. M. (2015). A social realist perspective on student learning in higher education: the morphogenesis of agency. *Higher Education Research & Development*, *34*(5), 841–852. <https://doi.org/10.1080/07294360.2015.1011095>
- Case, J. M., & Light, G. (2011). Emerging Research Methodologies in Engineering Education Research. *Journal of Engineering Education*, *100*(1), 186–210. <https://doi.org/10.1002/j.2168-9830.2011.tb00008.x>
- Cech, E. (2013). The (mis)framing of social justice: Why ideologies of depoliticization and meritocracy hinder engineers’ ability to think about social injustices. In J. C. Lucena (Ed.), *Engineering Education for Social Justice* (pp. 67–84). New York: Springer.
- Cech, E. (2014a). Culture of disengagement in engineering education. *Science, Technology, & Human Values*, *39*(1), 42–72. <https://doi.org/10.1177/0162243913504305>
- Cech, E. (2014b). Engineers and Engineeresses? Self-conceptions and the Development of Gendered Professional Identities. *Sociological Perspectives*, *58*(1), 56–77. <https://doi.org/10.1177/0731121414556543>
- Chapman, A. (2013). The Ethical and Political Framework of Regulation. In *Democratizing technology* (p. 2603). <https://doi.org/10.1145/2470654.2481360>
- Danielak, B., Gupta, A., & Elby, A. (2014). Marginalized Identities of Sense-Makers : Reframing Engineering Student Retention. *Journal of Engineering Education*, *103*(1).
- Decoteau, C. L. (2017). The AART of Ethnography: A Critical Realist Explanatory Research Model. *Journal for the Theory of Social Behaviour*, *47*(1), 58–82. <https://doi.org/10.1111/jtsb.12107>
- del Cerro Santamaría, G. (2020). *Challenges and Drawbacks in the Marketisation of Higher Education Within Neoliberalism*.
- Deters, J. R., Paretti, M. C., & Ott, R. (2020, 21-24 Oct. 2020). Engineering graduates perceived preparedness for the first three months of work in industry. 2020 IEEE Frontiers in Education Conference (FIE),
- Dias, M. C. (2019). Paulo Freire and humanization: the vocation to be a human being. Retrieved from <http://blogs.law.columbia.edu/critique1313/matheus-chatack-dias-paulo-freire-and-humanization-the-vocation-to-be-a-human-being/>
- Downey, G. L. (2014). The Normative Contents of Engineering Formation. In A. Johri & B. Olds (Eds.), *The Cambridge Handbook of Engineering Education Research*. Cambridge University Press.
- Downey, G. L., & Lucena, J. C. (2004). Knowledge and professional identity in engineering: code-switching and the metrics of progress. *History and Technology*, *20*(4), 393–420. <https://doi.org/10.1080/0734151042000304358>

- Eagleton-Pierce, M. (2017). *Neoliberalism: The Key Concepts* (Vol. 91).
- Egert, P. R., & Allen, B. L. (2017). Knowledge Justice: An Opportunity for Counter-expertise in Security vs. Science Debates. *Science as Culture*, 0(0), 1–25. <https://doi.org/10.1080/09505431.2017.1339683>
- Elliott, J. (2005). Listening to people’s stories: the use of narrative in qualitative interviews. In *Using Narrative in Social Research* (1st Edition, Vol. 33, pp. 358–371). London: Sage Publications. <https://doi.org/10.1016/j.jmedhist.2007.09.004>
- Faulkner, W. (2007). “Nuts and Bolts and People”: Gender-troubled engineering identities. *Social Studies of Science*, 37(3), 331–356. <https://doi.org/10.1177/0306312706072175>
- Fletcher, A. J. (2017). Applying critical realism in qualitative research: methodology meets method. *International Journal of Social Research Methodology*, 20(2), 181–194. <https://doi.org/10.1080/13645579.2016.1144401>
- Flumerfelt, S., Kahlen, F.-J., Alves, A., & Siriban-Manalang, A. (2015). *Lean Engineering Education: Driving Content and Competency Mastery* (1st ed.). ASME Press. <https://doi.org/10.1115/1.860502>
- Ford, J. D., Paretto, M., Kotys-Schwartz, D., Howe, S., & Ott, R. (2021). New Engineers’ Transfer of Communication Activities From School to Work. *IEEE Transactions on Professional Communication*, 64(2), 105–120. <https://doi.org/10.1109/TPC.2021.3065854>
- Ford, J., Paretto, M., Kotys-Schwartz, D., Howe, S., Gewirtz, C., Deters, J., ... Giardine, F. (2019). Transitioning from capstone design courses to workplaces: A study of new engineers’ first three months. *International Journal of Engineering Education*, 35(6B).
- França, J., & Giroux, H. A. (2019, July 2). Henry Giroux: “Those arguing that education should be neutral are really arguing for a version of education in which nobody is accountable.” *CCCBLab*.
- Fraser, N. (2010). Reframing Justice in a Globalizing World. In *Scales of Justice* (pp. 16–20). Columbia University Press.
- Freire, P., & Ramos, M. B. (1970). *Pedagogy of the Oppressed* (2nd ed.). Bloomsbury Academic Publishing.
- Fricke, M. (2007). *Epistemic Injustice*. New York, NY: Oxford University Press.
- Gary, K. (2018). Where is My Mind? Consumerism Vs. The Practice of Liberal Education. *Philosophical Studies in Education*, 49.
- Gee, J. P. (2000). Identity as an Analytic Lens for Research in Education. *Review of Research in Education*, 25(1), 99–125. <https://doi.org/10.3102/0091732X025001099>
- Gewirtz, C., Giardine, F., Kary, A., & Ott, R. (2020). Women’s Unique Challenges in the Transitions to Engineering Work. In ASEE Annual Conference & Exposition.
- Gewirtz, C., Kotys-Schwartz, D., Knight, D., Paretto, M. C., Arunkumar, S., Ford, J. D., ... Hernandez, C. (2018). New engineers’ first three months: A study of the transition from capstone design courses to workplaces. In 125th American Society for Engineering Education Annual Conference & Exposition. Salt Lake City, UT.
- Gilbuena, D. M., Sherrett, B. U., Gummer, E. S., Champagne, A. B., & Koretsky, M. D. (2015). Feedback on professional skills as enculturation into communities of practice. *Journal of Engineering Education*, 104(1), 7–34. <https://doi.org/10.1002/jee.20061>
- Giroux, H. A. (2010). The US University under Siege: Confronting Academic Unfreedom. *A Concise Companion to American Studies*, 407–431. <https://doi.org/10.1002/9781444319071.ch21>
- Giroux, H. A. (2014). *Neoliberalism’s War on Higher Education*. Haymarket Books.
- Godwin, A., Potvin, G., Hazari, Z., & Lock, R. (2016). Identity, Critical Agency, and Engineering: An Affective Model for Predicting Engineering as a Career Choice. *Journal of Engineering Education*, 105(2), 312–340. <https://doi.org/10.1002/jee.20118>

- Gregory, A. and Milner, S. (2009), Editorial: Work–life Balance: A Matter of Choice?. *Gender, Work & Organization*, 16: 1-13. <https://doi.org/10.1111/j.1468-0432.2008.00429.x>
- Harremoës, P., Gee, D., MacGarvin, M., Stirling, A., Keys, J., Wynne, B., & Vaz, S. G. (2001). Late lessons from early warnings: the precautionary principle 1896–2000. Copenhagen, Denmark. Retrieved from https://www.eea.europa.eu/publications/environmental_issue_report_2001_22/Issue_Report_No_22.pdf
- Hatch, K. S. C. (2017). Drive All Blames Into One. Retrieved March 8, 2021, from <https://medium.com/kaitlynschatch/lojong-practice-journal-drive-all-blames-into-one-719ba5317612>
- Hatmaker, D. M. (2012). Practicing engineers: Professional identity construction through role configuration. *Engineering Studies*, 4(2), 121–144. <https://doi.org/10.1080/19378629.2012.683793>
- Healy, K. (2017). Fuck Nuance. *Sociological Theory*, 35(2), 118–127. <https://doi.org/10.1177/0735275117709046>
- Hohendahl, P. U. “Humboldt Revisited: Liberal Education, University Reform, and the Opposition to the Neoliberal University.” *New German Critique* 38, no. 2 113 (2011): 159–96. doi:10.1215/0094033X-1221812.
- Hoipkemie, M. (2016). Critical Realism and Common Goods. *Journal of Critical Realism*, 15(1), 53–71. <https://doi.org/10.1080/14767430.2016.1124312>
- Holland, D., Lachiocotte, W., Skinner, D., & Cain, C. (1998). *Identity and Agency in Cultural Worlds*. Cambridge, MA: Harvard University Press.
- Holland D., Lave J. (2019) Social Practice Theory and the Historical Production of Persons. In: Edwards A., Fler M., Böttcher L. (eds) *Cultural-Historical Approaches to Studying Learning and Development. Perspectives in Cultural-Historical Research*, vol 6. Springer, Singapore
- hooks, b. (1989). *Talking Back: Thinking Feminist, Thinking Black*. Between the Lines.
- hooks, b. (1994). *Teaching to Transgress: Education as the Practice of Freedom*. Routledge.
- Hora, M. T. (2018). Beyond the Skills Gap. *Liberal Education*, 104(2). Retrieved from <https://www.aacu.org/liberaleducation/2018/spring/hora>
- Hora, M. T., Benbow, R. J., & Oleson, A. K. (2016). Beyond the skills gap : How the lack of systemic supports for teaching and learning undermines employer , student , and societal interests, 63.
- Howe, S., Ott, R., Paretto, M. C., Hernandez, C., Deters, J., Gewirtz, C., ... Kary, A. (2019). Women’s experiences in the transition from capstone design courses to engineering workplaces. In *ASEE Annual Conference and Exposition, Conference Proceedings*.
- Høvring, C. M., Andersen, S. E., & Nielsen, A. E. (2018). Discursive Tensions in CSR Multi-stakeholder Dialogue: A Foucauldian Perspective. *Journal of Business Ethics*, 152(3), 627–645. <https://doi.org/10.1007/s10551-016-3330-4>
- Huff, J. L. (2015). Psychological journeys of engineering identity from school to the workplace: How students become engineers among other forms of self. *Dissertation Abstracts International: Section B: The Sciences and Engineering*, 76(6–B(E)). <https://doi.org/UMI 3669254>
- Hyslop-Margison, E., & Welsh, B. (2001). *Career Education and Labour Market Conditions: The Skills Gap Myth*. Retrieved from <https://eric.ed.gov/?id=ED459328>
- Jaffe, S. (2021). *Work Won't Love You Back: How Devotion to Our Jobs Keeps Us Exploited, Exhausted and Alone*. Bold Type Books.
- Jasanoff, S. (2003). TECHNOLOGIES OF HUMILITY : CITIZEN PARTICIPATION IN GOVERNING SCIENCE. *Minerva*, 41(3), 223–244.
- Jasanoff, S. (2004). Ordering Knowledge, Ordering Society. In S. Jasanoff (Ed.), *States of Knowledge: The co-production of science and social order*. Routledge Taylor & Francis Group.

- Jasanoff, S. (2007). Technologies of Humility. *Nature*, 450(1).
- Jasanoff, S. (2015). Future Imperfect: Science, Technology, and the Imaginations of Modernity. In *Dreamscapes of Modernity: sociotechnical imaginaries and the fabrication of power* (pp. 1–33). <https://doi.org/10.1007/s13398-014-0173-7.2>
- Jesiek, B., Buswell, N. & Nittala, S., (In Press) Performing at the Boundaries: Narratives of Early Career Engineering Practice. *Engineering Studies*.
- Johri, A., & Olds, B. (2011). Situated Engineering Learning : Bridging Engineering Education Research. *Journal of Engineering Education*, 100(1), 151–185.
- Judson King, C., & Pister, K. S. (2015). How best to broaden engineering education? *Engineering Studies*, 7(2–3), 150–152. <https://doi.org/10.1080/19378629.2015.1062489>
- Kahn, P. E. (2017). The flourishing and dehumanization of students in higher education. *Journal of Critical Realism*, 16(4), 368–382. <https://doi.org/10.1080/14767430.2017.1347444>
- Kellam, N., Gerow, K., & Walther, J. (2015). Narrative Analysis in Engineering Education Research : Exploring Ways of Constructing Narratives to have Resonance with the Reader and Critical Research Implications. *American Society for Engineering Education*.
- Kim, J.-H. (2016). Narrative Data Analysis and Interpretation: Flirting with Data. *Understanding Narrative Inquiry*, 185–224. <https://doi.org/10.1002/ajhb.22346>
- Kitcher, P. (2017). The Importance of Dewey for Philosophy (and for Much Else Besides). *Preludes to Pragmatism: Toward a Reconstruction of Philosophy*, 21(4), 359–379. <https://doi.org/10.1093/acprof>
- Knight, D. W., Gewirtz, C., & Chowdhury, T. M. (2019). The impact of capstone design courses on new engineering graduates preparation for teamwork: A mixed methods investigation. In *Proceedings of the 8th Research in Engineering Education Symposium, REES 2019 - Making Connections*.
- Korte, R., Sheppard, S., & Jordan, W. (2008). A Qualitative Study of the Early Work Experiences of Recent Graduates in Engineering. In *American Society for Engineering Education Annual Conference*. Pittsburg, 2008.
- LaCroix, J. & Pratto, F. (2015). Instrumentality and the denial of personhood: The social psychology of objectifying others. *Revue internationale de psychologie sociale*, 1(1), 183-211. <https://doi.org/> Garai, László. “Social Identity: Cognitive Dissonance or Paradox?” *New Ideas in Psychology* 4, no. 3 (1986): 311–22.
- Lambrinidou, Y., Rhoads, W. J., Roy, S., Heany, E., Ratajczak, G. A., & Ratajczak, J. H. (2014). Ethnography in Engineering Ethics Education : A Pedagogy for Transformational Listening. In *ASEE Annual Conference and Exposition*.
- Leydens, J. A., & Lucena, J. C. (2014). Social Justice : A Missing , Unelaborated Dimension in Humanitarian Engineering and Learning Through Service. *International Journal for Service Learning in Engineering*, 9(2), 1–28.
- Leydens, J. A., & Lucena, J. C. (2017). SOCIAL JUSTICE IS OFTEN INVISIBLE IN ENGINEERING EDUCATION AND PRACTICE. *Engineering Justice: Transforming Engineering Education and Practice*, 45–66.
- Leydens, J. A., & Lucena, J. C. (2017). ENGINEERING DESIGN FOR SOCIAL JUSTICE. In *Engineering Justice: Transforming Engineering Education and Practice* (pp. 1–274). <https://doi.org/10.1002/9781118757369>
- Loui, M. C. (2005). Ethics and the development of professional identities of engineering students. *Journal of Engineering Education*, 94(4), 383–390. <https://doi.org/10.1002/j.2168-9830.2005.tb00866.x>

- Lucena, J. C., Schneider, J., & Leydens, J. A. (2010). Engineering and Sustainable Community Development. *Synthesis Lectures on Engineers, Technology, and Society*, 5(1), 1–230. <https://doi.org/10.2200/S00247ED1V01Y201001ETS011>
- Lutz, B. D. (2017). Into the Workplace: Exploring the Learning Experiences of Recent Engineering Graduates during the School-to-Work Transition.
- Lutz, B. & Paretto, M., (In Press) Exploring the social and cultural dimensions of learning for recent engineering graduates during the school-to-work transition. *Engineering Studies*.
- Mambrol, N. (2016). Strategic Essentialism. Retrieved from <https://literariness.org/2016/04/09/strategic-essentialism/>
- Marshall, D., & Case, J. (2010). Rethinking ‘disadvantage’ in higher education: a paradigmatic case study using narrative analysis. *Studies in Higher Education*, 35(5), 491-504. <https://doi.org/10.1080/03075070903518386>
- Mathias, B. D. (2014) WEARING MANY HATS: ROLE IDENTITY AND ENTREPRENEURSHIP OVER TIME. PhD diss., University of Tennessee. https://trace.tennessee.edu/utk_graddiss/3151
- McMillan, C. (2018). “I’ve Learned to Question Everything”: Critical Thinking, or, the Pedagogical Logic of Late Capitalism. *Journal for Critical Education Policy Studies (JCEPS)*, 16(1), 1–29. Retrieved from <http://www.jceps.com/wp-content/uploads/2018/04/16-1-1.pdf>
- Melsa, J. L., Rajala, S. A., & Mohsen, J. P. (2009). *Creating a Culture for Scholarly and Systematic Innovation in Engineering Education*. *Journal of Engineering Education* (Vol. 98). <https://doi.org/10.1002/j.2168-9830.2009.tb01019.x>
- Mintz, B. (2021). Neoliberalism and the Crisis in Higher Education: The Cost of Ideology. *American Journal of Economics and Sociology*, 80(1). Retrieved from <https://onlinelibrary.wiley.com/doi/epdf/10.1111/ajes.12370>
- Mirón L. (2017) Collective Praxis: A Theoretical Vision. In: Peters M.A. (eds) *Encyclopedia of Educational Philosophy and Theory*. Springer, Singapore. https://doi-org.ezproxy.lib.vt.edu/10.1007/978-981-287-588-4_79
- Mishler, E. (1986). *Research interviewing: context and narrative*. Boston: Harvard University Press.
- Mulvaney, D. (2013). Opening the Black Box of Solar Energy Technologies: Exploring Tensions Between Innovation and Environmental Justice. *Science as Culture*, 22(2), 230–237. <https://doi.org/10.1080/09505431.2013.786995>
- NAE, National Academies of Science, National Academy of Engineering, & Institute of Medicine. (2011). *Expanding Underrepresented Minority Participation. Public Policy*. National Academies Press. <https://doi.org/10.17226/12984>
- National Academy of Engineering. (2004). *The Engineer of 2020. The Engineer of 2020*. Washington D.C.: National Academies Press. <https://doi.org/10.17226/10999>
- Noble, D. (1977). *America by Design: Science, Technology, and the Rise of Corporate Capitalism*. Oxford University Press.
- Nudelman, G. (2018). A Social Realist Study of Development in Engineering Education. Rhodes University.
- Nussbaum, M. (1995). Objectification. *Philosophy and Public Affairs*, 24(4). Retrieved from <https://www.mit.edu/~shaslang/mprg/nussbaumO.pdf>
- Nussbaum, M. C. (2011). The Central Capabilities. In *Creating Capabilities*. <https://doi.org/10.4159/harvard.9780674061200>

- O'Connor, D., Schonsheck, J., & Wright, R. H. (2018). Debating Capitalism in Interdisciplinary Education: An Example of Informed, Yet Willfully Thoughtless, Argument. *Conflict Resolution and Negotiation Journal*, (4).
- Ottinger, G. (2017). Making sense of citizen science: Stories as a hermeneutic resource. *Energy Research and Social Science*, 31(June), 41–49. <https://doi.org/10.1016/j.erss.2017.06.014>
- Ornelas Martins, N. (2016). Justice and the Social Ontology of the Corporation. *Journal of Business Ethics*, 17–28. <https://doi.org/10.1007/s10551-016-3360-y>
- Paretti, M. C. (2008). Teaching Communication in Capstone Design: The Role of the Instructor in Situated Learning. *Journal of Engineering Education*, 97(4).
- Paretti, M., Ford, J. D., Howe, S., Kotys-Schwartz, D., & Ott, R. (2021). *Research Methods for the Capstone to Work (C2W) Project*. Retrieved from <https://vtechworks.lib.vt.edu/handle/10919/102437>
- Paretti, M. C., & Mcnair, L. D. (2012). Analyzing the intersections of institutional and discourse identities in engineering work at the local level. *Engineering Studies*, 4(1), 55–78. <https://doi.org/10.1080/19378629.2011.652120>
- Patton, M. Q. (2002). *Qualitative research & evaluation methods* (3rd ed.). Sage Publications
- Pawley, A. (2008). What Counts as “Engineering”: Toward A Redefinition. In C. Baillie, A. Pawley, & D. Riley (Eds.), *Engineering and Social Justice: In the University and Beyond*. <https://doi.org/10.1016/B978-1-890661-40-3.50006-5>
- Pawley, D. L. “Universalized Narratives: Patterns in How Faculty Members Define ‘Engineering.’” *Journal of Engineering Education* 98, no. 4 (2009): 309–19. doi:10.1002/j.2168-9830.2009.tb01029.x.
- Perry, L. (2021). *A MULTI-CASE STUDY ON THE TRANSFER OF ENGINEERING LEARNING BETWEEN CAPSTONE AND WORK*. Virginia Tech.
- Polkinghorne, D. (1988). Research with Narrative. In *Narrative Knowing and the Human Sciences* (pp. 161–177).
- Reckwitz, A. (2002). Toward a Theory of Social Practices: A Development in Culturalist Theorizing. *European Journal of Social Theory*, 5(2), 243–263. <https://doi.org/10.1177/13684310222225432>
- Riessman, C. K. (2001). Analysis of Personal Narratives. In J. Gubrium & J. Holstein (Eds.), *Handbook of Interviewing* (pp. 1–41). Sage Publications. <https://doi.org/http://dx.doi.org/10.4135/9781412973588>
- Riessman, C. K. (2002). *Narrative Analysis. The Qualitative Researcher's Companion*. Retrieved from <http://ci.nii.ac.jp/naid/110009909186/ja/>
- Riley, D., (2008). *Social Justice and Engineering. Synthesis Lectures on Engineers, Technology, and Society* (Vol. 7). Morgan & Claypool Publishers.
- Riley, D.. “Facepalms and Cringes: Liberal Education Misapprehended.” *Engineering Studies* 7, no. 2–3 (2015): 138–41. doi:10.1080/19378629.2015.1062499.
- Riley, D., Joseph, G., Jalali, Y., & Adams, S. (2016). Citizen Engineering: Disrupting Expertise in Classroom and Community. In *ASEE Annual Conference & Exposition*. New Orleans, LA.
- Rulifson, G. (2019). Designing Engineering Careers in Social Justice and Peace. In *The 14th Annual Engineering, Social Justice and Peace Conference*. Windsor, NY.
- Saldaña, J. (2015). *The Coding Manual For Qualitative Researchers*. Sage Publications.
- Schön, D. (1983). *The Reflective Practitioner*. Basic Books.

- Secules, S., Gupta, A., Elby, A., & Tanu, E. (2018). Supporting the Narrative Agency of a Marginalized Engineering Student. *Journal of Engineering Education*, 107(2), 186–218.
<https://doi.org/10.1002/jee.20201>
- Seely, B. E. (1995). SHOT, the History of Technology, and Engineering Education. *Technology and Culture*, 36(4), 739–772.
- Sen, A. (2009). Lives, Freedoms and Capabilities. *The Idea of Justice*, 225–268. Retrieved from <http://files/6676/Sen - 2009 - Lives, Freedoms and Capabilities.pdf>
- Seron C, Silbey SS, Cech E, Rubineau B. Persistence Is Cultural: Professional Socialization and the Reproduction of Sex Segregation. *Work and Occupations*. 2016;43(2):178-214.
 doi:[10.1177/0730888415618728](https://doi.org/10.1177/0730888415618728)
- Silbey, S. S. (2015). The elephant in the room: constraints and consequences of a four-year undergraduate engineering degree. *Engineering Studies*, 7(2–3), 164–167.
<https://doi.org/10.1080/19378629.2015.1062488>
- Slaton, A., & Pawley, A. (2015). The Power and Politics of STEM Research Design : Saving the "Small N". In *ASEE Annual Conference & Exposition*. Seattle, WA.
- Smith, J. M., & Lucena, J. C. (2016). Invisible innovators: how low-income, first-generation students use their funds of knowledge to belong in engineering. *Engineering Studies*, 8(1), 1–26.
<https://doi.org/10.1080/19378629.2016.1155593>
- Smith, L. T. (1999). Imperialism, history, writing, and theory. *Decolonizing Methodologies: Research and Indigenous Peoples*, 19–41. Retrieved from http://books.google.com/books/about/Decolonizing_Methodologies.html?id=Nad7afStd8C&pgis=1
- Sochacka, N. W., Walther, J., & Pawley, A. L. (2018). Ethical Validation: Reframing Research Ethics in Engineering Education Research To Improve Research Quality. *Journal of Engineering Education*, 107(3), 362–379. <https://doi.org/10.1002/jee.20222>
- Spring, J. (2016). The Purposes of Public Schooling. In *American Education* (19th ed.). McGraw-Hill Education.
- Tonso, K. L. (2006). Student engineers and engineer identity: Campus engineer identities as figured world. *Cultural Studies of Science Education* (Vol. 1). <https://doi.org/10.1007/s11422-005-9009-2>
- Trevelyan, J. (2019). Transitioning to engineering practice. *European Journal of Engineering Education*, 44(6), 821–837. <https://doi.org/10.1080/03043797.2019.1681631>
- Trevelyan, J., & Williams, B. (2018). Value creation in the engineering enterprise : an educational perspective. *European Journal of Engineering Education*, 0(0), 1–23. <https://doi.org/10.1080/03043797.2017.1421905>
- Tyson, R. (2016). What Would Humboldt Say: A Case of General Bildung in Vocational Education? *International Journal for Research in Vocational Education and Training*, 3(3), 230–249.
<https://doi.org/10.13152/IJRVET.3.3.4>
- Vanasupa, L., Stolk, J., & Herter, R. J. (2009). The Four-Domain Development Diagram: A Guide for Holistic Design of Effective Learning Experiences for the Twenty-first Century Engineer. *Journal of Engineering Education*, 98(1), 67-81,
- Visanich, V. (2020). Neoliberal Intersubjectivity: A Way of Doing Things. In *Education, Individualization and Neoliberalism : Youth in Southern Europe*. Bloomsbury Publishing Plc.
- Walker, E. A., Pettit, J. M., & Hawkins, G. A. (1968). Goals of Engineering Education. Retrieved from https://www.asee.org/documents/publications/reports/goals_of_engineering_education.pdf
- Walther, J., Sochacka, N. W., & Kellam, N. N. (2013). Quality in interpretive engineering education research: Reflections on an example study. *Journal of Engineering Education*, 102(4), 626–659.
<https://doi.org/10.1002/jee.20029>

- Walther, J., Miller, S. E., & Sochacka, N. W. (2017). A Model of Empathy in Engineering as a Core Skill, Practice Orientation, and Professional Way of Being. *Journal of Engineering Education*, 106(1), 123–148. <https://doi.org/10.1002/jee.20159>
- Walther, J., Sochacka, N. W., Benson, L. C., Bumbaco, A. E., Kellam, N., Pawley, A. L., & Phillips, C. M. L. (2017). Qualitative Research Quality: A Collaborative Inquiry Across Multiple Methodological Perspectives. *Journal of Engineering Education*, 106(3), 398–430. <https://doi.org/10.1002/jee.20170>
- Watts, J.H. (2009), ‘Allowed into a Man's World’ Meanings of Work–Life Balance: Perspectives of Women Civil Engineers as ‘Minority’ Workers in Construction. *Gender, Work & Organization*, 16: 37-57. <https://doi.org/10.1111/j.1468-0432.2007.00352.x>
- Wells, K. (2017). Framework for Collection of Narrative Data. *Narrative Inquiry*, 21(4), 359–379.
- Wenger, E. (1998). *Communities of Practice*. Cambridge, U.K.; New York, N.Y: Cambridge University Press.
- Wilson-Lopez, A., Mejia, J. A., Hasbún, I. M., & Kasun, G. S. (2016). Latina/o Adolescents’ Funds of Knowledge Related to Engineering. *Journal of Engineering Education*, 105(2), 278–311. <https://doi.org/10.1002/jee.20117>
- Winner, L. (2017). The Cult of Innovation: Its Colorful Myths and Rituals. Retrieved from <https://www.langdonwinner.com/other-writings/2017/6/12/the-cult-of-innovation-its-colorful-myths-and-rituals>
- Wisnioski, M., Hintz, E. S., & Kleine, M. S. (2019). Remaking the Innovator Imperative. In *Does America Need More Innovators?* Cambridge, MA & London, England: MIT Press.
- Zwolinski, M., Wertheimer A., (2017) Exploitation. *The Stanford Encyclopedia of Philosophy*. <https://plato.stanford.edu/archives/sum2017/entries/exploitation/>.