“We’re Still Writing That Story”

How Successful Women Engineers Use Narrative Rhetoric to Open Possibilities for Change

by

Sean Moxley-Kelly

A Dissertation Presented in Partial Fulfillment
of the Requirements for the Degree
Doctor of Philosophy

Approved October 2020 by the
Graduate Supervisory Committee:

Patricia Boyd, Chair
Shirley Rose
Mark Hannah

ARIZONA STATE UNIVERSITY

December 2020

ABSTRACT

Women are under-represented in engineering, in school and in the workplace. Reasons for this include the socio-historical masculinization of technology, which has been established by feminist technology researchers such as Faulkner, Lohan and Cockburn, and makes developing role models of women engineers difficult. The under-representation of women in engineering is a social problem that typically lies outside the area of interest of rhetoricians. However, my dissertation considers storytelling by women engineers as a powerful rhetorical tool, one that is well-suited for the particular structural inequalities endemic to engineering. I analyze stories told by participants in an oral history project conducted by the Society of Women Engineers, with women engineers who worked between the 1940's and the early 2000's. I use a textual coding research method to reveal the claims participants make through stories, themes that are evident across those claims, and how women engineers effectively use stories to advance those claims.

My study extends the scholarly understanding of the rhetoric of engineering work. I find that in their stories participants argue for a complex relationship between social and technical work; they describe how technical thinking helps them work through social problems, how technical work is socially situated, that an interest in technical work impacts family and interpersonal relationships, and how making career decisions is facilitated by social relationships. They also demonstrate considerable rhetorical expertise in their use of narrative. As a collection these stories meet a pressing need: the need for an understanding of engineering and women engineers that creates possibilities for change. They meet this need first by helping the audience understand both significant systemic oppressions and the problem-solving individual actions that can be taken in response (in ways that highlight possibilities without placing the full responsibility for change on women engineers), and second by illustrating a heterogenous understanding of engineering and women engineers (in order to avoid essentializing women and essentializing technology). As a result of these qualities, the stories are a way to get to 'know' engineers and engineering from a distance, which is exactly the pressing lack felt by so many potential women engineers.

ACKNOWLEDGMENTS

Thank you to my dissertation chair, Dr. Patricia Boyd, for her considerable support, encouragement and patience for the past three years, and especially for her guidance during our many helpful conversations on refining the direction of this research project.

Thank you to my committee members, Dr. Shirley Rose and Dr. Mark Hannah. In addition to their useful feedback, they supported me in the valuable professional opportunities I participated in while in this program.

Thank you to the graduate students and former graduate students who helped and inspired me: Gregg Fields, Maria Ocando Finol, William Kruger, Shannon Lujan, and Katherine Morelli.

Thank you to my wife, Rachel. This project would not have been possible without her inspiration.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Figure Page

CHAPTER 1

I would like to begin with two representations of women in engineering. Both of these were provided by the Society of Women Engineers (SWE), the largest professional association devoted to helping women "Aspire, Advance, Achieve" in engineering. The first representation is titled "Profile of the Woman Engineer." Published by SWE regularly from the early-1970's to the mid-1980's, "Profile of the Woman Engineer" contained data from the Society's yearly Member Survey. Each edition of about 25, 8.5"x11" black-and-white pages presented dozens of graphs, charts and tables depicting women engineers' employment status, education, salary, age and experience, along with explanatory notes on these statistics. Each edition opened with a profile like the one below (this one drawn from the 1974-75 edition):

> The typical woman engineer whose description emerges from this study is a 27-year-old holder of a degree in electrical engineering who has been working for three years. She is employed full-time by a private business in the field of aerospace, as an aerospace engineer. She spends most of her time on analysis, design, and development, and is beginning to do some administration although she doesn't have any direct supervisory responsibilities.
>
> She has some education beyond the bachelor's degree, and she is a member of the major professional society in her chosen field, but she does not hold state registration.
>
> Her income in 1973 was $15,200, up from $14,210 in 1971.
>
> She is married, has one child, and lives in a large California city. She keeps in close touch with her almost-as-prototypical friend who was a year behind her in college. This friend is now a mechanical engineering in the New York City area. ("Profile of the Woman Engineer, 1974-1975," 1975)

The profile offered here was distributed to SWE members at the yearly convention and beyond to interested parties. Judging from the correspondence also included in the SWE archive, it was the result of considerable time and careful thought by members of SWE's Statistics and Publicity committees ("Profile Draft" in 108-15).

Presumably this profile was meant to convey appealing facts about women in engineering, with this prototypical engineer serving as an example: she earns *good* money, lives in *sunny* California or *metropolitan* New York, maintains *long-term* friendships, and is *accepted* by her professional peers. Except, of course, that that the original lacks any of those italicized, value-laden terms. As written, the profile is an assortment of means, medians and modes. More significantly, it offers little in the way of clues that help a reader produce meaning from the information and reduces all female engineers to a single woman and her "almost-as-prototypical" friend, suggesting that there are one or two representative ways of being a woman in engineering. Engineers are likely to believe that "facts speak for themselves" (Winsor, 2003, p. 59), but the facts here don't tell us much about the kinds of work-life women in engineering can expect.

The second representation of a woman in engineering is a story. This autobiographical narrative is told by Lois Bey, who was the first woman to receive an engineering degree from the University of Illinois, in 1950. It's included in a collection of Oral Histories collected by SWE in the early 2000's. During her long career Bey worked in the chemical engineering industry in roles including development, sales, and research. In this story, about Bey's time working in a chemical laboratory developing products and materials such as fire extinguishers, she illustrates some of the ways that the expected technical challenges of working in engineering are complicated by troublesome men. She also claims that she "sat and thought" in order to overcome those challenges and achieve a satisfying success in her field. Here is Bey's story:

> So anyway, after that time I mentioned I got onto this special team. I was assigned to a special project by the manager of the department as another test, after being sort of tried and convicted and sentenced for something I didn't do. And this one, we made ozone, but not by a generator, but called an Ozonator.

We made it in very low percentage. But you had to use glass pipe in order to see what's going on -- Pyrex pipe, and stainless steel tubing. I had it in a pump; the pump wouldn't last. So I can bend copper tubing and aluminum tubing, but stainless steel is physically a little bit hard for me.

So there were three men in the next lab who also had to set up something with stainless steel tubing. And I asked them to help me, and they said no, since I was an engineer and wanted to work as an engineer, I've got to learn to do the same work as a male engineer.

So based on George's philosophy, I sat and thought about it, got the tubing bender out, marked all my tubing, took my tubing and my bender down to the machine shop, put one handle of the tube bender in the vice, put my tubing in place, and I sort of hung on to the other end, and I bent all of my tubing. So then, I went back to the lab, set up all my equipment.

That evening, the men came out moaning and groaning about their poor fingers. And I said, "You poor fellows." And they said, "Well, you'll face it when you do your setup." I said, "Mine's done." They looked in and couldn't believe it and wanted to know who helped me. And I simply said, "Me, myself and I. I did it." And they said, "How did you do it?" And I was very nasty. I said, "That's for you to learn and find out." I never did tell them. (Bey, 2003, pp. 73-74)

Bey's story works in ways that the highly-abstracted "Profile of a Woman Engineer" cannot. It does not shy away from the challenges of working in her field, including being "tried and convicted and sentenced for something I didn't do" and unhelpful coworkers and the physical challenge of bending steel pipe. The point of the story is not those challenges, but instead Bey's ways of overcoming them to achieve success in her chosen field. Some of these points include: Brains matter more than brawn. You can get back at difficult coworkers. There are many tools at your disposal. Mentors can provide useful advice. Bey's story is clear about the specific

challenges of being a woman in engineering while arguing that engineering is a possible and rewarding career for women. It does all this while helping us understand who Bey is – the values and priorities that constitute her professional identity. And, clearly, it does all of this in an interesting and inviting way.

Bey's story is just one example of many such stories included in a collection of oral history interviews recorded by SWE. These interviews, available in the SWE archive, are diverse, with participants working in a variety of disciplines (including aeronautical and aerospace engineering, electrical engineering, chemical engineering, mechanical engineering, and engineering education) and working between the 1940's and the early 2000's. However, the diverse participants are united by their commitment to the field and persistence in the face of challenges. In these interviews, participants tell hundreds of stories about their educational experiences, entry into the workplace, workplace discrimination, personal achievements, the Society of Women Engineers, and many other topics. These stories have considerable sociohistorical value: they plainly reveal decades of practices in the engineering field, and effectively highlight those practices that make engineering difficult for women. More importantly, they show how women have and are responding to those challenges. In these stories, we see women's responses to engineering challenges illustrated in engrossing ways.

These stories also have rhetorical value: they reveal women engineers making use of the particular rhetorical powers of narrative, despite the stereotype of engineers as lacking (or actively rejecting) rhetorical expertise. The participants in SWE's Oral History programs configure their experiences into rhetorically impactful narratives that argue for the efficacy of their actions and the benefits of persisting in engineering. Bey's story is just one example of this. In this dissertation, I will use a textual coding research method to explore these stories: to reveal the claims women engineers make through stories, themes that are evident across those claims, and how women engineers effectively use stories to advance those claims.

My research question is:

RQ: What claims do the women engineers included in SWE's Oral History collection make in the stories and narratives they tell? How do participants use stories to effectively argue these claims?

This dissertation suggests that stories from successful women engineers can provide a needed way of understanding women in engineering. The "Profile of the Woman Engineer" illustrates some of the serious challenges in communicating about women in engineering. I do not include the "Profile" here to criticize SWE for a text they published more than four decades ago – promoting engineering to women by listing a series of positive facts about engineering probably seemed to be a self-evidently good idea to the 1974 SWE Statistics and Publicity committee. Nevertheless, the "Profile of a Woman Engineer" is a valuable point of comparison. Because it presents one abstracted woman engineer and does not provide information about how she navigates the challenges endemic to her work, the "Profile" might provide a model of a successful woman engineer, but it does not model *how to be* a successful woman engineer. Although four decades have passed, that need has still not been met: a lack of many, varied, accessible and persistent models of women in engineering, actively engaging in engineering practices, makes it harder for other women to see themselves as engineers, and especially as successful engineers.

In contrast, some benefits of narrative as a rhetorical tool to represent successful women engineers is that narrative allows these participants to illustrate systematic discrimination while focusing on their own, active and productive responses to challenges. Through richly contextual information and by positioning individual actions as responses to situations (including outright discrimination) both challenges and actions can be kept in focus by storytellers. The SWE Oral Histories collection as a whole presents a much-needed heterogeneity of responses; by including

a variety of voices there is less risk of essentializing engineering or gender.[1] As a result of these qualities, readers/listeners of these stories can see what women do and why, understand them and their actions in context, and understand the complexity and variety of being a woman in engineering. The stories are a way to get to "know" engineers and engineering from a distance, which is exactly the pressing lack felt by so many potential women engineers.

In analyzing the SWE Oral Histories I found many examples of women making rhetorically effective claims that function in the above ways. In the following chapters I organize these claims into twelve Lessons, because I believe they are meant to serve as such for women on the cusp of engineering. The lessons I will discuss are:

- Lesson 1 – Technical Information Can Redress Interpersonal Problems
- Lesson 2 – Personal and Professional Information is Managed Like Technical Information
- Lesson 3 – Appreciate Being in the Right
- Lesson 4 – Walk Away, Because You Can
- Lesson 5 – "Race is the first thing"
- Lesson 6 – Brush off the Dirt, Think Through the Heavy Stuff
- Lesson 7 – Engineering Work is Not Done in a Vacuum
- Lesson 8 – Don't Expect Other People to Get It
- Lesson 9 – You Have Nothing to Lose
- Lesson 10 – You Never Know Until You Try
- Lesson 11 – Take Pleasure in Rejecting Expectations
- Lesson 12 – Mentors are Useful in Telling you to Go for It

It seems that these women engineers manage to walk a fine line, embracing both the technical and social aspects of engineering in ways that positively represent themselves and their work. In scholarship about women and engineering a recurring theme is that engineering,

---

[1] Which is not to say there is no risk, particularly in my own presentation of this material. SWE's Oral History collection contains a great variety of voices and experiences, and the participants don't generally make claims to universality. However, I am still selecting certain stories to include in these pages as a way to represent broader trends, which means I risk using the language of essentialism. I try to avoid this by drawing connections across stories while always positioning stories as an expression of one individual. The power of these stories is that they illustrate that there is no one single path to success in engineering – but rather diverse paths that can nevertheless be synthesized or mapped. If I am at times unsuccessful in avoiding essentializing gender or engineering, that is a failure of my presentation, and not of the storytellers I represent here.

masculinity, and the technical world are all closely associated, while the social world is placed in opposition, which facilitates women's exclusion from the field (cf Faulkner, 2001; Lohan, 2000; MacKenzie & Wajcman, 1999, all discussed in Chapter 2). Across these stories, women find ways of acknowledging and valuing the technical aspects of their work and the skills and experiences that go along with that. At the same time, I find evidence of women illustrating a complex relationship between social and technical work, such as how technical thinking helps them work through social problems, how technical work is socially situated, that an interest in technical work impacts family and interpersonal relationships, and how making career decisions is facilitated by social relationships. For instance, in Chapter 5, I show how these women's stories argue that engineering does not adhere to a social/technical divide. Instead, participants argue that engineering is sociotechnical, specifically that it involves individual technical problem solving (which provides valuable opportunities to take pride in one's work) performed within social constraints and socially implemented. This relative prioritization of the social aspects of engineering is atypical of discussions of engineering, and it is accomplished without erasing the technical core of the work.

THE NEED FOR RESEARCH ON STORIES OF WOMEN IN ENGINEERING

This research project will help fill multiple gaps in previously published research on gender and engineering. There are only two book-length studies that consider engineers' use of rhetoric, both by Dorothy A. Winsor: *Writing Power: Communication in an Engineering Center* and *Writing Like an Engineer: A Rhetorical Education.* As Winsor discusses in those texts, engineers have a reputation as poor rhetoricians (or, to put it another way, as awkward, stumbling nerds)(Winsor, 2003). By examining my participant's use of narrative as a rhetorical tool, I hope to add to our understanding of the engineering profession's under-appreciated rhetorical element.

Although the overlap of gender and engineering has been widely studied, that research has often focused on defining the exact scope and shape of the problem of women's underrepresentation – how few women there are in engineering and, most of all, when and where and why they leave engineering. But there has been too little research on *successful women*

engineers[2]. From the existing body of research we know the problems women engineers face, but too little about how they overcome those challenges. However, recently women's technical work has received increasing attention in academic and popular writing, some of which is intended to recover and celebrate women's successes in STEM. This trend is represented by the bestselling nonfiction book *Hidden Figures* by Margot Lee Shetterly, which tells the story of African-American women "computers" during the American Space Race, and was adapted into an Oscar-nominated film of the same name. Other recent popular publications in this vein include *The Glass Universe: How the Ladies of the Harvard Observatory Took the Measure of the Stars* by Dave Sobel and *Code Girls: The Untold Story of the American Women Code Breakers of World War II* by Liza Mundy. The stories included in this dissertation can play a valuable role in this ongoing effort.

There is also a lack of interdisciplinary research on this topic. It can be difficult to do interdisciplinary work in this field because although engineering, social sciences, and the humanities all have a stake in this issue, they also have different epistemologies and typical research methods. Research coming out of engineering (and engineering education) tends to use quantitative approaches and "systematically underuse" humanistic and social sciences practices (Pawley et al., 2016); meanwhile research from the social sciences disregards important context due to "distinct bodies of knowledge, different research approaches [and] limited cross-disciplinary learning" (Khapova & Arthur, 2011, p. 5). In contrast, my approach is influenced by feminist scholarship, which is "a perspective, not a research method," one which hopes to "represent human diversity" and "create social change," along with other priorities (Reinharz, 1992, p. 240). In order to accomplish this goal and create "connected knowing," feminist

[2] Throughout this dissertation I make reference to "successful women engineers." I define success broadly. I will discuss my data set in more detail along with my research methods, but all of the included interviews are with women I am comfortable calling successful women engineers, even though their experiences vary greatly. Some are widely-renowned for their contributions to the field. Others are early in their careers, or even taking a break from engineering work in order to focus on family and volunteering. However, all of them have earned degrees in engineering or a related field, call themselves engineers, and have persisted in the engineering field despite the myriad challenges they face. To persist as an engineer is sufficient to be a successful engineer.

scholarship is likely to be transdisciplinary (Reinharz, 1992, p. 250). My background includes technical writing in industry, and my education has included ethnic/social studies and writing, rhetoric and literacies. This project is also grounded in narrative studies, which is itself an interdisciplinary collection of scholarship spanning social sciences, psychology, linguistics, philosophy, and especially (for my purposes) rhetoric. I also employ diverse methods: my research methods incorporate elements of archival research, while I analyze my data using methods common to oral history research and interview research. Ultimately, as a scholar of rhetoric and writing, I am concerned with the content and function of the arguments which are made by the participants in SWE's research projects. With this perspective and method, I believe my research meets the need for transdisciplinary work on women in engineering.

There is also a need for research that attends to experiences of minority women engineers. As intersectional feminist theory argues, minority women will face challenges springing from how racism and sexism overlap and interact (Crenshaw, 1989). However, this analysis is limited because the available data is limited: only three minority women engineers are included in the 69 oral history interviews available from SWE. As I discuss in Chapter 3, I include all three of those women (namely, Lois Cooper, Irene Sharpe, and Yvonne Clark) in the selection of interviews I analyze. However, my analysis is focused on the stories women choose to tell and the ways they tell them. Although these women certainly faced many unique challenges, the majority of their stories do not explicitly address race. Moreover, because my method relies on synthesizing shared elements across stories through coding, with relatively less available interview data, I can come to only limited conclusions. So while I do focus on stories about race in a subsection of Chapter 4, this is not a study that can adequately address the need for intersectional research on women engineers.

Another pressing need for this research is, ultimately, practical. Gesa Kirsch asks "that research on women should also be for women" (1999, p. 2). Research on women in engineering, including this dissertation, can provide meaningful support for women in engineering and increase social justice. The lack of women in engineering-related careers is a major equity issue.

Engineering graduates are in high demand from employers, and as a result engineering degrees are the highest-paying degrees for both recent graduates and experienced professionals (Gardner & Gross, 2014). Engineering is also a high-status profession for its practitioners. However, more women in engineering is beneficial for more than just those individual women. Individuals in STEM contribute to innovation, the economy, and national defense in important ways. Engineers specifically play important roles in developing and producing technologies that address material problems from global warming to America's crumbling infrastructure to our information-technology needs. Because most engineering pursuits are team-driven, collaborative efforts, having women involved in development processes helps ensure a multitude of problem-solving perspectives are present, leading to a higher quality final product. Diverse engineering teams also help ensure that products and services meet the needs of a diverse population. For these reasons, greater diversity in engineering has been called for by the President of the National Academy of Engineering (Foor et al., 2007) and research that can support women in pursuing engineering careers is important.

WOMEN'S REPRESENTATION IN ENGINEERING

In addition, this research is needed because women are hugely underrepresented in engineering. This underrepresentation is evident in higher education, where women represent 18.4% of enrolled undergraduates in engineering, and under 20% in engineering-related disciplines such as computer science and physics (NSF, 2017). This percentage is uneven across sub-fields, with women making up nearly half of bachelor's degrees in environmental engineering and over 40% of degrees in biomedical engineering, while receiving only 10.9% of computer engineering degrees and 12.5% of electrical engineering degrees (Meiksins et al., 2017, p. 201).

The underrepresentation of women continues after graduation. The percentage of working engineers who are women is 12.9%, and women in engineering are more likely to be unemployed or partially employed (NSF, 2017). Although there has been exploration of how often women leave engineering at both educational and workplace levels, the latest research in this area seems to suggest that women generally persist through their education but are more likely to

leave the workforce (Meiksins et al., 2017). One 2008 study commissioned by SWE showed that women are more likely to leave the field for careers in other areas: three years after graduating with an engineering degree, 71% of men and 61% of women are still in engineering, and by the end of their careers 58% of men are still in the profession compared to 48% of women (Frehill, 2008a).

For all the reasons that it is important to have engineering teams with diverse gender representation, it is also important to have diversity of race. Asian Americans of all genders are well-represented in science and engineering, both in school and the workplace – they are more likely than a typical white student to pursue engineering and earn 9% of all science and engineering degrees. Asian men and Asian women are equally likely to pursue science and engineering (NSF, 2017). Underrepresented minorities (the National Science Foundation, the source of yearly reports with these statistics, uses that term to refer to African Americans, Hispanics, and American Indians or Alaska Natives) are about as likely as white students to pursue a science and engineering degree, but they are underrepresented in higher education overall (they are less likely to enroll in and graduate college). Overall, underrepresented minorities earn 21% of science and engineering bachelor's degrees, and occupy just 13% of science and engineering jobs (NSF, 2017). The percentage of minorities earning STEM degrees has been rising since 1995. Moreover, underrepresented minority *women* earn most of those degrees, 12% versus men's 9% of the 21% total (NSF, 2017; Sandrin & Borror, 2013). Despite those positive educational trends, black women and Hispanic women each make up just 2% of people working in science and engineering positions (NSF, 2017). In academia the situation is even worse. Women of color are hugely underrepresented in STEM academia, particularly at the higher levels – occupying just 1% of full professorships (Hess et al., 2013). In 2013, Nelson & Rogers pointed out that, with less than 10% of engineering faculty being women, a female engineering student could complete their degree without ever taking a class from a female teacher (Nelson & Rogers, 2003). Although the situation has improved since then, with women

now holding 17.4% of engineering professorships, women's representation is still low, especially at the higher academic ranks (Roy, 2018).

ABOUT THE SOCIETY OF WOMEN ENGINEERS

The Society of Women Engineers (SWE) is the source for much of the material in this dissertation and so deserves some attention in this introduction. SWE is the largest, longest-enduring, most notable organization for female engineers. SWE is made up of student chapters at colleges and universities, geographically-specific professional chapters, and a national organization that provides coordination and resources. SWE summarizes its goals as: "introducing young women to careers in engineering, demonstrating to employers and the public the critical role women engineers play in creative teams, and providing support to women engineers as they advance in their careers" (*The SWE Story | Society of Women Engineers*, 2012). These goals are represented by the SWE motto, "Aspire, Advance, Achieve." Each of these distinct but overlapping goals has a different audience; the organization faces the challenge of speaking to young girls, to women in engineering, and to male engineers/professionals. To young girls, SWE strives to facilitate in-person interaction in order to make the image of a woman engineer concrete and show that "women could and did go into engineering" and successfully overcome challenges (Bix, 2004). For college students SWE has tried to connect girls and students with professionals who serve as role models. Specifically, SWE's student and professional chapters have provided networking and mentoring opportunities for women, outreach to young girls and college students, social events, conferences, publications, and more. Through these means it hopes to equip its members and potential members with the tools to be successful as engineers. Simultaneously SWE has had the additional task of increasing visibility of women engineers to the broader public and engineering firms. To this end the national organization partners with companies to stage hiring events, engages in public policy advocacy, and provides awards to women in engineering in order to highlight their successes.

SWE plays an important role in this project for the following reason: First, SWE provides unique data to researchers. SWE is one of the largest organizations working to advance the

cause of women in STEM, and part of that effort has meant creating and making available to researchers these oral histories along with other archival data. Second, the data SWE produces spans the entire field of engineering and many decades. For professionals like engineers, organizational membership, i.e. for what organization you work, is less important than professional membership, i.e. what you do (Pratt, Rockmann and Kaufmann, 2006). Because the oral history interviews included in the SWE archive are with women at a variety of employers, this study can consider the context of engineering rather than the situation at a particular employer.[3]

AN OVERVIEW OF THIS DISSERTATION

This dissertation is organized in the following manner. In Chapter 2, I will ground my work in feminist theory, rhetoric, writing and linguistics scholarship, and narrative studies. I will begin by more broadly describing the relationship of this work to feminist theory. I am particularly interested in different ways of conceptualizing the cultural role of technology, of gender, and their interactions – and what implications those theories have for women's success in technology-related work like engineering. I will also explore some work done by other compositionists and rhetoricians about women and engineering. Then I will move on to defining narrative's powerful rhetorical function and why the stories participants tell are important to their oral histories and, ultimately, this dissertation.

In Chapter 3: Methods, I will describe my research methods. This project involves elements of oral history research and archival research, and I will describe each here. I will also describe my steps to collect my data, analyze it, and present it in this dissertation. Because I was not present for the interviews that form the primary material of this dissertation, one of my goals in this chapter will be to explain the method of those interviews: broadly speaking, they are semi-

[3] I would also note that although SWE is important to the *process* of my research it is not essential to the *goals* of my research. My questions are not about SWE the organization, nor did I assume a priori that the answers to my questions would involve SWE.

structured, mostly done at the participants' home, performed by trained, professional archivists, as part of grant-funded programs.

Chapter 4, 5 and 6 present my analysis of the work stories or narratives told by participants. In Chapter 4 I show that these stories argue for addressing interpersonal problems by applying strategies associated with technical thinking and technical problem solving. Elements of this approach include prioritizing getting the work done, thinking logically about even interpersonal interactions, and being direct. When these tactics don't work, these engineers have the power to leave, a useful option that these women take satisfaction with exercising. Although much scholarship has shown that the engineering ethos embraces technical thinking, this chapter reveals that these successful women engineers argue that ethos is efficacious for addressing some of the most pressing social issues facing women engineers.

Chapter 5 focuses on managing technical challenges, and specifically on two important gendered binaries that serve to reinforce women's exclusion from the field: the hard/soft binary and the technical/social binary. In this chapter, I explore the claims women make about doing technical work that complicate these binaries. In their stories, these successful women engineers argue that engineering work is "hard" but only in particular, manageable ways. They also challenge the technical/social binary by illustrating how technical work is socially situated.

In Chapter 6 I analyze the claims participants make about how to manage Intrapersonal Challenges, particularly the challenge of feeling unconfident about choosing engineering or new, challenging engineering positions. In their stories, participants define engineering as a "can't lose" career, one which involves difficult work and difficult choices, but many good options. Participants construct stories that position engineering as the clearly rational thing to do, often through clear enumeration in their narratives of costs versus benefits; this approach blends reason with the empathetic power of narrative. They further reinforce this advice by positioning personal mentors as, typically, those in their lives who provided the same advice to the storytellers themselves, i.e. valuable mentors provide the rational advice to choose engineering (and new engineering opportunities) when one is unsure or unconfident.

In these stories, participants make an argument that succeeding in engineering is possible for those that welcome novel challenges and can apply their technical thinking skills across a variety of contexts. In my concluding chapter, I will envision the place for this research in the field. I'll describe some possible applications of this research and of these stories.

MY OWN CONTEXT

As Sullivan and Porter (1997) point out, the questions which guide research are not neutral, but rather situated in a material, political and ethical context. Sullivan and Porter, echoing a long tradition of reflexivity in feminist scholarship, argue that context should be explicitly disclosed. Research questions are not neutral, but rather situated in a material, political and ethical context which should be "made manifest" (p. 5) through methodological reflexivity. Researchers should disclose the factors that guide their research (p. 9). Gesa Kirsch also calls for us to examine HOW the personal shapes our work, not just disclose our identity – to submit it to the same careful analysis we employ in other areas. She reminds us that "Reflective accounts of research are important because they remind readers that scholars are always products of their culture and history, that observations are always limited and partial, that interpretations are complex and contradictory, and that all accounts of research are open to revision and reinterpretation" (Kirsch, 1999, p. 82). To that end, here is my own story of how I came to this project.

My interest in this topic began initially with my post-college work experience. After completing my Bachelor's degree in English I began working at a for-profit firm that provided job search training (resume review, interviewing skills practice, etc.) to recently laid-off workers. This work was responsible for my general research and teaching interest in professional and technical communication. But more specifically, I developed an interest in the ways that people use language to develop an effective professional identity and articulate a place for themselves in a competitive work environment – the essential task I saw so many job seekers struggle with. I was also interested in how they recognized and responded to ways that environment involved unequal power dynamics. Because my employer was located in San Francisco, sexist and ageist hiring

practices in tech companies were a widely-discussed fact of life among my coworkers and our clients. Many of our older clients knew they faced an uphill battle in finding new work, and we assisted them with making sense of their particular challenges. While pursuing my Master's Degree from the University of Wisconsin-Madison, and now in my PhD studies, I have continued to explore how this effort to articulate a place for oneself is complicated by cultural categories like race and gender, and how this effort sometimes occurs in the face of strong and explicit resistance. I see the accessibility of high-earning and stable professions such as engineering as an issue of equity. The project sits at the nexus of my interests in identity, culture, and professionalization. It is also of personal interest to me because I am married to a woman in engineering. My wife, Rachel, is an extraordinarily capable and hard-working engineer. In an ideal world – the world I wish she lived in – she could reach her potential without any unnecessary barriers. But, barring that, the stories included in these narratives may at least help her navigate some of those barriers.

As a final note, I encourage the reader to approach this dissertation with an interest in, to put it simply, the pleasures of stories. This dissertation will relay dozens of stories, big and small, told by excellent rhetoricians, told for pleasure as well as purpose. Stories' engrossing, entertaining quality is part of what makes them rhetorically effective – this research will be most valuable if the reader will both experience and examine each story. In addition, taking pleasure in these stories is a way of paying respect to those who tell them.

CHAPTER 2

THEORETICAL GROUNDING

In this section I examine the available research that addresses in some way two broad questions: How can women succeed in engineering? How can researchers and engineers support women succeeding in engineering? At the end of this chapter I will narrowly focus on storytelling (and, by extension, attention to the stories of women engineers) as one valuable answer to these questions. Narrative offers a way for women engineers to establish and convey to an audience their professional identity; for the audience narratives help us perceive, at once, a variety of ways of being in engineering and how women engineers successfully respond to challenges that are rooted in systemic issues. These conclusions are grounded in narrative studies research which theorizes narrative as a way to make context-rich rhetorical claims.

The literature I review here also addresses concerns that underly the two key questions above. Is it important that women succeed in engineering? In the "Engineering as a Technological Practice" and "Perspectives on Women's Engagement with Technology" sections I discuss technological critiques offered by feminist scholarship, which helped us understand that engineering and technology are closely linked, and that the relationship between gender and engineering/technology is changeable, with broad social implications. Is it difficult for women to succeed in engineering and why? In the "Feminist Technology Studies" section I explore the most recent work on gender and technology being produced by interdisciplinary Feminist Technology Studies. This scholarship provides the most thorough and accurate explanation of why engineering, more than other professional disciplines and even more than other STEM disciplines, is difficult for women: it traces women's challenges in engineering to the persistent, pervasive, and artificial masculinization of engineering. It also helps us recognize the value of representing varied, heterogenous relationships between gender and technology.

What do we know about what strategies for success are available to women? In the "Practical Strategies for Success" section I explore the small body of work that investigates women's practical strategies to succeed in engineering. Although this work is directly relevant to

this dissertation, it is limited in scope and struggles with how to value women's ways of overcoming challenges without individualizing those challenges.

Finally, I discuss "Narrative and Stories" as a way to meet some of the needs made clear by the previous sections.

ENGINEERING AS A TECHNOLOGICAL PRACTICE

This dissertation discusses engineering as a technological practice, and in this section I explain why. We might typically think of technologies as items like printing presses, rockets, or automobile electronics (all artifacts designed by participants in this project), but theorists of technology argue that "technology" encompasses multiple cultural elements beyond such artifacts. Technology includes artifacts, the processes of using those artifacts, and the knowledge of those artifacts and processes required to take part in them (Banks, 2006; Webster, 1996). Technological artifacts depend on the social network in which they are situated; all aspects work together to compromise 'technology':

> An object such as a car or a vacuum cleaner is only a technology, rather than an arbitrary lump of matter, because it forms part of a set of human activities. A computer without programs and programmers is simply a useless collection of bits of metal, plastic and silicon. So 'technology' refers to human activities, as well as to objects… technology refers to what people know as well as what they do. Technology is knowledge… Technological 'things' are meaningless without the 'know-how' to use them, repair them, design them and make them. (MacKenzie & Wajcman, 1985, p. 3)

Martin Heidegger similarly defines technology as both the ends and the means of human technological activity, "the manufacture and utilization of equipment, tools, and machines, the manufactured and used things themselves, and the needs and ends that they serve" (Heidegger, 2009, p. 101). For my purposes, Heidegger's inclusion of "the manufacture… of equipment, tools, and machines" and MacKenzie and Wajcman's inclusion of "the 'know-how' to… design them" is critical. The process of designing, developing, and maintaining "technological 'things'" – and

designing, developing and maintaining the things that are used to design, develop and maintain those technological things – is the work of engineers. This means engineering is technological work, work which applies technological know-how and processes to create new technology.

Definitions such as Heidegger's opens a broad array of interlocking human activities to technological critique. Feminist technology studies, which I discuss in the following sections, thus makes engineering work an area of focus. Improving women's relationship with engineering means reimagining the relationship between gender and technology, and vice versa.

PERSPECTIVES ON WOMEN'S ENGAGEMENT WITH TECHNOLOGY

This section provides a review of theorizations of women and technology. I will first define the culturally-dominant "neutral technology" view. Feminist scholarship has, for decades, critiqued this view, with scholars variously arguing that technology is either essentially repressive or essentially liberatory. These feminist perspectives provide useful lessons for examining women's experiences in engineering. More recent Feminist Technology Studies, which I am influenced by and which I discuss in the next section, both builds and critiques the views I discuss in this section.

The Gender-Neutral Technology View

The view of technology as "fundamentally (gender) neutral," (Wajcman, 2007) is widespread in Western culture (Lohan, 2000, Lohan & Faulkner, 2004; Webster, 1996) – it is in many ways the default view of the role of technology in our culture. This view sees technology as a force which does not itself act on or effect the world with any sort of "intention," but instead is put to use by humans in ways that reflect the goals of the user (Wajcman, 2007). Technology is only a tool. Thinking in this model envisions bias, or deviations from correct technological method, as error.

This viewpoint entails a clear path to women's success in engineering: by trying hard and acting in accordance with the ideals of engineering (including its associated technological practices) women can succeed because those structures, being neutral, accommodate women as

well as men. With appropriate attitudes, interests, and behaviors women can become engineers in the same ways men do. The unfortunate implication of that view is that any woman can "make it" in engineering if she's willing to act appropriately – which positions women themselves as the cause if they are unsuccessful in engineering and problematizes their behavior (Wajcman, 1991). Men face the inverse benefit of this challenge: because they are already successful in technology work, their behaviors are naturalized and no changes are expected (Wajcman, 2007).

The neutral technology does allow for the existence of bias, which can take the form of discrimination against women. Anderson (2017) outlines the forms of possible discrimination characterized by a gender neutral view, including 1) men excluding women, 2) using science and technology to repress women, 3) ignoring women's needs that could be addressed with science and technology, and 4) failing to apply scientific principles in studies of women in order to produce biased results (for instance, poor-methodology studies that "show" women are bad at math.) But each of these is seen as a misapplication of science and technology which hurts women. In this view the challenges women engineers face are primarily related to the first form of discrimination; men using their positions and power to exclude women.

Another implication of the neutral technology view is "technological determinism." This refers to the view that technology development follows a singular path – technology inevitably begets new, better and more advanced technologies, and the form of each new technology is inevitable. In a technologically determinist view new technologies are not shaped by the society that creates them; every culture, given the same current level of technology, will "discover" the same "next" technology (Lohan & Faulkner, 2004, p. 388; Wajcman, 1991). These concepts are captured in the metaphor of the "march of progress." This viewpoint effectively erases the role of individuals or groups in effecting change; only existing technology produces new technology and whatever social shaping effects that new technology has are equally inevitable and natural. It also places technology (and thus engineering) in a position that, due to its inevitable, asocial nature, is beyond critique or reproach (Lohan & Faulkner, 2004).

In sum, in this widely-held view not only do women need to fit into existing engineering structures, but those structures are entirely natural and cannot/should not be changed. Because the current technological method is seen as inherently sound, changing the way engineering is practiced to accommodate more women is not considered.

Feminist Rejections of Technology as Inherently Repressive

Beginning in the 1960's and later, radical feminist scholarship critiqued the dominant neutral technology view and the implications that women are ultimately responsible for changing to fit into existing technological structures or failing out of them, and calling for a change in the way women relate to technology. These critics argue that technology has strong social shaping effects, technology is used in gendered ways, and is itself a gendered element of society (Cockburn, 1985; Lohan & Faulkner, 2004; Wajcman, 1991). The gendering of technology may be traced to some inherent quality of the technology or a persistent historical weight of how that technology has been seen and used. But in any case, technology is inherently something, which is where it diverges from the previous view.

A pessimistic perspective on feminist technology critique embraces Sandra Harding's 1986 publication, The Science Question in Feminism. Harding wrote that "The Woman Question" (i.e. the approach that focuses on and problematizes women's behavior) erroneously "conceptualize[s] the scientific enterprise we have as redeemable, as reformable" while the more radical "Science Question in Feminism" problematizes science itself, arguing that it's unlikely "that we can locate anything morally and politically worth redeeming or reforming in the scientific world view, its underlying epistemology, or the practices these legitimate" (S. G. Harding, 1986, p. 29). Although Harding was writing about science, other researchers applied Harding's skepticism to the related realm of technology (Wajcman, 1991), making Harding a touchstone for these critiques.

In this pessimistic paradigm, Western technology "is deeply implicated in the masculine project of the domination and control of women and nature" (Wajcman, 2007). Technology cannot be separated from the "dominant conceptions and practices of knowledge attribution, acquisition,

and justification" which serve to "systematically disadvantage women and other subordinated groups" (Anderson, 2017, para. 1). In this view, the sexist biases described in the previous section are seen not as the result of a mis-application of science and technology, but as inherent to it. Radical feminist activism during the 1960's through the 1980's critiqued medical technologies, military technologies, and domestic technologies (Cockburn, 1992) as both expressions and tools of gendered oppression. For instance, domestic technologies which women use regularly in the home (such as the blender or microwave oven, or home medicines) are culturally defined as not real or not sufficiently hard technologies, and as requiring no technical expertise – even when these technologies are complex (Cockburn, 1985). That is to say, even the definition of technology works to subjugate women, a phenomenon that played out after World War II when computer work was redefined from being clerical and feminine to being technical and masculine as women were pushed out.

Radical critiques can be read as dismissive of some women's interest in technology and engineering and, broadly, as pessimistic of technology (Lohan & Faulkner, 2004). By arguing technology is inherently oppressive, this view limits women's options and does not make space for the enthusiastic interest in technology felt by many women (Webster, 1996). This "politics of separatism… fails to take account of the diversity of technologies and technological practices and discourses in which men and women participate" (Lohan, 2000, p. 902). It is important not to ignore the fact that some of those discourses and practices are enjoyable. The pleasure men take in technical work is culturally recognized and endorsed (MellstrÖm, 2004). The pleasure women take in technical work must also be recognized, acknowledged and understood. A highly pessimistic theorization also risks placing women in a passive role as victims of technology (Wajcman, 2000; Webster, 1996), ignoring the many women (including those discussed in this dissertation) who have participated in the shaping of technology. The pessimistic paradigm is one that suggests the only way to win at technology is not to play at all, which makes it difficult to support women in technology.

However, radical feminist theorizations of technology did emphasize that technology is not, in fact, inevitable or natural, and open technology and engineering up to critique. In that way it provides a foundation for later work across disciplines, including the technological literacy work I discuss later.

Feminist Optimistic Engagements with Technology

An alternative, optimistic theorization of technology is expressed in cyberfeminism, a movement within feminism that examines the intersection of gender and digital technology (Cunningham & Crandall, 2014, p. 76; Daniels, 2009). Although cyberfeminism is a diverse movement and has certainly been critical of technological practices, it nevertheless tends towards a utopic outlook (Paasonen, 2011).

In contrast to previous views, cyberfeminism invites and considers productive women's own feelings of technological interest (Paasonen, 2011). These theorizations suggest that active, positive engagement, particularly in the role of technology creator, is important as a way to create individual and large-scale social change. The attention to the roles of user and creator remains important in engineering studies and has, in part, motivated recent work focused on engineering. An example of this is Blair et al. in "Cyberfeminists at Play", where the writers, all writing scholars and self-described cyberfeminists, describe their experiences staging a four-day residential girls' computer camp. Their approach moves participants from being just "users of technological spaces to designers of them" (2011, p. 46), and associate that move with empowerment and positive identities as "technological agents" (2011, p. 49). Blair et al. emphasize that these feelings can lead to reorganizations of young girls ways of engaging with technology and, presumably, more options for them to engage with technology in the future.

Another model of positive engagement with technology was offered by feminist theorists including Donna Haraway, notably in her "Cyborg Manifesto" originally published in 1988. Rather than reject technology, Haraway claimed to prefer identifying as a cyborg, "a creature in a post-gender world" and a post-binary world (Haraway, 2011). She asserted technology can break the boundary between physical and non-physical, a transgression she associates with "dangerous

possibilities which progressive people might explore as one part of needed political work" (2011, p. 456). Rather than positioning technology as an element of the self-reinforcing systems of domination, Haraway instead describes in technology opportunities for radical change: "there are also great riches for feminists in explicitly embracing the possibilities inherent in the breakdown of clean distinctions between organism and machine and similar distinctions structuring the Western self. It is the simultaneity of breakdowns that cracks the matrices of domination and opens geometric possibilities" (2011, p. 463).

The possibility that technology is a means to larger social changes is built on by later feminist studies of technology. In addition, recognition of the important difference between the roles of creator and user of technology is an important contribution of cyberfeminist and related optimistic feminist perspective. This distinction drives attention to engineering specifically and helps us see that engineering has broad implications implications.

The Risks of Essentializing Gender

Both the optimistic and pessimistic theorizations of technology at times essentialize gender, meaning they claim "to identify a universal, transhistorical, necessary cause or constitution of gender identity" (Anderson, 2017, sec. "Feminist Postmodernism"). They argue that women's needs or uses of technology are different from men's because women are inherently different from men; women are, for instance, more nurturing, empathetic, and/or social, and thus should either avoid certain technologies or will use them differently. Although a discussion of distinctive feminine ways might be intended to "celebrate what they see as specifically feminine" (Wajcman, 2007) it nevertheless risks reducing gender to a set of norms. This disregards those individuals who do not fit the norms, for instance (depending on one's perspective) women who feel some degree of technophilia (Webster, 1996) or have no interest in social media.[4]

[4] Men can be equally essentialized – radical critiques of technology accused men of creating destructive technologies (including but certainly not limited to military technologies) out of "womb envy," driven to destroy life by their inability to create life (Wajcman, 1991, p. 7).

Such an ideology would also suggest that women's ways of creating technology, i.e. their ways of doing engineering, are distinct. However, claims that women have distinctive modes of thought (e.g. "Women's Ways of Knowing" by Belenky, Clinchy, Goldberger, & Tarule, 1986) are controversial, and it's unclear that there's some inherently feminine way to "do" engineering work. Finally, such essentialist views complicates the possibility of creating change by suggesting there is some immutable core to femininity or technology. In this dissertation, narrative functions as a way to discuss women's ways of doing engineering while avoiding biological essentialism. I discuss this in the Narrative section.

FEMINIST TECHNOLOGY STUDIES

Recent feminist scholarship on technology, typically grouped under the label Feminist Technology Studies, argues that both technology and gender are constructed phenomena and co-constructing of each other. Overall, these recent works emphasize the importance of scholars respecting, understanding and exploring the variety of ways women productively engage with technology, including through engineering, in order to support women's engagement with technology.

This literature influences my approach to the stories in these oral histories. It shows that a retreat from technology does not attend to women's diverse technological interests, and that women can engage with technology in a variety of ways to produce positive change. In particular, it further emphasizes that adopting an identity as a creator of technology (for instance, as an engineer) creates opportunities for intervening in the ways technology shapes, restricts or enables social action.

Gender and Technology as Co-Constructing Phenomenon

Feminist technology studies has develop a theorization of technology and gender in which both are recognized as social constructions, contingent, contextual, and constructed over time – and therefor changeable (Berg, 1994; Bray, 2007; Faulkner, 2000a, 2009a, 2009b; Lohan & Faulkner, 2004; MacKenzie & Wajcman, 1999; MellstrÖm, 1995, 2004; Wajcman, 1991; Webster,

1996). Feminist technology studies has significantly raised the profile of engineering as a nexus for possible change. The constructivist philosophy builds on the previous attention to the ways that technology is socially situated and the understanding of the diversity of ways that technology can be productively engaged with. This growing body of work conceives of gender as socially constructed, meaning it is variable across time and space, and constructed through social interactions, including interactions with technologies. Technology is also seen as socially constructed, contingent on social forces, including economic interests which vary across social contexts (MacKenzie & Wajcman, 1999). Seeing both of these social elements as constructed allows for exploration of the ways they are co-constructed, and how the relationship between gender and technology is fluid (Lohan, 2000). Broadly speaking, feminist technology studies also argues for the significance of this co-constructing relationship (Lohan & Faulkner, 2004); indeed, gender and technology are inseparable: "gender relations can be thought of as materialized in technology, and gendered identities and discourses as produced simultaneously with technologies" (Wajcman, 2007). This viewpoint embraces the complexity and diversity of this relationship: Faulkner concludes her review of feminist engineering work up to 2000 by noting that "the complexity of gender and the necessary coexistence of multiple tensions—both in the lived masculine (or feminine) identities of engineers and in the material and symbolic gendering of engineering practice and culture. We have yet to acknowledge this complexity in either technology studies or gender studies, let alone make sense of it" (Faulkner, 2000a, p. 110).

One example that illustrates the co-construction of gender and technology comes from the little scholarship that sits at the nexus of feminism, engineering, and Writing, Rhetorics and Literacies. Claudia Herbst has researched the relationship between women and computer code literacy, providing an in-depth and vivid example of the way technology and gender are co-constructed in a dynamic that reinforces social hierarchies of gender. Herbst (2004) argues that computer languages share many features with traditional languages including that they "enable individuals to express their identity; like natural languages, computer languages define a community of practitioners and operate based on sets of rules" (2004, p. 360). Most importantly,

both computer and natural languages have a "social and cultural effect" (2004, p. 360). Because coding is largely the domain of men, Herbst argues that gender inequities can be and are built, by computer engineers, directly into the computer code. Moreover, because that code forms the underlying technological infrastructure which governs much of our day-to-day lives, gender inequalities in the code can construct gender inequalities in the physical world. In Herbst (2009) she further develops this theorization by exploring the litany of ways online spaces prioritize male voices and ways of speaking. She claims "gender imbalances in programming translate into gender imbalances in the use of the internet" (2009, pp. 137–138) and effectively lead to social phenomenon such as online harassment. For instance, online forums can be (and arguably are) constructed in such a way that harassment is facilitated. Thus, gender and power imbalances in access to the literacy of technology are endlessly reinscribed with each new technology: gender constructs the technology (in this case, technology is a form of literacy), while technology constructs how gender is expressed (in this case, restricting access to that literacy).

The Masculinization of Engineering

The co-construction view of gender and technology is particularly valuable because it offers the most thorough explanation of the ongoing challenges of the discrimination women in engineering face, which helps address the critical question: Why engineering? Why do women seemingly encounter such challenges field in particular? The answer explored by feminist technology studies is that, in many ways, engineering and femininity are constructed as in opposition. This opposition may have roots in engineering's "physical" past but now primarily functions as a way for men to preserve power. A thorough examination of this mutually-reinforcing dynamic is important to understanding how women can succeed in engineering.

In Machineries of Dominance, feminist scholar Cynthia Cockburn asserts that technology-associated work is always gendered. Gender is a socially constructed category, which is both expressed through work, and at the same time constructed by work. One of the ways that we learn what "femininity" and "masculinity" are is by seeing what forms of work are associated with those concepts. As Cockburn says, "Work is a gendering process" (1985, p. 168) and "the result

of this gendering process is that all behavior becomes gendered, and all interpretations of behavior too" (p. 168-169). According to Cockburn, there is no "neutral" work – all work behaviors are defined as masculine or feminine – and technology-associated work is firmly in the masculine camp. In her mid-1980's study of male engineers and men in other technology-related jobs, Cockburn reveals a general feeling among her participants that women, by nature of their femininity, are not fit for the more creative, engaging, and challenging jobs associated with the production of technology. Instead, the mainly-male engineers she speaks with "identify themselves with technology and identify technology with masculinity" (1985, p. 171). These engineers perceive men to have a "natural affinity" (p. 172) for technology, and represent themselves as "striving, achieving, engaging in the public sphere of work" while women are represented as "static, domestic, private people" (p. 185).

Other feminist technology scholars have echoed Cockburn's claim that engineering is co-constructing of masculinity. This has long historical roots. As engineering was becoming a recognized profession it was associated with outdoorsiness and sports. Frehill quotes the following typical example from a 1916 volume of Engineering News:

> Engineering appeals to boys because it requires a vigorous, active life which includes much adventure and hardship. The latter may not appeal to his mother, but a healthy boy loves to test his endurance and measure his courage and strength with full-grown men. And in engineering he can find his fill. From the bowels of the earth to the mountain peaks, there are surveys to make and railroads to build. There is work in Alaska, China, and Africa as well as in lands more like home. There are strange men and strange animals and strange currents and storms and secret dangers. (Frehill, 2004, p. 397)

Today engineering is described, particularly by male engineers, as dirty and physical and tough, practical and hands-on, an imposition of the will on inanimate technology. It's also seen as highly competitive, involving a rigorous "weed-out" process in engineering education with considerable stress and hardship (Frehill, 2004). These themes are evident in research that

examines men's opinion of engineering (MellstrÖm, 2004). All of which contrasts with the pervasive and persistent cultural image of women as soft and gentle and people-focused. Engineering is a 'self-evident' choice for men which requires no particular explanation (MellstrÖm, 1995, qtd. in Faulkner, 2009b) because it aligns with a masculine persona, while for women it is perceived as a gender inauthentic choice (Faulkner, 2009b).

This image persists even though many modern engineers perform little hands-on work (Faulkner, 2009a) and some engineering fields, such as electrical engineering, depend heavily on precision and cleanliness (Cockburn, 1985, p. 190; Oldenziel, 2009, p. 47), and even though engineering is a discipline that relies on strong people skills (Faulkner, 2000b). Whatever its origins, the idea that, as Wendy Faulkner argues, "engineering represents a particularly visible instantiation of the still durable cultural equation between masculinity and technology" (Faulkner, 2000b, p. 761) has been thoroughly supported by Faulkner's other research and the work of Ruth Oldenziel, Judy Wajcman, Karen Tonso and others (Faulkner, 2001, 2007, 2009a, 2009b; MacKenzie & Wajcman, 1999; Oldenziel, 2009; Pawley & Tonso, 2011; Wajcman, 2000, 2007).

Implications of the Masculinization of Engineering for Women in Engineering

A result of this gendering of engineering is that women who persist in engineering must face what Faulkner identifies as the key challenge for women engineers: the in/visibility paradox, "whereby women are highly visible as women yet invisible as engineers, both within their own communities of practice and in the wider world" (2009b, p. 172). Faulkner claims this is a key element of women's day-to-day interactions as engineers.

Tonso provides an example of the in/visibility challenges of women, drawn from her ethnographic study of engineering students. She describes a female student working on a yearlong capstone project with a small group. This student was assigned a majority of the difficult engineering work required by the project. Although the student successfully handled these technical challenges with her high level of technical expertise, she was nonetheless closely monitored by a male teammate who insisted on reviewing her work. However, during client and teacher presentations – the settings which led to institutional recognition - her accomplishments

were either minimized or claimed by other team members. In sum, inside her small team she was hypervisible as a woman requiring surveillance, while outside of her team she was invisible as an engineer despite her considerable accomplishments. This student did not receive the job offers and internships that her peers did (2007, p. 233), which Tonso attributes to her difficulties managing the in/visibility paradox.

This division of engineering+masculinity vs femininity makes it difficult for women to succeed in engineering. Powell, Bagilhole, and Dainty identify a "double bind" effect in which "women engineers who perform in highly feminine ways are likely to be considered incompetent and competent women engineers are seen as unfeminine; thereby instilling a norm whereby only male masculinity is likely to be accepted in the current situation" (A. Powell et al., 2009, p. 425). Tonso similarly argues that "women student engineers were constructed as deficiently women if they were successful engineers and deficiently engineers if they are successful women" (Tonso, 2007, p. 233). In an ethnographic study of engineering students, Tonso found that the group labels associated with engineering success were gendered male-specific (for instance, students referred to over-achievers as "nerdboy" but there was no "nerdgirl" equivalent). As one of their participants put it, "'You don't think of women as [nerds]'" (Tonso, 2007, p. 218). For these students there is no identity framework for women to be seen as full-fledged engineers and as women – the language to conceptualize that concept simply does not exist.

Ways Forward in Feminist Technology Studies

Although these challenges are very real, the recent work that explores the co-construction of gender and technology is productive: this theorization allows for the possibility of re- or de-constructing the divide between femininity and gender, and thus supporting women's engineering work. Exactly how to create change is unclear, but some keys can be drawn from the above review. A first step is to embrace "human agency and creativity in relation to technology" (Berg, 1994, p. 95), particularly women's creative engagement with technology. It is also important to prioritize women's positions as technology designers. The social constructivist view implies "that in a very real sense, those who design new technologies are, by the same stroke, designing

society" (Lohan & Faulkner, 2004, p. 322) including gender in society. Engineering is thus an area of focus because it is engineers that design technology and are in position to re-construct the gender/technology relationship (Faulkner, 2000b).

It is also important to avoid an essentialism which limits women's options or restricts the construction of gender and/or technology. Wendy Faulkner's study of gender and engineering concludes with the call to actively avoid essentialism, saying that "engineering as a profession must find ways to foreground and celebrate heterogeneous understandings of engineering and heterogeneous engineering identities" (2001, p. 351). Other engineering scholars have echoed this call for embracing variety in our understanding of women's ways of being in engineering or using technology (Bystydzienski & Brown, 2012; Hughes, 2001). Heterogeneity creates openings for women to participate in engineering on their own terms, whatever those are, complicating the pernicious engineering-femininity contradiction.

Embracing heterogeneity may be a way to make engineering relatable to young girls without pandering to them or limiting their options. Boys are surrounded by models of men successfully engaging in STEM work, but young women in engineering have difficulty finding role models that they identify with (Ibarra, 1999). Unfortunately, girls are less likely to have ways of seeing that heterogeneity, less likely to have role models that demonstrate multitudinous ways of being a female engineer. Having those models would help girls imagine a "repertoire of possible selves" – a pool of narrative models from which they can draw and try on as they navigate their work lives (Ibarra, 1999).

Thus, feminist technology studies has emphasized a need for a way of articulating heterogenous models of engineering identity and processes to support women's engineering success. Later in this chapter, I will describe narrative as a powerful rhetorical tool to achieve this objective. Before turning to narrative, I will first consider scholarship that investigates women's current strategies for success in engineering.

PRACTICAL STRATEGIES FOR SUCCESS

There is a bounty of research that investigates the difficulties women face in engineering. In contrast, there is only a small amount of research that tries to investigate how women succeed in engineering, particularly in the workplace. In this section I discuss that research, most of which comes from organizational studies scholarship, and generally does not overlap or reference the feminist technology studies I have been discussing. Nevertheless, it is important because this is the only work which directly queries (whether through observations, interviews, surveys or some other method) women's strategies for success. There is too little of this research, and particularly too little about women at work (undergraduate engineering students are, as always, more accessible to university researchers, so strategies for school success are more studied). The research here does not reveal any "magic bullet" solution to address women engineer's problems. It is my belief that what does exist tends to drastically reduce women's experiences to a small number of equally-bad "options."

Three Strategies

The first strategy that women take is becoming "one of the boys" (Evetts, 1998; Kvande, 1999; Ranson, 2005). In this approach, women operate as "conceptual men," accepting the values of the engineering workplace and succeeding on the terms laid out by the male majority. Women using this approach tend to see engineering as gender-neutral work (Ranson, 2005). They work to be like the men they work with, for instance by describing their motivations for working as being the same as men's (Ranson, 2005), i.e. money, respect, satisfaction in technical work, etc. This group also commits especially strongly to downplaying the effect of discrimination (Jorgenson, 2002), and instead emphasize – like male engineers do – that technical competence and excellent performance in the workplace will override any gender-related concerns (Evetts, 1998, p. 288).

Motherhood, inevitably, is the nexus around which these tactics pivot. Women can become "one of the boys" most easily if they are younger and childless. The "conceptual cover" of masculinity "is blown when [women engineers] become, or think about becoming, mothers" (A.

Powell et al., 2009, p. 146). The physical changes of pregnancy make it impossible to deny the femininity of women engineers, and some research participants describe being treated differently during this time (A. Powell et al., 2009, p. 146). In addition, mothers face more family demands and expectation than their male peers with children. In many cases, having a family necessitates moving from the "one of the boys" strategy to one of the following strategies.

The second strategy is avoidance/blocking, which describes a set of tactics intended to avoid engaging challenging gender dynamics. This tactic can take many forms, such as taking a go-along-to-get-along attitude, or ending any gendered interactions (Hatmaker, 2013). Avoidance/blocking also includes leaving a specific employer for one perceived to be more women-friendly (Shih, 2006) or leaving engineering altogether for another career or to focus on family life. This strategy acknowledges the existence of gender-based discrimination (K. S. Powell & Jankovich, 1998), but seeks to work around that discrimination rather than confront it. Avoidance entails serious risks for women engineers because it does not fit with aspects of engineering culture. Failing to adopt the aggressive attitude expected of engineers risks the woman engineer being seen as "lacking in promotion potential" (Evetts, 1998, p. 287). Too much job-hopping can make an engineer appear undedicated, while leaving engineering altogether is clearly not a desirable outcome for anyone who wants to be an engineer. On the other hand, women relying on this strategy may make room in their lives for non-work obligations (K. S. Powell & Jankovich, 1998).

The third strategy is challenging (Kvande, 1999) or "fronting it out" (Evetts, 1998). Evetts identifies "fronting it out" as responding to discrimination through aggressive joke-making or challenging. Like "one of the boys" this approach requires building a reputation for strong engineering work. But unlike that approach, it recognizes that gender plays a role in workplace challenges. Kvande labels this an approach "based on the idea of difference. By using this strategy the challengers reject and criticize certain aspects of the culture and norms in the organization…. They actively participate on their own terms" (312). This approach risks being seen as too aggressive, confrontational, masculine or unprofessional – i.e. insufficiently feminine.

Taking a management position, which comes along with additional expectations, tends to place these risks into stark reveal. Gaining the credibility to challenge depends on having a reputation as a strong technical engineer (Hatmaker, 2013).

The Challenges of Investigating Women's Strategies for Success

The above research is limited in part because investigating women's tactics for overcoming the challenges of engineering can be difficult. Many female engineers downplay the role that discrimination plays in their career (Jorgenson, 2002), rationalize away discrimination (Hatmaker, 2013), or "frame incidents [of sexism] as minor" (Powell et al., 2009, p. 151). Faulkner suggests that this approach is intended to protect women's status. She argues that "by refuting or playing down the significance of gender, women engineers are better able to strengthen or protect their fragile membership as engineers," while in contrast, "playing up gender and heightening their visibility as 'women' can be seen (and felt) to threaten their belonging in the community of practice" and so women avoid this behavior (Faulkner, 2009b, p. 177). Similarly, Jorgenson argues that denials can be read as evidence that research on women engineers "is by definition a challenge to their professional legitimacy" (2002, p. 374). As she points out, this denial is a rhetorical move that is contextual – specifically, all researchers can say is that, when women engineers are interviewed by researchers, those women deny the significance of sexism. If participants confirm to their interviewer that discrimination is a common occurrence, how will that help their careers or their cause? It might only drive additional women from the field. As a result, they make the considered move of downplaying the role of discrimination in their work.

This research into women's tactics for navigating engineering wrestles with an inherent contradiction. When researchers emphasize the challenges women face and the compromises they make in their efforts to be successful, these tactics can read as meaningless and futile. These are individual strategies that exist in the shadow of the overwhelming historical fact of women's underrepresentation in engineering. On the other hand, when proposed solutions focus narrowly on women's own actions as a productive way forward they risk individualizing and personalizing the issues, and risk suggesting those women are responsible for fixing the situation

(Evetts, 1998, p. 146). Most of the above research wrestles with this inherent challenge in one way or another. How can we value women's individual responses to challenges without individualizing the problems they face? How do we balance our analysis between free choice and well-established gendered power structures (Henwood, 1998)?

Although this work is, as I said, largely distinct from feminist scholarship studies, these challenges further reinforce the need for ways for women, in their own voices, to productively and positively articulate a relationship to engineering. In the next section, I discuss narrative as a rhetorical device for making claims that embrace context, complexity, and productive change – without eliding over the very real challenges women in engineering face.

NARRATIVE AND STORIES

To support women who are working to succeed in engineering the above review suggests we have multiple imperatives. We can – indeed, we must – offer advice to women who are engineers or considering engineering that is useful for them; we must help them navigate the very real challenges they face. But in doing this, we must not naturalize existing structures of inequality and place the full burden of success on the individual – we must offer critiques of a broken system while we simultaneously celebrate the ways that system is navigated, challenged, and overcome. Finally, as Faulkner says, we must "foreground and celebrate heterogeneous understandings of engineering and heterogeneous engineering identities" (2001, p. 351). Developing heterogenous models can help reimagine the relationship(s) between gender and technology and create long-term change.

In this section, my first goal is to describe a theorization of stories and storytelling as persuasive (Eubanks, 2004), "inherently rhetorical, contextualized, purposeful, and dialogic actions" (Malesh, 2009, p. 132). We do not experience life as stories, but we make sense of our life in reflection by using stories, and although the data in this dissertation includes "true" life stories, we can consider the stories themselves as a series of choices made by storytellers for persuasive effect (Freeman, 2004; Gabriel, 2004; Ibarra & Barbulescu, 2010; Polkinghorne,

1988). Ultimately, I hope to position stories as a way to make context-rich claims about navigating change and challenge; they also develop identities and invite strong feelings of identification and thereby, across a collection of stories like I am analyzing, are a device to model heterogenous engineering identities and critique social structures.

Stories as a Tool to Make Sense and Structure of Human Experience

French social theorist Paul Ricouer establishes the centrality of narrative to human communication by arguing that humans make sense out of our past by transforming experience into narrative. The "ordinary notion of time" describes it as "a series of instants succeeding each other along an abstract line oriented in a single direction," a model captured in the metaphor of the arrow of time (Ricoeur, 1981, p. 170). In terms of human experience, however, when we recollect time we create "human time" out of the line – we elicit "a pattern from a succession" by assigning a beginning, middle and end at positions we choose (Ricoeur, 1981, p. 174). All human action is thus potential narrative and our experiences "remain inchoate until they can be given narrative form" (Frank, 2015, p. 37). Ricoeur calls the transformation of experience into narrative emplotment. He defines plot as that which unites the events of the story into an intelligible whole while also being governed by those events, a necessarily circular relationship he describes thusly: "A story is made out of events to the extent that plot makes events into a story" (1981, p. 167).

Plot turns a series of events, or a chronicle, into a story by linking events with causality (Boje, 2001). An example of sequential but unconnected events would be: "The King died, then the Queen died." This is not a story. In contrast, "The King died, then the Queen died of grief," is a story. It expands the original series of events by adding an element of causality, the logic which gives the events meaning (and in this case, pathos). By linking the two events into a plot, both events gain additional meaning and significance (Polkinghorne, 1988) – we understand that the King left family behind, that the Queen cared for him and is in pain because of his loss, and we are invited to attend with sympathy to the personal lives of powerful political figures. Through emplotment a deeper understanding of human experience is created. Socionarratologist Arthur W. Frank calls the affect added by plot imagination, that element of the story the story which

engages the audience. Without an element of imagination, passages of text might contain markers of being a story, but they won't feel much like a story or create interest from the audience (Frank, 2015, p. 45).[5]

Through emplotment we establish meaningful connections and causation between occurrences that, in a cosmological sense, have no inherent human meaning. Emplotment is a retroactive process; it always occurs after-the-fact, or after the end. Only when the ending has been chosen is the story – and the meaning and significance of the experience – created/found (Freeman, 2004). That is to say, telling autobiographical stories is both a creative and interpretive act. In telling stories about ourselves we are making sense of and applying meaning to our past experiences. The idea that in telling stories we make/create sense is commonly echoed in studies that consider narratives across disciplines (Boje, 1991; Eubanks, 2004; Yang, 2013).

Stories as Representations of Personal and Cultural Realities

There are a number of significant implications to thinking about even highly autobiographical stories as creative in this way. The first is that stories represent subjective experiences. Because even highly autobiographical stories about historical events are subjective constructions, studying stories is appropriate for research projects that seek to understand subjective meaning. For such purposes, debating whether a particular story is exactly true or not is beside the point – stories are valuable as a representation of the participants' perceptions of their past and their social realities.

A second implication is that when telling stories, we are making choices that can be read and assessed. In the process of telling stories we draw on a suite of narrative and rhetorical

---

[5] Boje calls the first, not-story passage a "narrative" in order to differentiate that from passages that are stories. Other scholars exactly reverse this terminology, calling the first example a story and the second a narrative (Barker & Gower, 2010a). Other scholars simply use one or the other term, or both interchangeably, and define non-stories as chronicles or something else (e.g. Polkinghorne, 1988; Polletta, 2006; Sarbin, 2004). In any case, an effort is being made to mark passages of text which contain plot, interest, imagination, or evaluation (Labov & Waletzky, 1967) from other passages. I will follow this final group and use story and narrative (and occasionally synonyms such as tale) interchangeably throughout this dissertation.

resources that we have on our disposal. One resource is of course the experience of our own lives, which can be crafted into any potential number of stories depending on how we emplot the experiences. We draw on our own lives, a "stock of narrative capital," to create our stories and develop meaning (Goodson, 2013). Another resource are the cultural stories we know. Some scholars emphasize that there are a limited number of available plots and characters, and that in telling stories we are simply drawing on that existing stock of cultural material (Frank, 2015). This narrative stock shapes, legitimates, and constrains the stories we are able to tell (Benford, 2002; Eubanks, 2004). The available stock of resources vary by culture, and even vary by subculture; we can see certain occupation-specific narrative templates (Cortazzi, 1993, p. 102; Santino, 1978). These cultural stories guide the patterns we create from the succession, using Ricouer's terms.

Stories for Understanding Successful Women in Engineering – High-Context Claims

Given that stories are rhetorical reconstructions of experience, I want to highlight some ways that stories are useful to those who want to support women's success in engineering. Given that goal, when approached for interviews, why do women engineers tell stories? What qualities of stories make them worth telling in that context? And why, as a researcher, examine them? In this context, stories matter because they provide an avenue for describing (for the storyteller) and understanding (for the listener/reader) rich contextual information – including forms of discrimination – along with responses to that context and story outcomes.

The first role of stories in these oral histories is that they are appropriate for conveying the complexity of life experiences of these participants. "Unlike other social studies research methodologies, such as surveys and structured interviews, narrative analysis opens the researcher to complex patterns. Narratives can reveal identity, values, expertise, and relationships in natural language. The complexity of stories reflects the complexity of social relationships" (Daiute & Lightfoot, 2004). These interviews represent the speech of speakers with greatly varying experiences, stretching from the 1940's to the present day, and by studying stories I can "explain phenomena without reducing them" (Daiute & Lightfoot, 2004, p. xiii). Education

researchers value stories as a way to represent an authentic expression of the speakers that resists being reduced to simple takeaways or sublimated under theoretical formulations (Elbaz, 1990). Narrative theorist David Polkinghorne argues that stories are both claim and an "exhibit of an explanation." According to Polkinghorne, narrative explanations…

> …of why one does something focuses on the events in an individual's life history that have an effect on a particular action, including the projected future goals the action is to achieve. It accepts complex sets of events, including reflective decisions, and explains an event by tracing its intrinsic relations to other events and locating it in its historical context. (Polkinghorne, 1988, p. 21)

In other words, stories help us understand the actions of the storyteller along with the past, present, and future results – we see the forest and the trees simultaneously.

As an extended example, in his book Narrative Analysis, Martin Cortazzi engages in a research project that bears many similarities to this dissertation. Cortazzi set out to study the culture and thinking of experienced teachers by examining the same types of discrete work stories, drawn from extended interviews, as I do, using similar methods. He feels that narrative is particularly appropriate for examining teachers' knowledge, because teacher knowledge is complex and "high-context" in that interpreting that knowledge requires a lot of contextual information – about the classroom, school, and teacher culture. This quality of teacher knowledge tends to lead teachers to telling narratives, and in fact narrative may be the only means to express some teacher knowledge (1993, pp. 9–10).

Although I won't argue that engineers and teachers are particularly alike, the knowledge that participants in these stories are trying to impart is certainly high-context. These women have a privileged position to speak to a set of experiences that are not accessed by most women. Their work-lives are highly structured by the physical contexts in which they operate – surrounded by technology (including, as we will see in later chapters, large industrial machinery, holding tanks, and early computers) on large corporate campuses dominated by men. They are also speaking

about situations and experiences that may be read skeptically by some listeners. Events immediately preceding or following the choices these women make through their careers are important for understanding those stories. As Cortazzi says with regards to teachers, stories, more than other forms of discourse, can convey the meaning being created by the storyteller while also conveying that supporting web of contextual information. Through emplotment, storytellers connect situation, response and outcome in a way that provides additional meaning to all aspects of the story. At the risk of being overly reductionist, my argument is that stories are the best way to understand how a woman engineer handles a specific problematic coworker, while seeing that this problematic coworker is part of a system that creates problematic coworkers, while seeing that handling one specific problematic coworker is still worth doing.

Stories for Understanding Successful Women in Engineering – Identity and Identification

If autobiographical stories help us understand the meaning of the actions in context, they also help us understand the identities of the storytellers. Self-narratives (Ibarra & Barbulescu, 2010) are claims about ourselves that constitute a flexible identity. A significant aspect of stories that is described in interdisciplinary narrative studies suggests that by telling these self-narratives to each other we model ways of being and help and encourage others to address possible future challenges. Although these claims will not necessarily be accepted, they can be powerful ways to create identification and unity. This is not a novel concept – work by rhetoricians and compositionists that is attentive to women's experiences in technology has described storytelling as a particularly powerful way to build mentorship relationships that support women in feeling a sense of "mastery" over technology (Blair et al., 2011; B. T. Williams, 2006). Cyberfeminist pedagogy also has strongly emphasized that stories are valuable for the specific goal of encouraging women to engage with technology by modeling ways of productive engagement (Haas et al., 2002).

Narratives are closed linked to identity, and frequently seen by narrative theorists as constitutive of identity. For instance, Bamberg says that narratives, "irrespective of whether they deal with one's life or an episode or event in the life of someone else, always reveal the speakers'

identity" (2004, p. 223). When we create stories from our experience, we also create ourselves – "self-articulation and self-discovery entail self-creation as well" (Freeman, 2004, p. 77). Like other narratives, self-narratives are constructed from a set of available resources (Ibarra, 2003, p. xi). Ricoeur also saw narrative and emplotment as being closely associated with identity. He called this, simply, narrative identity. This theory of narrative-as-identity allows for identity to be flexible and rhetorical, shifting and contingent, but "also not incoherent or self-alienated… For Ricoeur, this self-relationship is essentially one of active interpretation, rather than fully autonomous self-authoring" (Rhodes, 2016).

Like other claims, the audience of identity-narrative claims can assess them and choose to grant the claims they contain or reject them. According to Ibarra and Barbelescu, "Not all self-narratives are equally satisfying or effective in meeting the implicit or explicit goals that motivated their telling" (Ibarra & Barbulescu, 2010, p. 144). This includes the goal of establishing an identity. Thus, if a told story doesn't produce the intended effect(s) or impart the intended lesson it's likely to be revised for future tellings (Bamberg, 2011, 2015; Goodson, 2013; Ibarra, 1999; Ibarra & Petriglieri, 2010). The same story might be told many different ways, or different stories might be slotted in or out, all depending on context and past success. This doesn't make a given story any less true; perhaps it just begins earlier or ends later. Over time, if a story seems, to the teller, to be well-received by the audience, then that story is likely to be continue to be told and polished (Ibarra & Petriglieri, 2010). The process of creating a self through stories is iterative. Like other stories, identities can be changed. When we read the stories present in this collection, we read women "rewriting the self… a developmental process and project" (Freeman, 2004, p. 77).

Organizational scholars and technical communication scholars have also highlighted stories' value for helping us navigate change and challenge in our careers (Faber, 2002; Ibarra & Barbulescu, 2010; Malesh, 2009), including changing from one job to another or from school to the workplace. In telling stories about change, we unite past and present into a cohesive whole – connect both to the same plot with a consistent self at the center. The act of telling cohesive stories becomes an essential narrative and identity-constructing device when we face struggles

that challenge our sense of self (Faber, 2002). In addition, stories can form a useful roadmap for navigating challenge. We can re-read or re-tell these stories to remind ourselves of how to handle such challenges when they reoccur (Faber, 2002).

Finally, stories are powerful because create identification and engagement (Barker & Gower, 2010b; Davis, 2002; Polletta, 2006). Stories contain lessons (Cortazzi, 1993; Elbaz, 1990), which Labov and Waletzky say are captured in the evaluation component of stories (Labov & Waletzky, 1967 - discussed in the next chapter). But those lessons are not explicitly stated – finding Labov's evaluation takes work, and is never an exact science. In It Was Like a Fever: Storytelling in Protest and Politics, Francesca Polletta's examination of stories told by social activists, suggests that it is just the ambiguity of the lesson and the work demanded of the listener that makes stories so engrossing. Stories necessarily, inevitably leave gaps. It is up to the listener to fill in those gaps, which engages their own creativity and creates engagement and identification – stories require our "interpretive participation" (Polletta, 2006, p. 8). In stories, we accept ambiguity and the work that requires us to do, including revising our interpretation (Polletta, 1998). Already engaged in the act of deciphering the story, it is just a small step to relating it to our own lives, our past or future experiences.

In sum, to meet the imperative to "understand heterogenous engineering identities" that has been identified by Feminist Technology Studies, stories are a critical tool. According to some theorizations, stories constitute our diverse, changeable identities; they create real, authentic understanding; they are changeable but also help us establish consistency across change; they deliver lessons on how to act; and they elicit investment and engagement from others. Meanwhile, they convey rich information about individuals and contexts. Thus, stories are a rhetorical tool that meets the imperatives I describe – they help us embrace heterogeneity; they provide a way to critique structural inequalities while demonstrating, in a useful way, and celebrating ways inequalities are navigated, challenged, and overcome.

CONCLUSION

In this chapter I have tried outline the ways scholarship on women and technology, which always means also women and engineering, suggests we can support women's success in engineering. The answer is, at least in part, that technology and gender are inextricably linked, and that if engineering is going to change to be more inclusive it is going to happen, at least in part, because women are engaged with engineering – producing technology artifacts, systems, and cultures, "constructing" engineering itself. Women are going to be making arguments about diverse ways to "do" engineering, to reinvent engineering and technology more broadly. And stories are going to carry much of the weight of those arguments. Stories demonstrate both the challenge and the action taken in response to that challenge, emphasizing the strategies for success without minimizing the problems that create the need for that strategy. Stories also invite identification and understanding across diverse ways of being. Ultimately, the interviews in SWE's archive that I analyze present a much-needed rich array of tactics for overcoming engineering challenges, which I will discuss in the following chapters.

CHAPTER 3

METHOD

In this chapter I will describe my research methods. For this project, I selected oral histories from a digital organizational archive. I also visited the archive to retrieve additional documents about the collection of the oral histories and the participants. I then performed an analysis of the stories contained in those oral histories by coding the story elements using an iterative approach of cycling between the data and existing theory. As a result, this project is archival research, oral history research, and narrative analysis. Throughout this process I have been guided by feminist research principles, including respect for participants.

This chapter will be organized in the following manner. I will first discuss the archival elements of my method and the works which guided me for that portion of the project. I will then discuss the oral histories and how I selected the specific documents I am working with in this project. Then I describe how I analyzed the narrative elements of those documents.

In my research I draw a distinction between my methodologies, which are the system of values and beliefs that govern what and how I create my research question, and methods, which are the techniques I use to answer those research question (S. Harding, 1987; Kirsch & Sullivan, 1992). This chapter is focused on my methods, but my methods are guided by my methodology and, thus, my methodology will also be discussed here. Shulamit Reinharz states that feminist research involves the research as a real person, which has implications for methodology and for presentation. Regarding presentation in methods sections like this one, “The feminist researcher is likely to describe the actual research process as a lived experience… Feminist research then reads as partly informal, engagingly personal, and even confessional” (Reinharz, 1992, pp. 258-259). To that end, I will narrate my research process and endeavor to be transparent and self-reflexive.

ARCHIVES

For this project I drew on the Society of Women Engineers archive. SWE’s extensive archive was started in 1953 “to organize and share the Society’s publications, correspondence,

governance documents and administrative records" (Eller, 2012, p. 301). The physical archive is housed at Wayne State University in Detroit, Michigan and employs a full-time archivist, who also maintains the archive's digitally-accessible collections. The archive currently includes many valuable collections, including an image gallery, copies of many of SWE's promotional documents, the papers of former SWE president Ada Pressman and, of relevance here, an extensive set of interviews with SWE participants. Troy Eller, the current SWE archivist, has written that "Prior to 2002 the [SWE] archives were rarely used to support scholarly research" but a few SWE-organized exhibitions increased the archives' profile in academia following that (2012, p. 301). There are still many stories to be told from that material.

As Shirley Rose and Sammie L. Morris say,

> Because of their interest in discursive genres, rhetoric and composition researchers are likely to want more information about archival document types and forms. Because of their interest in rhetorical contexts, they are likely to have extensive and specific questions about the provenance of records and be especially interested in the form in which records were original created and the purpose for which they were created. (Morris & Rose, 2010, p. 56)

That is particularly true for this project. The interviews in SWE's archive are, ultimately, the source of my conclusions. For that reason, in this chapter I explain SWE's method for collecting these interviews, just as I would explain my methods if I had performed the interviews myself. I'll also describe my own process of acquiring and eventually analyzing these interview. In a sense, this project contains nested methods.

Discovering the Material

The impetus for this project was my discovery on the SWE archive's web page of dozens of interviews with women in engineering. Archival researchers describe the feeling of discovering something in an archive that strikes a chord, that seizes the reader's interest. Sometimes this happens when a previously-unknown document is unearthed from the bottom of a box. This is the

sensation I felt – inspired to raise the profile of these stories in whatever way possible. SWE's archivists ensured these documents were easily accessible, and the SWE organization had used samples of the material in their own promotional efforts, such as the *Petticoats and Sliderules* traveling exhibit. But, as far as I have been able to determine, no new scholarly knowledge has been produced from this material. In many of the interviews participants were asked, "What message would you give to women in engineering?" – but the answers had gone unrecognized. While this project has evolved over three years, the centrality of these oral histories to my work remains unchanged.

Archival Objectivity

The focus of this dissertation is on the oral histories I retrieved from the SWE archive's website, supplemented by physical documents from SWE's archive that elucidated SWE's interview collection process (I describe my visit to SWE's physical archive later in this chapter). The interviews were readily available online, and I spent only a small percentage of my research time engaged in what I believe is the platonic ideal of archival research: digging through boxes of documents (and those boxes I did dig through were not in a dusty basement.) Nevertheless, I describe this as an archival project because archival theory provides a needed reminder that archives are not sources of complete, objective fact.

Archives are collections of artifacts and documents which are rare, one-of-a-kind, or otherwise considered worth preserving by an archivist, and are thus always partial and subjective; this shapes the kinds of projects that happen in archival research (Connors, 1992). An archive should never be seen as containing or representing *the history*. Instead, archives contain *a history*, for a variety of reasons. One reason is that decisions about what merits inclusion in an archive are made by archivists. The "claims to objectivity associated with the traditional archive" are contradicted by the fact that archives are produced "as a result of specific political, cultural, and socioeconomic pressures" (Burton, 2005, p. 6). The work of archivists is inevitably responsive to those pressures. In addition, physical, practical realities mean what gets included in an archive is often as much a matter of chance as intention. Historians might ideally want to "save

everything" (Sentilles, 2005), but that won't happen in practice. Certain papers might end up in an archive after sitting in a pile, in a box, in an office, which survives until their historical value is recognized – while a similar box a few feet away is accidentally water-damaged by a ceiling leak. The final element of partiality is provided by the researcher, who makes choices about what to include and not include in a specific project. Each researcher "assembles" the archive and produces their own "constructive, subjective ordering" and meaning from the material (Masters, 2010). They then perform their own interpretation of those materials.

This partiality is not a limitation to be overcome, but it does shape the types of conclusions that can be drawn from archival research projects. In this archival project, I do not claim to produce a "complete" history or representation of women in engineering. Instead, this project investigates the kinds of stories women tell about their experiences, which is an appropriate and achievable goal within these constraints.

SWE's Method for Conducting Oral Histories

SWE's oral history interviews were collected as part of three research projects. In this section I will discuss the origins of each project, in order to be transparent about the forces that resulted in this material being included in this archive, and then discuss the interview method. I discuss these first because they effectively preceded my own work.

The collection of Oral Histories from notable SWE members was part of the grant-funded "Profiles of SWE Pioneers: An Oral History Project" (T. Eller, personal communication, February 22, 2018). The grant application describes the purpose of the project as being "to conduct, compile, interpret and disseminate comprehensive oral histories that would illustrate the experience of pioneering women engineers" (*Profiles of SWE Pioneers: An Oral History Project*, n.d.). SWE saw the benefits of the project as that it provided an opportunity for "women to speak for themselves" (*Profiles of SWE Pioneers: An Oral History Project*, n.d.). The program was also seen as having explicitly promotional component in that it "concentrates attention on women who promote a positive public image of the relationship between women and technology and science."

Many interviewees were the first woman engineering graduate in their program, the first woman engineer at their company, or both. Participants in “SWE Pioneers” tended to be high-profile and successful, with long and varied careers, mostly retired at the time of the interview. Participants were selected by the SWE Archive Committee. The grant allowed the interviewing archivist to travel to the location of the participant.

“SWE Pioneers” ran in three phases: an initial pilot with a small set of interviewees in 2001-2002, then two rounds of interviews between 2002-2005. A second round of funding also allowed the full collection of interviews to be made available digitally along with a short biography of the participant (“Proposal: Profiles of SWE Pioneers: A Proactive Oral History Program”).

Following the SWE Pioneers project, SWE launched the “SWE Grassroots Oral History Project,” also funded by a research grant, to continue and extend the work of collecting oral histories from women engineers (T. Eller, personal communication, February 22, 2018). The format of the Grassroots Oral History interviews is essentially identical to the SWE Pioneers interviews, but participants represented a more diverse group of engineers, including people who were still active in their careers.

SWE also collected oral histories in association with StoryCorps. StoryCorps is a nonprofit organization which focuses “on the collecting, sharing, and preserving of people’s stories”(*Storycorps - About*, n.d.). StoryCorps provides expertise and recording equipment to their partners, and charges for the service. StoryCorps organizes interview sessions at events across the country, and SWE began inviting Storycorps to the SWE national convention in 2007, after the Pioneers and Grassroots projects ended, in the hope of continuing to collect similar information without grant support (T. Eller, personal communication, February 22, 2018). SWE’s StoryCorps interviews were funded by SWE itself, but the cost eventually proved prohibitive and the partnership was ended, effectively bringing a close to SWE’s efforts to collect oral histories from women in engineering (T. Eller, personal communication, February 22, 2018). StoryCorps oral histories are slightly different in format from the Pioneer and Grassroots projects because StoryCorps interviews are typically conducted by someone close to the interviewee, such as a

friend family member (Rice, 2008). All of the StoryCorps interviews in this collection were conducted by a friend or family member or by a SWE archivist. Participants address similar topics as do participants in the Pioneers and Grassroots projects.

Documents in the archive also suggest that all three projects were developed and pitched to participants with a key audience in mind: women who are considering engineering or just becoming engineers. A goal of the programs was to provide ""significant career guidance potential" (Profiles of SWE Pioneers: A Proactive Oral History Program, n.d.), and the one-page interview invitation letter offered this incentive to participate: "your perceptions and reminiscences will serve as invaluable career guidance resource for young women and men who aspire to careers in science and engineering." (sample pre-interview letter, n.d.) This is reflected in the oral histories themselves, in which interviewers ask questions like "What kind of advice would you give to someone who's young – a young woman going into engineering?" (Bierman and Pederson, 21-22) and interviewees make comments like "I hope that women who look at this tape will be encouraged and realize that… engineering opportunities are better" (Bey 96). Such comments don't feature in every interview, but whenever there is an explicit reference to audience in these oral histories, that audience is evidently young women in the liminal spaces between engineering and not-engineering.

In conclusion, the three collection projects are distinguished to some degree by the date that the participants started their career, the identity of the interviewer, the source of funding for the project, and the name of the associated program. The projects are united by the fact that all interviews have a similar structure, cover similar material, and are primarily addressed to a single audience. I believe they are sufficiently alike to justify drawing from all three for this dissertation.[6]

[6] Indeed, the SWE archivists draw little distinction between the projects: the SWE Archive website includes all interviews in a single, undifferentiated group. Only by reading each individual interview PDF can one find mention of the specific collection projects.

Drawing from all three allows me to consider nearly 60 years of women's experiences in engineering as I work towards answers to my research question.

SWE's Interview Method and Methodology

These interviews provide access to many prominent women engineers for lengthy interviews and ready-to-hand complete transcription. These oral histories are effective in answering my research question in part because the interviewers elicit short narratives from participants through techniques described in interviewing guides (e.g. King & Horrocks, 2010), for instance, using open-ended questions, using eliciting phrases such as "what was your first encounter with…," and giving participants time and space to answer questions in their own words. These interviews are semi-structured (Tracy, 2019, p. 183); interviewers went in with notes but used those to stimulate open-ended explorations of the participants' points of view. They also align with the goals of this project in that they demonstrate the principles of feminist oral history interviews as described by Reinharz (1992) and others. The interviews, like this dissertation, are clearly grounded in ethical research practices, particularly an ethics of care: they show researcher and participant working together to mutually advance the causes of both (King & Horrocks, 2010). For instance, SWE's announcement of the Grassroots Oral History project describes producing oral history material as beneficial for researchers (in a variety of disciplines) and for the individuals and SWE sections that participate (Eller, 2009). In this dissertation project I strove to respect the individuals who shared their experiences for the purposes of research by using those experiences to support women in engineering.

They also express some qualities of feminist research methodology which would be impossible for me to replicate. In *Feminist Methods in Social Research,* Reinharz bluntly states, "For a woman to be understood in a social research project, it may be necessary for her to be interviewed by a woman" (Reinharz, 1992, p. 23). Most interviews were conducted by trained

archivists employed by SWE: Troy Eller[7], Deborah Rice[8], and Lauren Kata[9]; the rest were conducted by friends and family. As a white, male, non-engineer I could not realistically develop a similar rapport with participants. [10] Moreover, as recommended by Reinharz (1992), these interviews were conducted in places comfortable to participants (T. Eller, personal communication, February 22, 2018): participants' homes and offices or the yearly SWE conference.

However, these interviews also present challenges. SWE paid for professional transcription of these oral histories and transcription always involves making choices about representing the material. These interviews were edited for readability: pauses and filler words are removed, timestamps are only sometimes provided, and overlapping/interjecting comments are not clear. This is not ideal for rhetorical research, because it removes some elements of the speech act, which may impact the validity of my research project (Riessman, 2002, p. 8). I responded by structuring my research question around the rich data that *is* available.

Working with these materials also presents ethical dilemmas. If I had performed these interviews myself, I would have ideally used collaborative practices endorsed by feminist researchers, such as sharing drafts of research results (Reinharz, 1992; Selfe & Hawisher, 2004). (Participants were also given a chance to review the interview transcript and make edits.) Because this information is included in an archive and many participants are now deceased, my options for collaborating with the interview subjects were highly curtailed. Another ethical consideration is that I use participants' real names. Because this information is publicly available and included in an archive IRB rules regarding confidentiality do not apply. Participants signed

---

[7] The current SWE archivist.
[8] Former SWE archivist and currently an archivist at Wayne State University.
[9] Former SWE archivist and currently an archivist for the Episcopal Church.
[10] Early in my dissertation research, I performed an IRB-approved interview with a student member of the Society of Women Engineers. I hoped to produce something comparable to SWE's Oral Histories. However, despite my best efforts, the interview results were dramatically different – terse, formal, and, I believe, much less revealing. There are many reasons for that, but it underscored the remarkable nature of SWE's oral histories and encouraged me to focus my efforts there.

releases to “grant and assign all rights of every kind whatever pertaining to this information, whether or not such rights are now known, recognized, or contemplated, to the Society of Women Engineers” (*SWE Oral History Project Deed of Gift/Release Form*, n.d.) and SWE has worked to “disseminate” (*Profiles of SWE Pioneers: An Oral History Project*, n.d.) that information for research purposes such as this project.

Ultimately, my goals are sympathetic to the participants and I hope they would consider this project a reasonable, even desirable, use of their words. As Deborah Rice, SWE archivist, wrote in her proposal for the Grassroots research project, these interviews are a part of “the relatively new endeavor of documenting this history for women in engineering *using the words of women engineers themselves*” (*Profiles of SWE Pioneers: An Oral History Project*, n.d., emphasis in the original). In the pages that follow I will give those words the priority they merit. I attempt to take an ethic of care towards my participants even though I am not able to interact with them directly.

SELECTING MATERIAL AND RESEARCHING PROVENANCE

SWE’s archive provided access to 69 transcribed oral histories, totaling nearly 3000 pages of transcriptions – too many for a highly qualitative research project. In this section I will describe how I selected material for close analysis and performed that analysis.

I selected specific interviews to include in this project in the following manner. First, I created a spreadsheet of all available interviews and performed an initial coding of some essential descriptive information of each – what Saldaña calls “Attribute Coding” (2016, p. 83). These were all the categories of information that I could create from the data provided by the SWE Archive on each interview (i.e. what was available without closely reading all 3,000 pages.) In cases where information was missing I was able to fill the gaps by opening and scanning the transcript. The attributes I organized by were:

- Name of the participant.
- The year their career started.

- Their engineering field, such as Electrical Engineering or Aerospace Engineering. Many participants have worked in a variety of fields, or in academia, or are known for their business entrepreneurship. In these cases I included all of these fields.
- The collection the interview was drawn from (Pioneers, Storycorps, Grassroots).
- The format of the interview, such as whether it was a traditional interview, an interview conducted by a friend of family member, an interview with two interviewees, or a mutual discussion between two participants. In those cases I noted the co-interviewee(s).
- Length, in transcription pages.
- Other notes, such as the race of the participant if noted in the interview. Only three of the available participants were non-white. All three were black women.

From this data, I selected interviews to create a maximum variation (Tracy, 2019) or stratified sample. Stratified sampling is appropriate when the researcher can take advantage of existing knowledge about the research material to create a sample which illustrates a variety of experiences present in the data (Geisler, 2004). SWE is a 65-year-old organization which accepts engineers of all types, engineering educators, and women who work in engineering-related positions. My research question query how women engineers overcome professional challenges, according to their own words. My interest in capturing a variety of challenges and responses makes stratified sampling an appropriate choice (Geisler, 2004), while in general "feminists affirm the belief that diversified samples or case studies improve research quality" (Reinharz, 1992, p. 254). I do not claim that a diverse sample will lead to representative conclusions, only that breadth helps illustrate the meaningful range of experiences of the interview subjects.

For my maximum-variation sample, I selected at least two interviewees with experience in each of the six major engineering practices represented in the archive (Aerospace, Electrical, Civil, Mechanical, and Chemical, and Engineering Education). I selected at least two interviewees from each decade between 1940 and 1990 for career start; there was only one interview available with a career start after 2000, which I included. I included all three minority-identifying participants

in order to access as diverse a set of experiences as possible. This left me with 17 participants. While working on the project I found it helpful to return to the data and read new material to test my developing theories. This led me to add 6 additional records, which I again selected for maximum variation, for a total of 23 participants. Across these oral histories I sampled nearly 180 individual stories (using a method I describe in a moment). Saldaña (2016) suggests that 15 interviews or observations is an appropriate amount for a study which builds qualitative theory, while Cortazzi recommends at least 100 similar stories for building themes from narratives (Cortazzi, 1993). This sample meets those benchmarks, and maximizes variety given the available data set, while still being a manageable amount of data.

Below is a table showing the full list of participants[11] and their attributes.

[11] I make frequent reference to these participants throughout this dissertation. I will generally refer to them by first name and last name, then on following mentions by last name. In the interest of brevity and readability I will not always restate other attributes. The reader may find it helpful to return to this table while reading the following chapters.

Table 1 – Selected Oral Histories

Last Name	First Name	Career Start	Field	Source	Date of Interview	Interviewer	Pages	Format
Fletcher	Ann	1943	Engineering Illustration	SWE Pioneers	4/4/2003	Lauren Kata	56	Standard interview
Graham	Lois	1946	Mechanical, Academia	SWE Pioneers	6/3/2003	Lauren Kata	43	Standard interview
Brill	Yvonne	1946	Aerospace	SWE Pioneers	11/3/2005	Deborah Rice	60	Standard interview
Bey	Lois	1950	Chemical	SWE Pioneers	4/16/2003	Lauren Kata	97	Standard interview
Clark	Yvonne	1952	Engineering Management/ Aerospace, Academia	SWE Pioneers	6/29/2001	Lauren Kata	65	Co-interview w/ Irene Sharpe
Cooper	Lois	1953	Civil/Transportation	SWE Pioneers	11/5/2005	Deborah Rice	56	Standard interview
Taber	Margaret	1958	Electrical, Academia	SWE Pioneers	5/12/2003	Lauren Kata	74	Standard interview
Sharpe	Irene	1963	Electrical	SWE Pioneers	6/29/2001	Lauren Kata	64	Co-interview w/ Yvonne Clarke
Baum	Eleanor	1964	Electrical, Academia	SWE Pioneers	4/1/2003	Lauren Kata	44	Standard interview
Anderson-Rowland	Mary	1965	Computer, Academia	Storycorps	11/7/2008	Troy Eller	36	Standard interview
Hooks	Ivy	1965	Aerospace, NASA	SWE Pioneers	4/9/2003	Lauren Kata	102	Standard interview
Dunbar	Bonnie	1971	Aerospace	SWE Pioneers	3/2/2002	Lauren Kata	37	Standard interview
Hickel	Maggie	1975	Industrial	Storycorps	10/26/2007	Katie Peterson	29	Interviewed by daughter
Brody	Bernice	1979	Chemical	SWE Grassroots	11/9/2012	Troy Eller	66	Standard interview
Jenniches	Suzanne	1979	Environmental Engineering-Manufacturing	SWE Pioneers	5/29/2003	Lauren Kata	36	Standard interview
Williams	Jan	1982	Mechanical	SWE Grassroots	10/14/2009	Troy Eller	44	Standard interview
Layne	Margaret "Peggy"	1984	Environmental/Civil	SWE Grassroots	11/5/2010	Troy Eller	40	Standard interview
Lucietto	Anne	1985	Mechanical Engineering	Storycorps	10/26/2007	Diane Peters	36	Co-interview with Diane Peters
Griffin	Denise	1991	Electrical	SWE Grassroots	10/16/2009	Troy Eller	26	Standard interview
Bierman	Elizabeth	1998	Electrical, Systems	Storycorps	11/7/2008	Allison Pederson	32	Co-interview w/ Alison Pederson
Pederson	Allison	1998	Electrical	Storycorps	11/7/2008	Elizabeth Bierman	32	Co-interview with Elizabeth Bierman
Peters	Diane	2000s	Mechanical Engineering	Storycorps	10/26/2007	Anne Lucietto	36	Co-interview with Anne Lucietto
Madden	Diana	2004	Electrical	SWE Grassroots	11/15/2009	Troy Eller	21	Standard interview

Supplemental Document Collection in the SWE Archive

Following selecting my research material, I researched the "provenance of records… the form in which records were original created and the purpose for which they were created" (Morris & Rose, 2010, p. 56). (What I eventually discovered formed the basis of the previous "SWE's Method for Conducting Oral Histories" section.) To meet this need, I traveled to Detroit, Michigan to explore the SWE Archives at Wayne State University's Walter P. Reuther Library. I spent four days at the archive.

Prior to leaving, I reviewed the archive's finding aid (provided by the archivist), which included basic description of the contents of each box. I noted any boxes with material related to the Oral History projects and boxes containing biographical material on Oral History project participants.

Upon arriving, I worked with the archivist to retrieve folders of biographical material on the participants I had selected. These folders contained newspaper clippings about the individual, SWE records such as membership and award applications, and correspondence. Most relevant for this project, I located correspondence related to the collection of the oral histories, including copies of the releases signed by participants, letters requesting participation and responses, and rough copies of transcriptions marked up by participants. This information provided additional context for the stories I went on to analyze. Other participants I selected, particularly those less-established in their careers, did not have folders of biographical material.

Seized by "archive fever," (Burton, 2005) a powerful fear of missing a critical piece of information, I prioritized taking photos of the material. I took over 900 photos in that time. Following my archive visit, I reviewed all the documents and organized them into folders for each participant for whom I located records.[12]

---

[12] Some of my effort during also went towards finding, photographing, and organizing documentation about SWE publications: copies of publications such as the yearly "Profile of a Woman Engineer," and a "Facts About the Society of Women Engineers" pamphlet; correspondence and meeting minutes associated with

In addition, while at the archive I interviewed Troy Eller, SWE's full-time archivist, and Deborah Rice, the former full-time archivist who performed some of the included oral history interviews. These were brief interviews which revealed additional information about the SWE Oral History research projects. They discussed the goals and priorities of the research, and the experience of collecting the material. I took notes during these conversations.

MY CODING METHOD

After selecting material I applied Narrative Analysis research methods to work towards answers to my questions. I turned to the narrative or stories told by participants because I valued rhetorical functions of stories and storytelling, described in the previous chapter.[13] I wanted to understand thoroughly the claims participants make through stories – coding was the means to that end. Narrative Analysis can refer to a variety of analytical techniques which take the stories people tell as the object of investigation (Daiute & Lightfoot, 2004).

I first noted which segments of the oral history constituted narratives or stories – I picked out the stories. It is not always clear what is and is not a "story" for research purposes, and definitions of narrative are countless; some researchers use very strict criteria while others take a you-know-it-when-you-see-it approach (Frank, 2015). William Labov and Joshua Waletzky, in a linguistics-grounded analysis of stories, define stories structurally: as passages of text or talk which take place in the past, describe events as they occurred in chronological order, and contain certain structural elements (Labov, 2013; Labov & Waletzky, 1967). Others define stories based on

---

the development of those publications; a book draft and related correspondence for a "Women in Engineering" book project in 1974 that sadly never found a publisher; and much more. I thought this material might make up a chapter in this dissertation. Ultimately, excepting the excerpt from the "Profile of a Woman Engineer" in Chapter 1, there wasn't space in this dissertation to explore SWE publications, although I think the material I collected could support a future research project on historical attempts to promote engineering to girls and women.

[13] In analyzing narratives researchers may be interested in narratives' structure, their content, or their performance (Bamberg, 2015; King & Horrocks, 2010). Although I am concerned with all three elements (because all play a role in making claims persuasive), I do not have access to the full audiovisual recordings of the SWE interviews, limiting my ability to analyze performance. So I focused my research primarily on content and structure.

content: character and point of view (Frank, 2015) or plot (Polkinghorne, 1988, 1995, p. 7). For my project, I looked for descriptions of a series of events, some kind of conflict and response, especially if the storyteller was an actor in the events. Often participants used phrases such as "I remember a time that…" to signal the start of storytelling. Here is an example of a story that begins in this way. In this passage, Jan Williams is discussing how male managers can cost women opportunities by saying things like "Well, you know, she's got that young kid" (2009, p. 18). She then says:

> And I am very—I'm a stickler now as a manager about sayin, "You know, guys, you ought to give her that choice." (laughs) Because I wouldn't, you know—. And they did at times give me choices where I said, "No, I'm sorry, this is a really bad time."
>
> A prime example was the first time I got asked to bid on a management job. It was right after Ryan was born. I was working part time. I was nursing him. And they wanted me to be the manager of all those group inspectors doing the field work, weekend work, Christmas break work. And I called the director and I said—you know, and I was on the maternity leave at the time. And I said, "It's a great idea and I'm really flattered but the timing is bad and I just don't think I could put a hundred percent in for you on this kind of a job, so I have to say no." [30:00] He said, "Well, I was afraid you were going to say that but I thought I would ask," which I always appreciated. I just couldn't be anything less than honest with him or myself at that point in time—a newborn that was nursing, you know. There are some jobs you can get away with it, especially nowadays with more telecommuting and that kind of thing. And we didn't have that in those days like we do now. So I think I did the right thing by postponing.

Williams' begins this story by explicitly positioning it as an example of a phenomenon she is discussing, declaring it a story to her audience. For that reason, and because it included the story elements I developed through my research (discussed below), I included it. The process of

selecting what material to include was iterative: some near-stories did not fit the categories of codes I was developing, and were removed; other passages I only recognized as stories after multiple passes. I tended towards being generous in my criteria and including story-like passages. Here is an example of a passage that, although it contains reference to a specific experience, I ultimately excluded from my analysis. This is also from Jan Williams:

> I mean somebody—I think my dad actually may have mentioned engineering to me. The only engineer I knew was a guy who sat in front of a drafting board at his office and it was like, that doesn't sound like fun, you know. (laughs) So I just didn't—and I just didn't have a clue what engineering was and what engineers did or what I'd have to do to get there, any of that. Nothing like that had been ever presented to me in any way, shape, or form, so. And I had no role models in my family, obviously. I didn't have any people who had college degrees, so it just wasn't easy, you know, straight from high school for me. And I wished I'd had more of that. (Williams, 2009, p. 21)

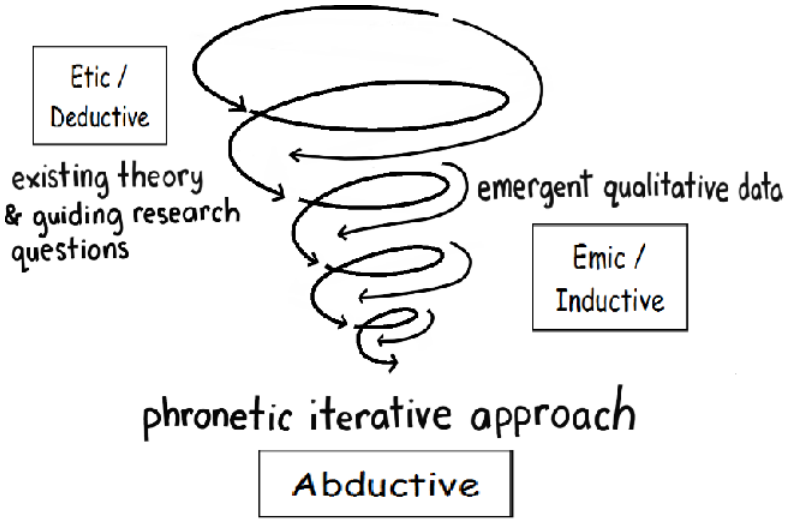
Here, Williams relays an experience, but it is described in general terms. This passage of text initially appeared story-like but was ultimately excluded because it did not contain material that fit into the story elements I was seeing, described below.

Creating Codes from the Data

I used textual coding techniques to transform this data into useful information and, eventually, the conclusions I discuss in the following chapters. As described by Saldaña in *The Coding Manual for Qualitative Researchers* (2016), Tracy in *Qualitative Research Methods* (2019), as well as King and Horrocks (2010) and Geisler (2004), coding is a research process that structures and enables tacking back-and-forth from the general to the specific – a way to iteratively test theory or models against research material and refine the researchers' understanding of the data. I selected these coding methods because, as Saldaña states, these methods are appropriate when research question are ontological – when they address the nature of participants' realities… the exploration of personal, interpretive meanings found within the data" (p.

70). There are many ways to apply coding methods; my approach aligns closely with the "phronetic iterative approach," as synthesized by Sarah J. Tracy, in which "the researcher alternates between considering existing theories, research interest, or predefined questions/goals on the one hand, with emergent qualitative data on the other" (see Figure 1) (Tracy, 2019, p. 29).

Figure 1 - The Phronetic Iterative Approach



Thus, throughout my work with this data I reflected on "the active interests, current literature, granted priorities, and various theories [I] bring to the data" (Tracy, 2019, p. 240). For instance, early in my work with the oral histories I found myself drawn to the specific, individual narratives they contain because such career stories were a pre-existing interest of mine. As my research focused more closely on the stories told by participants, I began reading more narrative theory, which further impacted my reading of the material, and caused me to revise my research question such that they more specifically probed the functions of these narratives.

Practically, coding entails selecting segments of data, labeling (coding) them, defining codes, placing codes into categories, commenting on codes and groups, building networks of codes, and navigating back and forth from the categories to the codes to the relevant passages. Coding is a re-iterative process which requires many passes through the data and revisions (Tracy, 2019).

I should note that these procedures are similar to Grounded Theory methodology developed by sociologists Barney Glaser and Anselm Strauss (1967). Glaser and Strauss

developed Grounded Theory as a way to systematically produce theory from data. In Grounded Theory methodology data should be approached without preconceptions or reference to existing models. I did reference models in developing my codes and code categories, per the “phronetic iterative approach” (Tracy, 2019). This project is thus one which applies techniques of Grounded Theory, but is not a Grounded Theory study.

The “first” step of coding is to “label segments of verbal data according the phenomena in which you are interested” (Geisler 2004, p. 26). According to Saldaña, the codes/labels the researcher applies are meant to be “essence-capturing and essential elements of the research story that, when clustered together according to similarity and regularity (i.e., a pattern), actively facilitate the development of categories and thus analysis of their connections” (Saldaña, 2016, p. 9). As I have said, I coded the stories told by participants. Every story was marked with multiple codes, for each “essential element” of the story. As an example, a code I generated early was "Mistaken for secretary,” when I realized that multiple participants told stories in which they encountered this challenge. In the example story told by Jan Williams, I coded story elements with labels (codes) like “Raising children” “Receiving job offer” “Denying request” and “Autonomy preserved.”

After an essential element of the text was noted and coded, I defined the code in order to set the boundaries of what is included in the code (Saldaña, 2016). Writing code definitions is an iterative process of generating rules or models, then immediately testing definitions against the available data, then revising the definition to better reflect the data. Then the data is re-read and re-coded, leading to further refinements of the coding definitions. The definition of the “mistaken for secretary” code was “Someone either assuming the speaker is a secretary or asking them to do secretarial work.” Thus, the code definition did not specify who made the mistake; the code was also slightly broader than the name alone would suggest, because it encompassed events in which someone was both mistaken about the women engineers’ role and events in which someone was mistaken about what responsibilities were appropriate for her role. It was

distinguished from similar codes such as “Men making sexist assumptions,” which I defined as “Men commenting on women's capabilities in ways that are tied to sexual difference.”

My coding process was done with a Computer Assisted Qualitative Data AnalysiS (CAQDAS) program: Atlas.ti. Atlas.ti created a library of my interview transcriptions, allowed me to select passages of text and apply codes to those passages; it then generated a list of my codes and linked to the quotations in which each code was grounded. This facilitated writing code definitions with close attention to the associated text.

Creating Code Categories

The second step of coding was to create code groups or categories. This is a similar process as coding but writ larger: producing “essence capturing” (Saldaña, 2016, p. 9) labels for groups of codes, which are then tested against the existing codes and their corresponding definitions (which were tested against the available data). Categories can be generated entirely from the data or set beforehand. I began with some predetermined code categories; in doing this, I was making an a priori decision about story structure. To develop this structure I drew on my own experiences, the theories of narrative of Labov and Waletzky and Kenneth Burke, and my attention to the data. Coding is always iterative and as my research progressed I developed additional code categories and subcategories.

My coding of the stories began with three categories of codes: Challenges, Action and Results. Challenge, Action, Result stories are, for me, what Tracy (2019, p. 48) calls a sensitizing concept, something “gleaned from past experience or research [which] serve as background ideas that offer frameworks through which researchers see, organize, and experience the emergent data” (48). I learned this model as an employee of an employment/job search support company, and I teach it in my business writing courses as a key structure for telling career stories. As a result I am very comfortable locating these elements in stories. The CAR Method, sometimes called the STAR Method (Situation, Task, Action, Result), is a common piece of

advice for job search training.[14] I felt this model was suited for the types of stories participants were telling and would support my analysis of the data because it is a model for how to make claims about how one has succeeded at work.

I placed my initial codes into one of these categories. For instance, I identified "Receiving job offer" as a Challenge faced by Jan Williams in the above story, "Denying request" as an Action, and "Autonomy preserved" as a Result.

I developed additional categories by drawing on narrative theory scholarship. In Labov and Weletzky's influential "Narrative Analysis: Oral Versions of Personal Experience" the authors offer the following six-part structure for personal narrative:

1. Orientation, which marks the story as beginning, and establishes the time and place of the story.
2. Complication, of which there may be many, provides the next event of the story and answers the question "What happened then?"
3. Evaluation: the part of the story that makes "the point" clear, the part which reveals the attitude of the storyteller towards their story or "the consequences of the event for human needs and desires" (Labov, 1997, p. 403). The evaluation precludes the listener asking "So what?"
4. Resolution, any actions that follow the central action of the story.
5. Coda, the element of the story that returns the teller to modern day.

Labov & Waletzky's structure was similar to the CAR structure I was familiar with, but added important consideration. I valued Labov & Waletzky's emphasis on *evaluation*, the portion of the story which is itself a commentary on the story. The Labovian story structure has been interpreted

---

[14] A Google search for "CAR Method Resume" returns 40,200,000 results from college career services departments (*Creating an Effective Resume*, n.d.; *Resumes with Impact: Creating Strong Bullet Points*, n.d.; *Telling Your Story*, n.d.; *Telling Your Story Using the STAR/SOAR Model*, n.d.) and sources such as staffingadvisors.com (Corlett, 2016), topresume.com (Omoth, n.d.), and LinkedIn blogs (van Amerongen, 2014).

by some as dividing into just two essential components: action (the component that refers in some way to events in the physical world) and evaluation (the component which comments on those events) (Cortazzi, 1993; Daiute & Lightfoot, 2004, p. xiii; King & Horrocks, 2010). Labov and Weletzky claimed that evaluations were linguistically marked to stand out from the narrative – the "point" of a told story is evident and emphasized by the teller. Labov & Waletzky's Orientation, while less critical to interpreting stories, did provide a useful way of tag each story with codes indicating when and where the story occurred.

Thus, on later passes through coding the data, I included categories of Situation codes (I used "Situation" rather than "Orientation" because that terminology was more familiar to me from the STAR/CAR concept) and Evaluation codes.[15] Examples of the former include: "Situation: Early college" "Situation: Library" and "Situation: SWE event." Examples of the latter include: "Evaluation: Stepping away from job responsibilities for family was the right thing," which I applied to Jan William's story. The Evaluation codes were nearly always the last to be applied, because the "point" or "the consequences of the event for human needs and desires" (Labov, 1997, p. 403) was often not clear until I had read and considered the story and its elements repeatedly.

To recap, after many cycles from coding to refining categories, I settled on five major categories.

1. Situation
2. Challenges
3. Actions
4. Result
5. Evaluation

[15] I excluded what Labov & Waletzky call Coda because that component primarily addresses how storytellers transition from stories to non-story elements of speech, something of interest to linguists but not relevant to my research questions.

Within these categories, I developed subcategories of Challenges, Actions and Results as a way to identify "similarity and regularity (i.e., a pattern), [and] actively facilitate…analysis of their connections" (Saldaña, 2016, p. 9). Developing subcategories was, again, an iterative process of navigating through codes and definitions, developing and testing labels. In this case, I was labeling recurring elements of Challenges, Actions and Results. Example Challenge subcategories include "Intrapersonal– Making career decisions" and "Technical – Physical demands"; example Action subcategories are "Learning/researching" and "Delegating"; example Results subcategories are "Their wrongness was recognized" and "I built connections." I additionally defined Challenge categories as either Interpersonal, Intrapersonal and Technical,

Halfway through my first coding pass I had upwards of 400 codes – too many "essential elements" to develop into categories and subcategories. (Saldana recommends 100-200 codes as a manageable number (Saldaña, 2016).) I condensed codes, making decisions about what phenomena were meaningfully similar and which were distinct, down to 200. I broke codes into categories and reimagined connections; eventually I condensed code categories and subcategories. Over the course of many months I worked through this process multiple times: I discovered and labeled new elements in the data, refined, defined, recategorized, and repeated. Atlas.ti facilitated this work by allowing me to create categories of codes, and easily drag codes into and out of categories.

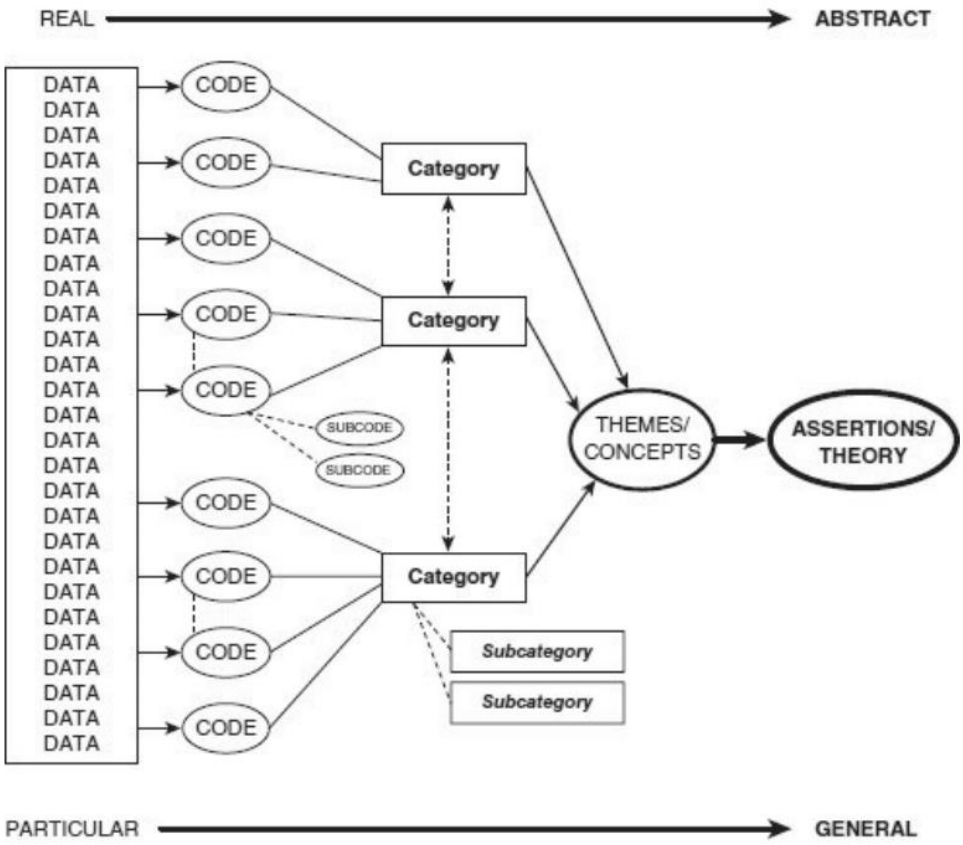
Moving from Codes and Categories to Themes and Theory

Saldaña argues that through qualitative coding the researcher moves from codes to categories to themes and finally to new theory (Saldaña, 2016). King and Horrocks suggest a similar approach beginning with descriptive codes (what is happening in the text), then building to interpretive codes (the significance) before finally developing themes. They define themes as "recurrent and distinctive features of participant's accounts, characterizing particular perceptions and/or experiences, which the researcher sees as relevant to the research question" (King & Horrocks, 2010, p. 150). This type of "thematic analysis… [is] a common-sense way to refer to patterns in the data reveal something of interest regarding the research topic at hand" (King &

Horrocks, 2010, p. 179). In either case the goal for the researcher is to develop themes and, eventually, interesting interpretations of the data.

Johnny Saldaña (2016) illustrates the process of moving from codes to themes with the following model, which effectively illustrates my process.

Figure 2 - Saldana's Codes-to-theory Model (p. 14)



One way I explored the data to develop themes was to use the "co-occurrence table" tool in Atlas.ti, which would display which codes co-occurred in the same narrative. This would allow me to see, for example, for each Challenge, what Actions were most likely to follow. In other words, I could get a table that helped me answer questions like, "In stories where participants are challenged by feelings of low confidence, what actions do they take? What actions do they not take?" I also explored connections through visualization. Many coding guides recommend writing

codes on slips of colored paper, moving them around or re-coloring them to see the codes in new ways, because new context can lead to new ideas. I used Atlast.ti and Excel for this purpose. I dragged and sorted actions codes, manipulating the order they appeared, and colored and formatted the data to highlight typical or anomalous results. This encouraged me to see new patterns in the data.

An essential element of the coding research approach is analytic memo writing, meaning regular informal writings that reflect on the research process and findings (Saldaña, 2016; Tracy, 2019). Memos are an exploratory, developmental element of coding. Saldaña suggests writing frequently to reflect on code choices, generate additional codes, tentatively develop themes and patterns, reflect on participants' lives, draw connections to existing theory, develop possible answers to the research question, and more (Saldaña, 2016).

I wrote memos throughout this process, which facilitated all of the above process of coding, defining, and creating categories, but especially facilitated developing themes and theory. I regularly read and re-read stories while writing about their connections and recurring elements and existing theory. Memo-writing was where the thinking about the data happened, and I produced hundreds of pages of memos during this project.

As an example, I once wrote about the ways I was seeing *pride* and *satisfaction* expressed in the stories. Later, when re-examining my codes and connected stories, *pride* rose to the surface of my writings as an extremely important concept – too abstract to be a code itself, but it related to a lot of codes: so, a theme. Then I re-read stories and re-considered codes while thinking about *pride*, and especially revising the lessons or Evaluations of each story. I continued to write while re-reading, and my writing focused on questions like: *Where and when is* pride *important? What are the exceptions? What are the conditionals? What does* pride *come from and cause? What's the relationship between* pride *and X code?* I also asked myself about Challenging, a concept I was familiar with from scholarship about women and engineering. *Where does* pride *interact with Challenging?* Exploratory answers to these questions would make up my writing, which I would then re-read to develop more writing.

My goal was to develop *pride* from a recurring element in the data into an idea about that recurring thing. I saw this as transforming a noun into a verb-phrase, an expression of some process or truth that was tacitly expressed in the data across the stories and answered (in part) my research question. In the case of the example above, I re-examined the stories involving "Malicious or malevolent coworkers" and "Challenging/pushing back" while thinking about *pride*. Eventually, I articulated a rough lesson that "There's pride in getting the work done, even (especially) when others around you are distracted by non-engineering concerns." Through further writing I developed this idea into "Lesson Three – Appreciate Being in the Right" which I discuss in the next chapter. I used a similar process to develop all of the "lessons" presented in this dissertation.

Saldana says the endpoint of coding is "new theory" but in this dissertation I have chosen to articulate each answer to my research question as a "Lesson." My research question asks, "what claims do successful women engineers make about how to achieve success in engineering?" Because the articulated audience of these narratives is young women considering or going into engineering, for the express purpose (as described in the interview invitation letter) of offering "career guidance," these stories have an advisory function. They offer information that is meant to be applicable and useful for this audience. "Lesson" seemed like an accurate and convenient description for the useful, discrete pieces of advisory information that I highlight here – more than "theory."

CHAPTER 4

INTERPERSONAL CHALLENGES

The stories in this chapter show how participants respond to a category of challenges I identify as Interpersonal Challenges. All stories in this collection involve interactions with others, even stories about highly technical issues. In stories in this chapter, other people are the *cause* of the challenge. This often means someone acting in a way that seems to violate professional norms but isn't expressly intended to hurt the storyteller. One of the participants in this project, Eleanor Baum, defines these as "well meaning [sic] but klutzy guys" (2003, p. 24). In other cases, oppositional characters behave with what another participant, Ivy Hooks, identifies as "malice" (2003, p. 68). Navigating these diverse challenges is difficult, but participants rely on a group of associated behaviors in order to overcome the Interpersonal Challenges.

My argument in this chapter is that participants' stories include claims that interpersonal conflicts are best handled using strategies that are appropriate for handling technical problems. This means applying technical and logical thinking to even interpersonal interactions, particularly the following techniques: researching and retaining complex information, prioritizing getting the work done, and being clear and direct. In the exceptional cases where these strategies are inadequate, participants value their ability to change their situation – to just walk away. These strategies (with the exception of walking away) are "technical" because they align with the ways engineers act to address technical problems, the kinds of work that define the profession. Typical engineering responsibilities are to identify scientific or technological issues or needs (examples from these stories include leaking high-pressure steam pipes, corrosive metals causing windows to fall out of buildings, or the need for efficient, long-lasting propulsion systems for satellites), identify possible technological solutions to those issues or needs, and implement those solutions in cooperation with others. In doing this, the engineering ethos is one of "professionalized calculative rationality" (Wajcman, 1991, p. 144) which emphasizes objectivity and autonomy (Keller, 1983) and prioritizes logical problem solving (Bejerano & Bartosh, 2015), and relies on extensive education in mathematics and science principles. In these stories, I see participants

aligning closely with this expected engineering ethos, but doing so in order to solve problems that are interpersonal rather than technical in nature. They use familiar (to engineers) tactics in surprising ways. In addition, this chapter also attends particularly to the ways race and gender intersect to create a "double jeopardy" (Houston, 2015, p. 48) requiring particularly careful application of these lessons and additional resources.

LESSON 1 – TECHNICAL INFORMATION CAN REDRESS INTERPERSONAL PROBLEMS

Managing technical information is an expected part of any engineer's work. Engineers are the experts on machinery, chemical interactions, computers, industrial processes, and other forms of technology. They are frequently called upon to learn technical information and apply that knowledge in new contexts. Dorothy Winsor's book-length study of rhetoric and literacy in engineering, *Writing Power,* reveals the degree to which engineers value technical expertise and information as a way to exert power in their workspace. Winsor believes engineers embrace a "devaluation of language and particularly of writing in the field of engineering. That is, I think engineers have particular problems in accepting the rhetorical view of knowledge" (2003, p. 4). Winsor argues that while engineers certainly do use various forms of rhetoric to be persuasive, they do not see it that way, and instead for engineers "the cultural capital of technical knowledge is most highly valued" (p. 59) as a way to "gain some measure of control" in the workplace (Winsor, 2003, p. 59). Research on engineers has emphasized the importance of the "cultural capital of technical knowledge" for the gender dynamics of engineering (Faulkner, 2007, 2009a). MellstrÖm claims that technical skills are seen as important to engineering identification. One of the reasons men persist and succeed in engineering is that they are more comfortable claiming technical expertise and marshalling their technical knowledge at work (MellstrÖm, 2004). Such research often highlights women's relative lack of confidence in their technical expertise as one cause of their underrepresentation in engineering. However, the stories in this collection reveal that successful women engineers do value their technical expertise, and in particular they claim that technical expertise is useful to address interpersonal problems.

In some cases, that connection is made very directly – for instance, in the first story I will discuss in this chapter Lois Cooper[16][17] claims that her ability to solve math problems ends a conflict with a difficult teacher. This story is from Cooper's college years, and describes an experience in which a teacher attempts to humiliate her by making her do a math problem in front of the class, which the teacher assumes she will do incorrectly. Stories of this type, in which a superior draws attention to the storyteller, making a spectacle of their presence and highlighting their difference, are told by multiple participants here. They illustrate the ways that men in position of power can use that power to discourage women from pursuing engineering. However, that is not an unresolvable challenge. In this example, Cooper's strong technical skills are positioned in the story as a direct solution to this problem. This story takes place at Tougaloo before Cooper switched to mathematics, in one of her science classes:

> I was taking this science – oh, I forgot which science class it was – chemical – anyway, I was taking this class. And my schedule was already set up. So I was in this class, and the teacher was doing – we were doing problems in the

---

[16] Shulamit Reinharz claims that "Biographical work has always been an important part of the women's movement because it draws women out of obscurity, repairs the historical record, and provides an opportunity for the women reader and writer to identify with the subject" (1992, p. 126). In acknowledgement of this, before I include a story told by one of these participants, I will first provide a brief biography of the participant in a footnote. I leave out the biography for second, third, etc., stories from the same participant.

[17] Lois Cooper is a civil engineer who graduated with a degree in mathematics in 1954. Cooper started her schooling in Mississippi with plans to become the first black female lawyer in the state. Although she enjoyed the "logic to law" (p. 5), she transferred to integrated Cal State Los Angeles to be close to her family, and switched to mathematics, making her, she says, often the only woman and only African American in her classes. She was the first African American woman employed in a technical position in the California Department of Transportation. She began her career as an engineering aide, but in her oral history she describes moving from that entry-level position at Caltrans to heading major civil engineering projects as a Transportation Engineer and Project Manager. She also held senior positions in the public information department and directed civil rights programs in Caltrans. While working full-time for Caltrans, Cooper also raised two children and became active with a variety of professional engineering organizations with a particular focus on recruiting women and minorities into engineering. Cooper emphasizes that she is independent. In her narrative, she states that she doesn't need anyone else, their support or approval. In school, "I was there to learn, and not necessarily to socialize or anything" (14) while at work she operated without any professional mentor, saying "I kind of think I was on my own, yeah. And see, I guess it doesn't bother me much. It didn't really" (p. 22). Cooper was not active in SWE for most of her life, mostly participating late in her career in recruitment efforts. However, she was active in the Los Angeles Council of Black Professional Engineers. After holding a variety of officer positions in that organization, Cooper was elected president while still the only female member.

class. And he put a problem on the board on calculating the square footage of a piece of rug, a carpet. And he put the problem on the board.

So I looked at the problem, and looked at the problem. And I lived in the dormitory because I couldn't afford to stay in the (Inaudible). So I was working, and I worked in the library, and I lived in the dormitory. So I went back to the room, and I looked at that problem, and I looked at that problem. And I said, "That's not right." (laughter)

So I worked the problem, and the next day when I went to class I told the instructor that the problem was not right. And so he said, "Well, put it on the board." So now I guess he's going to shame me by having me put the problem on the board. So when I put the problem on the board, it turned out that I was right and he was wrong. (laughter) And it was after that – and of course, no, by this time, because the college is kind of a small – by this time –

Interviewer: It's a historically black college, right?

Right, right, right. And so then everything is getting – you know, the word is getting across campus what I had done. And fortunately, Tougaloo gave us an entrance exam, and my algebra – I had done so well on the algebra part of the exam that they said I should not take freshman algebra, I should go to the next algebra class. So I took college algebra. And by doing that, they reworked my schedule such that I didn't have to stay in his class. (laughter) So that was good. But I really wasn't trying to embarrass him or anything, because I went to him personally and said that the problem wasn't right. But I guess he figured I was wrong, so I would embarrass myself by putting it… And that was really the beginning of my actively participating in math. (Cooper, 2005, p. 6)

This story makes the claim that technical skills and knowledge solve interpersonal problems. Cooper provides some information on what technical skills she applies, suggesting that

persistence and intuition are important. She shows that she spent a lot of time on the problem her professor provided by saying she “looked” at the problem four times, and “worked” on the problem twice in two separate locations. She kept with it some time before finding the flaw the teacher had made. Paradoxically, the insight seems to come suddenly rather than gradually, as Cooper at once knows fully that “That’s not right.” Cooper provides less detail on how she did “so well” on the algebra test, but in this collection stories about entrance exams and other tests usually depend on a history of choosing the most challenging educational opportunities and the ability to succeed under pressure. These skills – persistence, technical insight, educational ambition – are the kinds of skills associated with engineers’ technical work.

Ultimately, the specifics of the technical skills Cooper uses are less important to her point than the essential claim that, in general, technical skills solve interpersonal challenges. Cooper’s story is structured to emphasize that point. By performing well on her algebra test, Cooper is able to jump from this class into another and avoid this teacher, thereby solving the interpersonal challenge that instigates this story. The test chronologically preceded the event with the teacher (it was an entrance exam), but in the telling the math test follows; Cooper has to ‘back up’ in time when describing the algebra exam. Doing so positions Cooper’s strong technical skills as a tool for resolution of this issue, regardless of the chronology of the events. Cooper’s commitment to producing a thematic truth has led to a reordering of events, but this is one of the qualities we allow in stories as a way to describe a truth that is accurate to experience (Gabriel, 2004). It can also be helpful to consider what is not present in a story in order to understand the evaluative component (Labov & Waletzky, 1967). In this case we might consider that Cooper probably had to ask someone, a department advisor or course scheduler, about changing her class. But that element of the story – which would conceivably demonstrate initiative, verbal persuasiveness or other valuable qualities – is downplayed in favor of focusing on her mathematics performance. Initiative is not the solution to this problem – math is.

We might paraphrase the simple facts of this story as, “A teacher was making problems for me by trying to humiliate me. However, my strong mathematics ability left him humiliated to the

whole school. And I did so well on a math test that I was moved out of his class." The evaluation, the lesson for the reader (Labov & Waletzky, 1967), is that strong technical skills both helped Cooper avoid this problem in the short term and gave her a reputation among her peers as a skilled technical thinker.

Cooper's story depends on Cooper's strong technical performance. Women entering engineering feel they will need to do better than the men in order to be successful (Smith et al., 2013a), so it could be problematic to suggest that handling difficult colleagues always means outperforming them on complex calculations. However, that is not always the case in these stories, and the importance of technical skills can be emphasized in other ways. In the following story, Diane Peters[18] also suggests that an interpersonal conflict can be resolved with technical expertise. The conflict here is between Peters and a client, over how to use a piece of machinery about which Peters is the expert. However, Peters deliberately *understates* her own technological expertise here, instead suggesting that in some cases it only takes the bare minimum of technological expertise – barely rising to the level of common sense – to succeed. This conflict is not described by Peters as related to discrimination, but it is high-stakes for her client.

This story is from Peters time working with large industrial equipment. Note that Peters begins by emphasizing the importance of this story (and, therefor, the lesson it imparts). This is Peters' response to a broad invitation to share stories by the interview, and it is about safety, which has "always been a concern of mine."

---

[18] Diane Peters earned a Bachelor's degree in Mechanical Engineering from the University of Notre Dame in the early 1990's and at the time of her interview had been active in engineering for 15 years. Peters has experience designing small printing presses and large industrial equipment. While working she earned a Master's degree in Mechanical Engineering. Much of Peters oral history focuses on her active involvement in SWE with her friend Anne Lucietto (who is part of the same interview). The second major topic is her gradual exploration of further education and an academic career path, starting with teaching a single CAD (Computer Aided Design) course at a local college, then applying to PhD programs. Throughout this process she says she received little support from anyone other than her friend Lucietto. She says in her interview that in the future "I see myself as a member of the engineering faculty at some university, on the tenure track, getting tenure, and becoming one of the respected professors" (p. 21). Since her interview in 2007 she's moved into academia and become an Assistant Professor of Mechanical Engineering at Kettering University.

AL: So, do you have any good stories?

Diane Peters: Oh, everybody has stories. You work long enough, you get a lot of stories. Some of the best stories are in dealing with customers and some of the things that they want. Everybody, I think, in engineering has a few stories of somebody handing you a massive problem and saying, "You have plenty of time, we don't need the answer for a few hours yet." (laughs) I've had stories of customers who don't really understand various things. They'll ask questions and you just kind of have to be diplomatic. Some of the best stories have to do with safety. It's always been a concern of mine in machinery and I had one customer once call me up and say, "You know, I'd like to know how to get these particular parts out of the machine." And I said, "Well, you can't take them out." And he said, "But I want to take them out. They keep me from getting my hands in by the cylinder with the knives." And I said, "Precisely. That is their purpose." (laughs)

AL: (laughs) Absolutely. Oh my goodness.

DP: Yeah, it was quite interesting. It took a while sometimes to explain to people that, "No you really don't want to do that. Trust me. It's not a good idea." (2007, p. 10-11)

Peters characterizes her response to this conflict as being "diplomatic," which is necessary in order to persuade this person (and others like him) to behave appropriately. However, in this story, being persuasive is primarily a matter of being logical about technological artifacts and processes and speaking directly, all behaviors that align with the technical engineering ethos. Peters offers just two responses to her client: "Well, you can't take them out" and "Precisely. That is their purpose." She gives her interlocutor facts and instructions using few words. They are not complex facts and instructions; in fact, she just gives him back information that he already has, thereby helping him see a truth that is already in front of his face. Here the action that produces a positive result is not an extraordinary level of technical performance, just

an appropriate amount of attention to the machinery (and clarity in communication, which I discuss in a moment).

Peters' and Cooper's stories are particularly clear examples of how what Winsor identifies as an engineering rhetoric can be deployed across the kinds of contexts that women engineers encounter. Other stories in this collection could serve as similar examples. In one, for instance, Lois Bey requests to take a high school shop class and is first required by her high school administration to "to take written tests, aptitude tests, and go through some others." She found this battery of tests made her stand out and estranged her from her peers. However, her commitment to these technical tasks was admired and eventually adopted by "one of the popular girls" (2003, p. 20), who comes along on her testing regimen – an ally who eventually also goes into engineering. The evaluative component of Bey's story illustrates that a commitment to technical work can solve interpersonal problems such as exclusion by peers.

LESSON 2 – PERSONAL AND PROFESSIONAL INFORMATION IS MANAGED LIKE TECHNICAL INFORMATION

Winsor (2003) claims engineers manage and value technical information. In these stories, non-technical information is managed in much the same manner as engineers manage technical information: by carefully and intentionally gathering, assessing and applying it using processes that prioritize reason, logic, and clarity. Two types of non-technical information are handled in these stories. First, p*rofessional information*, including workplace mores, organizational structure, possible career futures, titles and roles. Particularly when problems involve inequal power structures, knowing those structures very thoroughly is needed to counteract the challenges. Second, *personal information*, such as information about family situations, personal goals, political opinions, and past experiences. Technical skills are the means to collect and manage non-technical information, which in turn leads to solutions to difficult interpersonal problems.

Some stories argue for research as a way to manage these kinds of information. Research is of course often used to solve technical problems, such as, in one story in this

collection, determining how to "model the lighting on the moon, so that we could model it -- understand it and model it so the astronauts could be trained for the Lunar Landing" (Hooks, 2003, p. 21). Ivy Hooks solves that problem by digging up decades-old reference material in a government library. But participants also illustrate using research as a way to carefully manage professional information to address personal problems. Sometimes that can be done in a library, while other cases other people are positioned in stories as resources for information.

Below is a story from Lois Bey[19] about her early years in college. In this story we can see that her lack of knowledge of a certain type of professional information (departmental procedures at her college) puts her in a vulnerable position. However, she is able to rely on her research in a different type of professional information (job prospects for women engineers) to assert her own interests in the face of an interfering superior with organizational power. In this story Bey constructs herself as a person navigating meddlesome figures by relying on research.

> Lois Bey: And my next confrontation was the fact that I went through a semester of organic chemistry, or – a semester there, and the former head of the chemistry department, Benjamin B. Freud, as we called "B. B. Freud," talked to me, and said to me that he didn't see me in the office to sign up for courses that had to be approved by the department head. And I looked at him, because that wasn't even done in the chemical engineering department. I just signed – put it down and got it back. I had no mentor in college. I had no faculty advisor in chemical engineering.

---

[19] Lois Bey was the first woman to receive a degree in chemical engineering from the Illinois Institute of Technology, and then pursued a diverse career. She worked in laboratories and in equipment sales, making her the only engineer in this collection to hold a role in sales, which she succeeded in due to her strong writing and communication skills. Bey eventually leaned into those skills by earning a Master's degree in Library and Information science and becoming an information specialist for multiple chemical engineering companies. Bey is a prolific storyteller throughout her oral history, and interfering authority figures are a recurring character type, beginning with her mother, who she describes in her oral history as opposing her entry into engineering at every step. Bey states she nevertheless chose to go into engineering in order to achieve independence and personal success. This story occurs when Bey is getting her undergraduate degree.

So I told him I was not a chemistry major, although I was taking the chemistry courses that only were designed for chemistry majors and chemical engineering majors. I was chemical engineering. So Dr. Freud told me to switch fields. He says, “You’re going to make a great research chemist.” And I said, “Dr. Freud, I can only afford to get a bachelor’s degree. And women chemists with bachelor’s degrees end up in the analytical lab. I’ve got a divergent right eye. I couldn’t work there, and I can’t afford [not] to work.”

Interviewer: How did you know that?

Lois Bey: Research. I had to write a paper in high school about women engineering and the profession. And I had to write a similar paper in college, when they found out what I was doing. And as I said, I looked and found as many papers written by women engineers as I could and all their troubles, and that. I read one paper I remember – I don’t know who wrote it, and I no longer have that work – who said that she was an aeronautical engineer. She graduated college before World War II, and said that she wrote hundreds and hundreds of letters to companies all over the United States, and was unable to get a job as an engineer. She said she only got a couple replies, which said, “Thank you for your letter. We have no offering for you.” So she ended up drafting. She says, “Believe it or not, when World War II started,” she said, “I started being inundated with letters offering – come in for interviews, and offering me jobs, because the men – male engineers were drafted, and now there were positions open for women.” So I thought, “Good.” Maybe her going into the field and working during this time and finding out that women could be good engineers may create an opening for me. This encouraged me.

So anyway, Dr. Freud told me that if I didn’t change my major, no matter how well I did in second semester organic chemistry I was going to get a C. If I

> change my major, I'd get an A. I didn't change my major; he gave me a C. But I went on through the courses. (2003, p. 30-31)

In this specific case, Bey faces two challenges. The first is that she does not possess some organizational/professional information. Without a mentor or faculty advisor, she's unaware of the policies in the chemistry department (she is in the separate chemical engineering department). Without sufficient professional information, she ends up in a position where a man can make unsolicited demands about her career future. That demand is the second challenge: another character pushing the storyteller towards a future other than engineering. (A frequently-occurring event in these stories.) Dr. Freud is wrong about Bey's best options. This is partially because he does not understand Bey's situation. But he also chooses not to know, and there is an intimation of something suspicious in Dr. Freud's demand that Bey get *his written permission* to take courses required for her own, separate major. His paternalistic involvement is mirrored by that of the unnamed figures who made Bey write a paper about women in engineering when "they found out what I was doing." And, at the end of the story, Dr. Freud demonstrates his willingness to abuse his organizational power to punish Bey.

While that "paper in high school about women engineering and the profession" may have been paternalistic (Bey's rhetoric suggests that the male engineering students were not required to write a paper about men in engineering, so Bey alone was forced to provide extra justification for her major choice), it did give Bey what she needs to at least avoid Freud's attempt at manipulation (if not his punishment): "Research" as Bey asserts in a word. In this story, Bey both suffers from a lack of knowledge (of departmental procedures) and benefits from having knowledge (of day-to-day work life as a chemist) that she can use as a rhetorical resource in her disagreement. Her ability to perform research as a high school student, retain the information, and deploy it to make a persuasive claim against her superior is similar to the kind of behavior Dorothy Winsor witnessed in her study of engineers. In this case, though, we can see Lois Bey claiming that the tactic can be deployed on professional, rather than technical, information. This allows her to overcome challenges created by a manipulative superior.

Managing information includes both collecting information, which Bey focuses on, and conveying it to others. In these stories, participants also convey personal and professional information to others using similarly technical-style means. Engineers tend to believe information should be stated plainly, without equivocation, unnecessary elaboration, or distracting rhetorical flourish (Winsor, 2003). They often rely on what they see as purely descriptive text and speech, which they believe represents itself directly and does not require interpretation (Winsor, 1998). In other words, technical skills related to conveying information are the ability to be direct, factual, and plain. In these stories, women do value being direct with information, including personal and professional information. Being direct takes many forms, and participants here engage various actions that collectively indicate directness and clarity. They offer criticisms and critiques, they say "no" and refuse to do something, and they ask for other people's time or service, all without equivocation. This behavior helps them overcome interpersonal challenges.

One example of this behavior is in Diane Peters story about the client who wants to reach into the blades of the industrial machinery Peters designs, but is prevented by metal bars and Peters' instructions. Again, Peters instructions are, "Well, you can't take them out" and "Precisely. That is their purpose." Peters speaks with no wasted words, and frames the story as if these two statements of fact resolves the issue. Another example is the short coda to Bey's story: "If I change my major, I'd get an A. I didn't change my major; he gave me a C. But I went on through the courses." Bey's description of this series of events is clear and matter-of-fact, which works to characterize her actions at the time as similarly matter-of-fact. (It also gives her story a nicely "punchy" ending.) In Bey's story Dr. Freud is manipulative, but in contrast Bey responds and acts directly and plainly. She conveys to him personal information, specifically that she cannot and will not pursue chemistry, and then follows through as promised: "I didn't change my major." The result, a C grade, is not entirely satisfactory, but Bey's priority was to stay an engineering major, and that was accomplished. So, Bey's technical-style communication supported her objectives. Mary Anderson Rowland tells a similar story about interacting with an unenlightened superior, and deals with him a similar way: "So I marched into the dean's office – again, I do not care what he

thinks or anybody else thinks – but told him what he should do. And I said, 'You need to decide which one of your associate deans will sponsor a Women in Engineering program'" (2003, p. 13). Following that encounter, Rowland was promoted to an associate dean position and asked to run the program, another example of direct communication of non-technical information leading to professional success.

There is a fine line between direct communication and confrontation, and the confrontational culture of engineering can be difficult for some women to manage (Evetts, 1998). There is no panacea for that risk here – the participants stories often do involve confrontation. However, sometimes being direct, even confrontational, can be enjoyable. In the following story, Ivy Hooks[20] uses irony to make her wishes clear with humor. After being repeatedly questioned about her family plans, Hooks pushes back. In this case, she tells a joke to put her male interlocutor on the spot, forcing him to examine his own actions more critically. In this story, she models a version of being direct about her wants (personal information) that seems to unite her and her coworkers, and argues that this is an effective strategy for handling certain kinds of interpersonal problems. This story takes place during Hooks early hears at NASA in the 1960's.

> Probably the most annoying thing was in the early days, maybe in the first couple of years, I remember somebody was forever asking me when I was going to have a baby, which I considered not anybody else's business. So one day, (laughs) one of the guys – and they weren't malicious. Okay? They really weren't. "Everybody else was having them, why aren't you having any?" So one

[20] Ivy Hooks was a member of the second generation of women to enter engineering after World War II, earning a Master's degree in Mathematics and Physics from the University of Houston in 1965. At the time of her interview, Hooks had worked in aerospace "for forty years, and it doesn't seem like a minute has gone by. It's been a lot of fun" (p. 101). She spent more than twenty years of that career at NASA where she was manager of the flight software team and won awards such as the NASA Outstanding Speaker Award. She also, as described in the story that opened the dissertation, worked on the space shuttle. Hooks is the only participant in this set to discuss entrepreneurship. She left NASA and started her own consulting company called Compliance Automation, Inc. when she identified a need for a software that "would work, but nobody wanted to do it" despite the fact that "I always said I would never own my own business. I have a lot of those 'I never wills' that I ended up – you know, take back" (p. 75-76).

> of the guys one day said something like “Do you want children?” And I looked at him and I said, “Are you giving them away or selling them?” (laughter)
>
> And he turned kind of bright red and he said, “I shouldn’t have asked that question, should I?” And I said, “No.” And he said, “And I won’t ask it ever again.” But it was just that he never thought about how it might be. You know, if they had children, they didn’t take off work, their wives took care of that for them. So they quit asking. They quit butting in about that so much. (Hooks, 2003, p. 68)

Hooks describes a recurring problem (men asking inappropriate questions) and a specific example of that problem, giving us a rich sense of the context within which she operates. She explains the broader significance of the story (the gendered division of labor, and the way men sometimes act with well-meaning klutziness, as Eleanor Baum says). She gives us her action (“Are you giving them away?”). And she concludes with a positive result that is produced by her action (“I won’t ever ask it again.”) The Labovian evaluation of this story, the lesson for the audience, is that presumptuous but well-meaning men should be confronted with humor. But they should, indeed, be confronted. Hooks does not ignore this problem or expect it to go away, and she’s only able to produce the desired result by applying a direct, confrontational technical style to the communication of her personal and professional information.

Like Cooper’s story that began this chapter, Hooks here tells a story in a way that strongly links together her response to the situation and the positive outcome, even though the reality is complex. Hooks faces a recurring, chronic issue related to her status as a woman in engineering – she is “forever” being asked about her family plans. In fact, it is the way this question comes back again and again that makes it a problem for Hooks. Hooks’ story, though, is about a specific response to the problem. It’s unclear how Hooks’ interaction with this singular individual led the plural “they” to “stop asking.” It seems likely this was not the end of Hooks’ experiences. However, more detail or more examples might undercut Hooks’ point, so that information is not included. Hooks is not arguing that overcoming these sorts of microaggressions requires patience or

forgiveness, as these behaviors are not part of the engineering ethos. Instead, the claim is that a strong, direct (if sarcastic) response produces the needed result.

The theme across these stories, and the others like them in this data, is that successful women engineers operate with the engineering ethos and engineering values identified by scholars who study engineering culture. They apply that ethos to resolve problems that are grounded in their experiences as women engineers.

LESSON 3 – APPRECIATE BEING IN THE RIGHT

Another claim made in these stories is that prioritizing getting the work done is a path to success. In stories throughout this collection, these successful women engineers portray themselves as more committed to doing *the work* than the men around them – they are harder working, more professional, less distracted by gamesmanship or other social concerns. These stories suggest that if engineering were done *right* by everyone, meaning appropriate priority is placed on technical problem-solving, there's no room for *any* engineers to be klutzy or malicious. Pure engineering and discrimination are not compatible. At the core of this argument is a belief that in the ideal, Platonic expression of engineering discrimination is not a factor. Clearly, this claim echoes elements of the neutral technology view which describes science and technology as essentially non-discriminatory, and only deviations from "pure" science as problematic. This idea, and its implication that hard work and persistence lead to individual success, has been roundly critiqued by feminist scholars (Anderson, 2017; S. G. Harding, 1986). It's an attitude that places the burden for success on women, and fails to problematize structures that reify discrimination.

However, these (entirely valid) critiques of the neutral technology view do not include an element of the experience that is vividly present in these stories, and proves to be vitally important. Here, participants prioritize getting engineering work done, which places them in the right; when someone else is making problems, they are not doing engineering right. The power of this approach hinges on the fact that the woman engineer *gets to appreciate being in the right*. It's not *her* problem that the man in the story is wrong, and indeed it's a source of satisfaction.

In the case of Lois Cooper's story of the teacher who tried to humiliate her, Cooper is focused on applying technical skills to get the work done correctly. Cooper "wasn't trying to embarrass him," just trying to get the work done the right way. Her teacher was more focused on looking correct than he was on getting the right answer. In addition, he allowed personal matters, a desire to shame a woman engineering student, to guide his decisions – decidedly non-technical thinking. Instead of driving Cooper away, Cooper reframes the incident as a victory. While Cooper is moved to a new class, word gets around campus about "what I had done" and what the teacher had done to him. He receives a very clear comeuppance for his failing. In Cooper's estimation, everyone in the school knew about her run-in with the teacher, which surely hurt the reputation of the troublesome teacher while raising her own profile as a competent mathematician. As this illustrates, when characters in these stories create interpersonal challenges for the storytellers they are deviating from professional mores. By adhering to them, storytellers have an opportunity to best any oppositional characters.

Yvonne Clark[21] provides another example of working through an Interpersonal Challenge by focusing on contributing to the collective enterprise of the engineering work. In the story that follows, Clark is mistaken for a secretary by her new boss in her first day on the job. In other words, this story is one of a quintessential challenge for women in engineering: an erasure of professional identity, a relegation to a less-powerful, "sex-typed" role (Webster, 1996), and a stinging reminder that womanhood and engineering are sometimes not seen as coexistent. But Clark also claims it "doesn't bother me one bit." Although it might be tempting to doubt Clark's claim, that is unnecessary. Because it's also possible to see in this story the satisfaction Clark

---

[21] Yvonne Clark was one of the first African American members of the Society of Women Engineers. She was the first woman to receive a bachelor's degree in Mechanical Engineering from Howard University, in 1951. After working in industrial research environments, Clark joined the faculty of Tennessee State University and later earned an engineering management Master's degree from Vanderbilt. In Clarke's oral history she frequently stresses the importance of forthright honesty, saying if "you ask me where I stand, I'll give you my opinion," and the connection between engineering and being a child who "always wanted to know why, you know. You can give me the what and the when, but you still got to tell me why." As an educator for much of her career, Clark is also supportive of students, although still very willing to deliver hard truths and "keep their feet on the ground" (p. 53).

takes in her successful commitment to her engineering identity. In this story, Clarke describes her first day on the job, early in her career before becoming a teacher.

> Interviewer: You must have been in a lot of situations where you were the only woman around. Did that make you uncomfortable?
>
> YC: Didn't bother me one bit, because I didn't need you to work. I had a job. At Frankford Arsenal – I think that's the summer job – this supervisor was expecting two people: an engineer and a secretary. I was on time at 8:30. He said, I need this. I said, where's the typewriter? I went over there and started typing like this, and then the secretary showed up about forty-five minutes late. Well, I was still typing by this time. He looked at me and at his secretary. He said, are you my engineer? I said, yes sir. Now don't have a heart attack, I said, you just needed something typed. He was turning red in the face, and I was trying to keep him calm. Come on. It's okay, all right. But you're my engineer. But you needed something typed, okay? I had to calm him down. He was getting – I mean, he – I felt sorry for him, because he had assumed I was the secretary. And when the secretary showed up, he knew she wasn't the engineer. And that's when he found out that he's given the engineer something to type that he needed. I'm a team man. I had no problems with that. Doesn't bother me one bit. But it was – those are the things that happened. (Cooper, 2005, p. 58)

This is an uncomfortable situation, and Cooper emphasizes that discomfort through the narrative. Tension is evident here in the way Clark doesn't wait for her mistaken boss to *say* he's upset or embarrassed, she just jumps right from "Yes, sir" to "Now don't have a heart attack." She knows he's going to be upset before he begins "turning red." And in her telling, she repeats his mistake and her willingness to go along with it multiples times between "Are you my engineer" and "I'm a team man." Finally, in Clark's telling this story lacks the satisfactory conclusion we might expect: it ends with the boss, by all appearances, confused and embarrassed. That isn't usually a good outcome for one's first day at a new job.

There's no easy answer to how to be an engineer, and in this story Clark seems to be wrestling with that as an early-career engineer. She has two options. 1) Clark can be team focused, which demonstrates her commitment, by doing menial typing, which is not the responsibility of an engineer. 2) Or she can reject the typing, but thereby also reject being a team player. She chooses to do the menial typing, evidently feeling that being team-focused is the top priority – being an engineer means getting the work done, no matter what that is. Her boss disagrees, but Clark's half-soothing, half-irritated interjections – "Come on. It's okay, all right" – suggest that she thinks he's in the wrong for being upset. And she feels "sorry for him" for being the kind of person who misunderstands engineering.

Clark is not "bothered one bit" because, on the first day of work, she seizes an opportunity to establish an identity as an engineer, by dealing with the "things that happen" and getting the work done. Normally for an engineer getting the work done would involve technical challenges. But in this case the "thing" is her boss making a presumptuous mistake, an interpersonal challenge. She is able to treat that mistake the way she would treat a technical challenge – work through it. She makes her values clear and seems confident and consistent in her application of those values. It's her superior's loss that he can't understand the priorities of engineering as well as Clark does, making her a better engineer than he. Clark summarizes all of this in the first line of this story, where she says "I didn't need you to work. I had a job." Across all the stories that evince this lesson, that job is a source of satisfaction in its own right. Regardless of the outcome of this story, Clarke has the satisfaction of being right and of being an engineer. Based on that, even very difficult conflicts with unsatisfactory outcomes can be "emplotted" (Ricoeur, 1981) into stories of victory.

LESSON 4 – WALK AWAY, BECAUSE YOU CAN

Although many problems can be handled by using technical skills, not all problems can be addressed in this way. The social studies literature on women in engineering identifies one type of available response as "Avoiding" (Evetts, 1998; Hatmaker, 2013; K. S. Powell & Jankovich, 1998; Shih, 2006). Avoiding is described as problematic because it is not a fit with the

engineering culture of direct confrontation (Evetts, 1998). However, as we saw in Lesson 2, direct confrontation is claimed as one option for these storytellers. Avoiding can also be critiqued as a personal solution, a way to avoid a specific problem without changing the more general situation that creates such problems. But in these stories I see participants arguing for two benefits to walking away. The first benefit is that walking away is a chance for a women engineer to get back at someone who is causing problems for the storyteller – to literally rob them of the benefits of her presence. The second benefit is the chance to explore better options elsewhere.

Here, Lois Bey relates an experience about being denied a promotion at work. Bey faces a challenge that is interpersonal, but deeply embedded in structural systems. Prior to telling this story, Bey relates a separate experience about being denied a school scholarship due to her gender and unusual major choice. The excuse she is given for the denial is, however, "A word I've heard many times, 'Clerical error'" (2003, p. 21) – a smokescreen for discrimination. Bey returns to the false "clerical error" again in this story. In other words, across her stories Bey builds a rich context that helps us see this particular incident and Bey's response to it in light of the persistent, systemic discrimination she faces. That discrimination is enabled by organizational rules, which are enforced strictly when it is to her detriment, while being bent or ignored when *that* is to her detriment. The persistence of that discrimination is emphasized, without detracting from the satisfaction that Bey feels in saying "Goodbye" to her employer.

> LB: So I was due for a promotion. And the usual thing: "Sorry, you got a raise, you didn't get a promotion. Clerical error"… So anyway, they said they'd have it corrected six months later. They said they couldn't do it because to give me a promotion they'd have to give me a raise, and I already got one. Go try again six months later. So at that time, I got a call from the alumni office that a man wanted to talk to me about a job. Now I hadn't been looking for a job, and I didn't know him. I said, "Okay, I'm willing to talk," because I wasn't exactly happy with what was going on here. I was just informed I had maybe another six months to wait (2003, p. 51-52).

Bey interviewed and received an appealing offer, which she took back to her current employer. She then resumes the story:

LB: So I went back to the woman who headed the technical information center and said, What are my chances here," you know, because of everything else. She said, "I doubt you will be getting it, because the men are fighting your promotion." They don't want to have a woman as an equal, because an associate engineer could be a project manager. An assistant engineer could not. Which meant I could run a project and supervise men. So she said, "You have no future."

So I agreed to take the other job, which meant possibly not a great salary, but at least a working salary. The minute I turned in my resignation, an assistant manager of the department called me in and asked me to retract my resignation. And I said, "Why?" He says, "You're too valuable." I said, "But you haven't let it" – he told me if I retracted my resignation, I would get my promotion immediately and a thirty-seven percent increase in salary.

Interviewer: Wow.

LB: Seventeen percent immediately, ten percent in three months, and another ten percent. I said, "Would you put it in writing?" He says, "I can't." I say, "Goodbye."

Interviewer: Good for you.

LB: And I went with the sales company, and I started out in the office. (2003, p. 53)

Bey has a tool at her disposal in this conflict, which is her desirability as an employee. As her manager says, "You're too valuable." She's also desirable to other employers. In this story she is approached, unsolicited, with a job opportunity. She is able to leverage that offer in a

discussion with her employer, which becomes a specific dollar amount that represents her employer's desire to keep her – a thirty-seven percent raise. But, when faced with further dissembling, which she immediately recognizes for what it is, she walks. She drives this home by switching to present tense with an emphatic, curt "Goodbye." In this story, Bey takes evident pleasure in making her boss articulate his need for her, and then denying that need. That pleasure is typical of these stories.

As a final example, Irene Sharpe[22] also leaves an employer who mistreats her, and also immediately steps into a new job. In this case, Sharpe is clear that she leaves "to get back" at a "so bad" supervisor she encountered. Similar to Bey's story, Sharpe finds herself in a difficult spot, tests the job market, and jumps to a different employer with pleasure upon finding her skills are in demand. Although she is avoiding this problem, it's framed as a victory for her personally.

> And I worked with GM until I was three-months short of being vested. I had four years and nine months. And there was a six-month period in which I got five different supervisors. And each one was worse than the previous one. And I thought, I don't need this. And it was a small group.
>
> And I have always said what I think. I don't care whether it's the boss or who I'm talking to. And the guys used to egg me on to do things that they were afraid to do. And then they would listen through the wall, and they would go get the rest of the group, Irene's in there bouncing them off of the wall again. And

---

[22] Sharpe earned her degree in Electrical Engineering at Howard in 1963. She spent her career designing electrical systems, first for the Bureau of Land Management and the National Park Service, then for automotive companies including Ford Motor Company and General Motors. In Sharpe's long career in industry she did not shy away from confrontation. Sharpe describes herself as a contrarian in strong language: "Everybody was telling me what I couldn't do. And of course, that was my motivation. You tell me I can't do it, I will show you I can or I'll die trying. It's going to be one or the other. And I'm still alive, so I guess, you know, that motivation has always been with me and is still with me" (p. 4). Throughout her oral history she tells of dealing with difficult coworkers through direct confrontation, or what she calls "bouncing them off the walls" (p. 42) and "giving this guy what for" (p. 45). She's also willing to stand up to people who intimidate everyone else, which she can do because "Irene doesn't get intimidated by anybody" (p. 45).

then they would cheer me when I come out. And this guy was just so bad. I mean, I just could not envision staying with him another three months.

So I call up the pension people and I say, If I stay with GM another three months, what do I get as a pension? They said, $90. I said, forget it. I'm going now. Used GM's fax machine to fax my resume to the headhunter. He faxed me back -- no, he called me. He wanted to know if wiring assemblies were the same as wiring harnesses. And I told him, Yes. He had me three interviews within two days. And I got a job offer, and I gave GM my notice that I was leaving in two weeks.

And then they let me interview all over General Motors, anywhere I wanted to go, if I would just stay, I could have a job. And I mean, they sent me to so many -- there was one job I really would have taken had I not already gotten another one. But I came to the conclusion that this supervisor wanted me to quit on somebody else's watch, and I said, No, I'm leaving because of you. I'm quitting on your watch. It's going on your record that you lost a female minority engineer. That was my thing to get back to him. (Sharpe, 2001, p. 42-43)

Walking away isn't a cowardly act. Sharpe apparently realizes that this story about her leaving a difficult employer could be interpreted in that unflattering way. To avoid that, she starts the story with a short aside that shows her to be unafraid of confrontation and not one to back down; this short Orientation extends just four lines from "And I have always said what I think" to "And then they would cheer me on." Sharpe doesn't make the connection between this aside and the rest of the story explicit, but they are part of the same story, because they all comes after the start of the story at "And I worked with GM until…" Rather than explain the connection, Sharpe shows us that she is not one to back down, and in fact that she is more willing to confront problems than the men with whom she works, and then invites the reader to see the connections. (As I discussed in Chapter 2, this invitation to the reader to draw connections is one of the particular powers of narrative as a rhetorical tool). In this case, Sharpe asks us to see her

decision to “bounc[e] them off the walls” and her decision to “qui[t] on your watch” as the same, both the opposite of cowardly.

Like with Bey, we can see the pleasure Sharpe takes in this act. One sign of this is that she includes the minor detail that she used GM’s own fax machine to find her next job, adding just a little bit of extra jab at the company. By moving on, she takes from her current company, starting with just a little fax machine ink. More significantly, Sharpe takes herself from GM. She shows herself being “fought over” by her current employer and her possible future employer. Again like Bey, she quantifies her importance, although rather than Bey’s specific thirty-seven percent Sharpe has the approximate “so many” (people to interview). Finally, Sharpe is committed to sticking it to her employer. She’s offered a job “that I really would have taken” but she is able to turn it down. She’s got two good options and, in deciding between them, getting back at her employer is the factor that tips the balance. All of these details contribute to the sense that that Sharpe is pleased to be able to walk away from GM.

This story also reveals one of the reasons that women engineers can flex this power to “get back to” their employers, which is the financial security offered by the job. Their skills are in-demand – they don’t have to take the job that pays them less. For Sharpe, she has the financial freedom to consider $90 (presumably per month) in a pension to be “forget it” money. She can literally afford to prioritize her own well-being. Bey also knows that her new position “meant possibly not a great salary, but at least a working salary,” which gives her options. Plenty of women are in poor working situations in which they are stuck, with no apparent way out, and bad bosses can show up in every field. Sharpe makes her experiences seem universal by describing her bad boss only as “so bad” and one of a line of bad bosses. In other words, she says nothing to suggest that this boss was out to get her specifically – there’s nothing unique or identifying about him at all. He could be any bad boss or every bad boss. In stories like these, women in engineering like Sharpe argue that, if you have to face a bad boss, you can at least do so with financial security.

Walking away is likely to be a tactic that invites critique or skepticism. After all, it takes persistence and commitment for any women to succeed in engineering. But in these stories, these storytellers help us see the situations in which walking away can be beneficial. It's a tool in the toolkit that these women are often proud to possess.

LESSON 5 – "THAT'S ALWAYS THE FIRST THING, IS THE RACE ISSUE"

Much feminist scholarship has urged attention to the ways that social attributes such as race, ethnicity, disability, sexuality and class intersect with the social category of gender (Maynard, 1994). These theorists recognize that oppressions based on multiple social categories are complex, interlocking, and mutually constitutive (Dill & Kohlman, 2012). As Marsha Houston points out, "women of color do not experience sexism *in addition to racism*, but sexism *in the context of* racism… an altogether *different* burden than that borne by white women" (Houston, 2015, p. 48), what she calls a double jeopardy. Given the ways that minority women are under-represented in engineering and minority-specific forms of discrimination have been described by research on workplace behaviors (see Chapter 1 and 2), the different experiences of minority women in SWE's collection deserve particular attention.

Three women in this data set discuss an African-American or Black racial identity. Those women are Yvonne Clark, Irene Sharpe, and Lois Cooper, all of whom have had stories and short bios already in this chapter. One of the goals of this dissertation has been to draw out themes, lessons and conclusions from this data without losing the individuality of the 23 participants. With only three individuals discussing a non-white identity, I don't feel comfortable developing a theme or lesson that is particular to the Black engineering experience. However, it is also true that these women have an "altogether different" experience of Interpersonal Challenges, which is worth highlighting. In this section I hope to highlight that experience and represent the individuality of Clark, Sharpe and Cooper with as much fidelity to their own words as possible. First, I will summarize their own comments on the role of race in their careers. Then, I'll make some comments about how I see their statements fitting into the other claims made in this dissertation. Overall, the stories told by these women help readers envision the ways race and gender

intersect in Clark, Sharpe and Cooper's lives. Although they didn't always have the power to effect change, Clark, Sharpe and Cooper's positions as engineers allowed them access to social and financial resources that shape the actions they take in their narratives.

All three individuals describe facing racial and gendered discrimination, particularly Cooper. She says that she grew up when things were "black and white" in her hometown, with everything segregated. In the workforce in unsegregated California, things were sometimes less black and white, but shades of grey did not disguise the racial animus she faced. "I mean, it was just my perception of things, but when you go to the bathroom, I was the only black person in there in the bathroom. And it just seems like people are looking at you differently, because you didn't share bathrooms back in those days." (2005, p. 19). The title of this section comes from Cooper, who says:

> Lois Cooper: You know, that's always the first thing, is the race issue.
>
> Interviewer: So you think that comes before—
>
> LC: Yes, before your knowledge, yeah. Because I mean, you could be the smartest person in the world, if you were black, you're black. And more times than not, a lot of times they never find out if you're smart, they've already defined you because you're black. So there are a lot of things that you have to go through. And you look at things different. (Cooper, 2005, p. 21)

Forms of discrimination show up in these stories many times. Some challenges share features with other stories in this collection, but some are unique to the ways gender and race-based discrimination interlock in these participants' lives. For instance, all three women attended a Historically Black College (HBCU) and while they speak positively of that, their experience also came with unique challenges. Sharpe tells a story about receiving a check each semester from the state of Virginia, "because they didn't want black students at the University of Virginia, they would pay us the difference between going to Virginia State College and Howard… when I applied there [University of Virginia] I was the wrong color, I was also the wrong gender. Naïve! Didn't

know all of this! They never even bothered to answer my application" (2001, p. 7). Sharpe eventually realizes the meaning of the checks she receives each semester, and is forced out of what she calls her own naiveté. As a result of these payments, Sharpe was able to graduate without debt but with apparent lingering frustration for the ways race and gender shaped her educational options.

These women turned to a variety of strategies for managing these challenges. For Clark and Sharpe, one strategy was to rely on the Society of Women Engineers as a source of support. There is one story in particular that deals directly with race and which I returned to many times in my work. This story is told by Yvonne Clark about a SWE Convention she attended in 1958 in Houston, Texas. In this story, Clark encounters racial discrimination intruding on what she hoped would be a safe space. Clark describes using the organizational resources of SWE to manage that discrimination – first in small ways, but then in a larger and more significant way.

> Anyway, they [SWE] told the hotel that they were integrated, and the hotel said, Oh, no problem. Well, I got everything I was supposed to have, reservations and everything, and I show up at the hotel. And I said, I'm here to attend the Women Engineers Convention, and here's my reservation for your hotel with guarantee. And the man reached for my [hand gesture] – I said, no, no, this is mine, you find yours. And I found out that they wouldn't let me stay there. Now that was a good ruckus.
>
> And somebody wanted to pull the convention out of the hotel. And I said, No, no, no, no, too much time has been [pause] – it takes time to get a convention, national convention, moving smoothly. So I wouldn't let them pull it, now, on my account. And we went on. And they sent me over to another hotel – they recommended a segregated hotel – black. And that's when I called my aunt. I said, I'm here for the women engineers convention, but I don't have a place to stay right now. She said, Okay, I'll come get you.

> The convention and the hotel compromised. I was met at the front door every day to go to the convention, and I was let out at the front door every night. And I got picked up by my aunt and uncle.
>
> But we had a ball. Anytime somebody wanted some cigarettes, they came and found me and we walked. Because as long as I had a person with me I could move around the hotel, but I had to be accompanied at all times, from the front door and back. So I'd been to the newsstand and coffee shop. We went everywhere that one week. We had a ball. And I did go to some of the meetings because I had to.
>
> But it was interesting. And the SWE Executive Committee canceled Atlanta – that was the next convention. They made a statement of whatever that they wouldn't go south anymore until the Civil Rights Bill was passed – and in '98, I went back to Houston and that's when I got a plaque. (Clark, 2001, p. 32)

The first part of this story contains a small conflict and resolution. Clark enters the hotel utterly prepared for what she encounters – not just discrimination, but also duplicitousness. When the man at the front desk asks for her reservation, Clark refuses to hand him her copy. Clark seems to expect the man to use any excuse, including taking and presumably keeping her documentation, to deny her service. Instead, she refuses to part with that documentation. (Other of Clark's stories show her as reluctant to trust the men she interacts with in a professional capacity, and challenging them with clear, direct statements and refusals.) At the same time, Clark is able to benefit from the power associated with engineering and with the Society of Women Engineers. She accepts that the current convention cannot be changed and works around these issues with, in this telling, a positive attitude and good humor. But change is effected for the following years and Clark's challenges are eventually recognized.

Clark summarizes her attitude in this story as: "if you roll with the punches and you don't wear other people's problems, you can make it with a smile" (2001, p. 34). Across Clark, Sharpe

and Cooper's stories, "I had no problem with that," or "it didn't bother me" are repeated phrases. It's easiest to understand that assertion when it is made alongside stories like Clark's above, in which the SWE organization changes large-scale plans to make a statement in support of racial equality. It's also easiest to understand alongside stories about shaping young people's careers in mentorship roles, something emphasized by all three women. And it's easiest to understand alongside stories about telling off employers, confronting managers, comfortably paying for full-time domestic help, and being in demand for technical skills (all evident in their oral histories). In other words, like other women in this collection, Clark, Sharpe and Cooper all emphasize their agency alongside their challenges. That agency is considerable, and closely tied to their positions as engineers.

That said, one of the most striking things about this small group of histories is that final element of agency, being in demand for technical skills. Not being bothered is a viable strategy for these women because they do have in-demand expertise – and lots of it. To put it simply, it's clear that these women were brilliant in their work. Cooper describes earning a reputation for taking on the hardest calculations, then doing her work so fast that her boss, annoyed, tells her to stop asking for more. Sharpe "set the curve" (2001, p. 10) in her 300-person physics class, while Clark wrote a 100-page engineering thesis with a single error (unnoticed by her advisors). They won over who they could with this work, and ignored who they couldn't win over. But even by their own estimation they were able to win over most of the people who mattered, earning respect through their strong wills and technical competence. It's only possible to "Appreciate Being in the Right" when one is in the right, and these women always are, perhaps even more than the other, white women in this collection.

As a researcher interested in considering strategies for success, this presents challenges. One of the themes in existing literature about women's strategies for success in engineering is that women engineers perceive that excellent performance in the workplace can override gender-related problems (Evetts, 1998; A. Powell et al., 2009), but that's not a universally-applicable strategy because not all women can be extraordinary engineers (nor can all men, but average

quality male engineers are readily accepted). Clark, Sharpe and Cooper's actions are difficult to separate from their excellence. All of the participants are excellent engineers, but I hope that across the variety of experiences in these stories I have identified claims that may be useful to a variety of people. Again, that's more difficult to do with just three participants, and so I resist making some concluding claim about race, gender and engineering here. That's not to say there's *nothing* to be said, because all three of these participants contribute extremely valuable stories that support the overall breadth this dissertation depends on. I have said many things about Sharpe, Clarke and Cooper so far in this dissertation, and I will continue to rely on their words and thoughts.

To be white is also to have an ethnicity, but that rarely becomes an issue in these oral histories. For a small number of participants an ethnic or cultural heritage is discussed, in every case European. Ann Fletcher, for instance, recognizes her Polish immigrant identity as both a cause of ethnic exclusion and as an opportunity to connect to more resources through the tight-knit Polish immigrant community. In some cases, participants attribute their drive to push through challenges in engineering in part to a cultural heritage of hard work. Participants never discuss the race of their coworkers, with the sole exception of Bernice Brody's mention of "interviewing with an African American Manager. I'll never forget that, because they were very rare. So that was kind of like, 'You know, I think I can fit in here'" (2012, p. 12). Overall, the lack of discussion of race is indicative of the ways that whiteness remains a default in engineering, just as much as masculinity. It's certain that to some degree the success of these women was facilitated by their whiteness even as it was challenged by their gender, but if that aspect of their experiences was evident to them it does not feature in their oral histories.

Unfortunately, other social attributes such as disability and sexuality do not feature in these narratives. Given that the focus of my dissertation is on uncovering what these participants say about how to succeed in engineering, and they do not speak to those experiences, I reluctantly leave these aspects of intersectional identity unaddressed for now.

CONCLUSION

Some of the above tactics I've highlighted might seem obvious, but one way to bring these stories into focus is to consider what is not present. Mentorship is a prominent theme in literature about women and engineering (e.g. Chesler et al., 2013; Haas et al., 2002; Marszalek et al., 2009; Poor & Brown, 2013), but mentors and actions associated with mentorship (collaborating, seeking help, taking advice, etc) do not feature in narratives around Interpersonal Challenges. Those actions exist in these stories, but they are not often used to solve Interpersonal Challenges. This is all to say that to solve Interpersonal Challenges, these women engineers are not seeking help, building, and collaborating, they are instead *learning, knowing and clarifying.*

An uncharitable reading of these stories might be that they echo in many ways the traditional perspective on engineering and gender that is critiqued by feminist scholars. In such a reading the first four lessons here are, respectively, to work harder and better than anyone else, to fit into the existing workplace culture, to prioritize work over other concerns, and to accept that some problems aren't solvable except by quitting – advice that would hardly encourage anyone to choose engineering.

However, I believe the rich nuance included in these stories contradicts that possible reading. In these stories I see participants claiming that their engineering way of thinking prepares them to handle serious workplace challenges. In applying these strategies, participants describe overcoming even the worst behavior and most systemic kinds of discrimination. And although these strategies do not guarantee success in every endeavor, success is possible. Moreover, close attention to these personal stories also helps us feel the impact of the hard-won victories, and particularly the satisfaction participants feel in succeeding by being more professional, more sensible, and more focused than the "klutzy" or malicious men around them.

CHAPTER 5

TECHNICAL CHALLENGES

This chapter is about strategies that participants use in handling Technical Challenges. Technical Challenge stories are those in which participants encounter some new or difficult work task – specifically something related to calculating, testing, designing, building, maintaining, or so forth. Technical Challenges also include those related to performing the physical aspects of engineering work. As I will discuss, these are the kinds of actions (physical exertion and calculating, testing, etc) that are critical to women's exclusion from engineering. In these stories, however, participants argue that they are capable of handling these challenges.

The first lesson I discuss here addresses how participants handle the supposed physicality of the work. As we will see, participants do articulate engineering as physical work, but suggest that physicality can be "washed off" or managed with careful thought and planning. The second lesson shows women handling technical tasks while including the social context, redefining their work as sociotechnical rather than just technical. At the same time, stories about difficult calculations provide opportunities for participants to argue for the value of their individual accomplishments.

LESSON 6 – BRUSH OFF THE DIRT, THINK THROUGH THE HEAVY STUFF

In *Machineries of Dominance,* Cynthia Cockburn claims that "the way gendering works is by ascribing a series of polarized characteristics, complementary paired values, to the 'masculine' and the feminine'" (1985, p. 190). Examples of these values include practical/impractical, active/passive, and rational/irrational. One division, hard/soft, is particularly important to women's exclusion from technological work and engineering (Keller, 1983). In this division, men are associated with the hard: tough, sweaty, dirty, heavy, physical. Women are associated with the opposite of those things. In later writings, Cockburn emphasizes the centrality of women's division from the "hard" to the ways women are culturally confined:

> The cultural barrier that is erected between women and technology is all too closely related to other physical taboos that confine and limit us. When you see a woman take a set of spanners and approach a car, you suddenly become aware of the manifold informal pressures against women in public places using their bodies in the way men do: getting dirty and sweaty, climbing up things, lying on the floor, spreading their legs, exerting muscular force. Learning to understand and use tools that work metal and wood, to translate geometry into motion and energy into work, these are things that we cannot do without if we are to stop being the world's victims. (Cockburn, 1999, p. 131)

Women's exclusion from engineering is predicated in part of their supposed lack of fit for the "hard." As I discussed in Chapter 2, engineering has historical roots as a highly physical profession. Nineteenth- and early twentieth-century engineers typically worked as what would now be called civil engineers (meaning they were out 'in the field' planning and building roads, bridges and other infrastructure) or manufacturing engineers (meaning they were in the factory, building and maintaining machinery). Engineering has retained that cultural association with physicality, despite the fact that as engineering expanded following World War II, engineers became less likely to do the things Cockburn described: lying on the floor, spreading their legs, etc. Instead, much of the physical work of engineering is performed by technicians, a class of jobs that have less training and function as engineers' "hands" (Winsor, 2003), executing on plans, running tests, and so forth.

Other forms of engineering require little physical exertion at all. Computer and electrical engineering depend more on detailed work than brute physical labor. For instance, John Kidder's nonfiction narrative book *Soul of a New Machine* depicts computer engineers in the late-1980's microcomputer boom. In one chapter, engineers "debug" hardware by methodically testing and placing wires on the back of a switchboard. This kind of detailed, careful work is often coded feminine (Kidder's descriptions sound close to needlework, in fact).

And yet, Kidder describes a culture in which participants see themselves as highly masculine. Regardless of how "hard" the job is in fact, engineers represent their jobs as physical, emphasizing the lifting and grime (Cockburn, 1985), in order to retain "masculine status and self-esteem" (Wajcman, 2010, p. 143). Defining engineering as hard, and hard as masculine, reifies women's exclusion from the field.

Participants in these stories do describe engineering as physical, but advise that the physicality of the work is limited in scope and effect. Specifically, in these oral histories, the physical challenges participants face are most often characterized as "getting dirty," which effects a person's clothes but not the person. Cockburn specifically names dirt as something associated with the 'hard' and the masculine, and it does present genuine conflicts for women for women in engineering. Still, the advised solution in many stories emphasizes the transitory nature of this element of the work – one can get dirty for work, then clean up. In a small number of stories about tasks that cannot be handled in this way, participants advise that careful thought will overcome physical challenges.

In the following story, Maggie Hickel[23] describes getting dirty on the job. Hickel begins this story by acknowledging the link between dirt and "these very hard-core—all guys." In contrast, Hickel, in one of her first days on the job and equipped with little understanding of the work or culture, describes wearing white slacks. When she is required to physically move around the engineering workspace, these things come into conflict. White slacks, a feminine style of clothing, is not simpatico with engineering – quite literally, in this case, as the pants are made "filthy" by the work.

---

[23] Hickel earned a bachelor's degree in industrial and management engineering from the University of Iowa in 1975, and spent her career working at 3M in a variety of management positions. Hickel describers being supported in her decision to become an engineer by family and teachers, even if, or she says, perhaps because, she was one of few women in her programs. She provided that same support to her daughter Katie Peterson, also an engineer, who interviews Hickel for SWE's StoryCorps program. Hickel was active in SWE, even serving as president of the society from 1990-1991.

> Maggie Hickel: One of my first days on the job. I worked in Abrasives, which—sandpaper, very dirty. And as a brand new engineer, and especially a female engineer, going into the manufacturing plant with these very hard-core—all guys. And the foreman at the time, a wonderful man at that time named John LaHore (??)—he's passed away—you know, said he was going to give me a tour and I had white slacks on. And I thought, you know, I can either say, "No, I'm going to get dirty," or I can just say, "All right, where do you want me to go." And he had me climbing over equipment and up ladders and down into everything to give me this tour. And did I get filthy? Yes. Never wore white slacks again. However I think I gained his respect because I was there. (Hickel, 2007, p. 9)

The practical challenge here is the dirty machinery, but that challenge is created by Hickel's failure to anticipate the work and her choice to adopt a kind of traditional feminine clothing. Hickel frames a distinct choice: get dirty, or say no (to engineering). The link between appropriate dress and engineering success surfaces elsewhere in Hickel's narrative. Hickel tells the following brief anecdote about an exchange with her husband just before the story about white slacks, where it functions as a sort of prologue. Here, Hickel establishes that some clothing is feminine and "really pretty" while other clothing is "more masculine," and only the latter is associated with "success" in engineering. Note that Hickel is talking with her daughter, also an engineer.

> Maggie Hickel: I think you had to prove yourself more. I remember going shopping with your dad and he saw a really—it was a really pretty, red suit, and he said, "Why don't you wear this to work?" And I asked him if he would ever wear a red suit to work. And he said, "Well, no." And I said, "I can't either." Because at that time "dress for success" was almost dressing more masculine. Navy blue, black, brown. Which I'm so glad now, you know, you can wear anything you want. And it took a long time before I felt comfortable that I could wear what I wanted, and still be considered a female engineer. (Hickel, 2007, p. 7)

Hickel here offers a brief but trenchant critique of the gendering of engineering. On one hand, both Hickel and her husband are held to the "same" standard about what they can wear at work. On the other hand, Hickel's husband just has to keep doing what he already does. His default behavior presents no conflicts between his identity and his work. In both stories, that's not true for Hickel. She has to change to fit into the existing culture, which isn't suited for her normal behaviors, such as wearing white slacks.

Hickel says she's glad that "you can wear anything you want" now, meaning you can dress in things that aren't "more masculine," and that now it's possible to dress more feminine and "still be considered a female engineer." However, that optimistic tag on this story is not supported by other stories in the collection or even Hickel's own stories. As occasionally happens in these narratives, Hickel's direct claim about how things are is contradicted by stories of her experiences. Through these oral histories participants don't get to wear what one participant calls "nice clothes" (Anderson-Rowland, 2008, p. 22) – clothes that are pretty, that look good, that are feminine. Instead, the physical demands of the job put women in a position where they wear lab coats, thick jackets, hardhats, or whatever they can throw on.

The second story is told by Ivy Hooks, an aerospace engineer who spent decades working for NASA, then started her own aerospace engineering consulting firm. This story is about how Hooks achieved her own success, which she calls "about as fun a thing that could have happened to anybody in their career." Hooks' story is lengthy, but worth including in its entirety because it contains themes that I saw throughout these oral histories and I will return to it. Hooks overcomes suspicion of her colleagues, a sense of being out of place, and completely novel technical challenges in order to reach that goal. Here is Hooks' story:

> On April Fool's Day, 1969, I got this phone call and it said, "Go to Building 36, the Third Floor." Now, I'm going to tell you I've worked with a lot of people who were not above April Fool's jokes. So I was a little suspicious because I really didn't know why I was going there or who this person was who told me to go there,

on the phone. It was a woman. I'd have been much more suspicious if it had been a man who called.

But about four people in my group, my area, also got calls.

None of us even knew where 36 was, as it turned out. We got the phone book out and looked on the back and saw where it was, and drove down there. It was only a two-story building, and we were supposed to go to the third floor, so now I'm really getting suspicious. But I looked, and there's a test bay on the side of it that's three stories tall. And there's a stairway. I could see other people going into the stairway there, so we figured that's where we were supposed to go. Now, it still could have been just a big April Fool's Joke, a real good one.

(Laughter) So I went up the stairs with everybody else. And we're standing around. There were about twenty of us. This is in the third story of one of these test buildings, which means it's just bare walls and pipes in the ceiling. And it's all dusty and dirty because nobody has used this for anything but to store furniture for years. And I'm in an all white suit, not the best thing to go in there in. And I still just thought it was an April Fool's joke, but there were some people in that room that you would not pull April Fool's jokes on. I'm not one, but there were some. So I decided maybe it wasn't.

And in a few minutes, Dr. Max Faget walked in. And he was carrying a balsa wood model of an airplane. And the airplane looked a whole lot like this airplane [holds up a model]. He was carrying this balsa wood model, and he strewed across the room, flew it across at us and said, "We're going to build America's next spacecraft. And it's going to launch like a spacecraft, it's going to land like a plane." And then he started describing to us what was going to become the Shuttle. So that was 1969, so I was twenty-eight years old. And I was in the original group with twenty or so people, that were on the original design team.

> Now, when I look back on that, it's just totally awesome that I got selected to be on that team. There were experts there in aerodynamics, there were experts there in thermal dynamics. There were the weight experts. There were guys for the drawings boards who did the artist concepts and the scale models. The propulsion engineers were there, the structural engineers were there. And I was really the generalist. And so very early on, I was off trying to figure out how you put air-breathing engines on this to land it like an airplane, because all of our propulsion guys were experienced in jet engines and things like that, not -- I mean, launch-type big engines, not aircraft engines. And I was the only one that flew, it looked like. And I did, I had a pilot's license, so they said, "Well, you know some of that stuff. Go find out about that." And then things had to separate. And then there were going to be jet firings on these things where you had to deal with the exhaust plumes. And I did a bunch of work in exhaust plume during my years. That was something the guys didn't want to do, so they gave it to me to do. And I found it really interesting, so it didn't bother me. Again, it was one of those, I didn't know what to do, but I'd find out.
>
> And all that general knowledge of every system and subsystem that would fly suddenly made a huge payoff, because I had some knowledge of all of them. I could look at putting things together and doing some of the things that involved all that. So it's about as fun a thing that could have happened to anybody in their career. But it's like when they say, "How did you get here," you say, "Well, let's see. I was avoiding this, and I was avoiding that, and I was avoiding something else, and eventually you got to go somewhere." (Hooks, 2003, p. 31)

Hooks' brief mention of her clothing is not the focus of the story. But it becomes more meaningful when read in the context of all the stories in this collection. As with Hickel, Hooks' all-white suit is definitely a feminine choice of outfit and, as with Hickel, it was an early-career misstep. Hooks is in a "dusty and dirty" room specifically because she is doing new and exciting

engineering, which means using previously unused physical spaces. Hooks' inclusion of this detail suggests that her feminine clothing made her feel or appear ill-suited for the work she was interested in doing. However, as serious as these conflicts are, it's telling that dirt, and its effect on clothing, is the prominent way participants describe engaging with aspects of engineering that align with the "hard" stereotype. Clothes can be changed, and grease can be washed off. Participants are quite willing to do that, to change into something, even something masculine, to better fit these physical elements of the job. In other words, the choice of dirt (and its effect on clothing) as the most-prominent representations of the physicality of engineering functions to minimize the impact of the gender and engineering conflict, positioning it as a matter of temporary sacrifice for long-term benefit, rather than a severe identity conflict.

Hickel, for instance, ends her story by saying "And did I get filthy? Yes. Never wore white slacks again. However I think I gained his respect because I was there." It's certainly problematic that Hickel feels she must "never" express femininity in the workplace through her method of dress. Nevertheless, this story is told in a way that gives it a "happy" ending. Hooks, similarly, discusses her own clothing mistake in the context of a major career success.

Yvonne Clark offers a good example of this phenomenon in a story about taking college classes that involve hard, physical work. There are two challenges in this story, both related to getting dirty, and only the second of them includes a positive outcome. In that second conflict, Clark finds herself in conflict with the work and is able to exert her agency. Through careful thought and preparation she is able to put in the "hard" engineering work but then return to having the "clean fingernails" she wants.

> Then I went to another class, manufacturing, that's when you made things. And I still have the project that I made. But it was a vice that I made. And we had to make sand molds and things like this. And the teacher would call off things for the students to do, and I'd end up in the sand area. So I'm in there shoveling for

the molds and my teacher took me aside and said, Miss Young,[24] What are you doing? I said, I'm shoveling sand. You can't do that! I'm not taking big shovels. I'm just – I'm good at that. So they picked me off of that sand bog, but…

Then when we – I don't like my hands dirty. So we were getting ready to go into the machine area where I could see all these dirty hands. I said, don't we have something that I can put on my hands so that they won't get dirty? Looked at me. So he called a technician over. Technician said, What's the problem? I said, There ought to be something that I can keep my hands clean.

So he says, We've got some salve that you can put on your hands and get them dirty, but then you can take ivory soap they come clean again. Had no problems with that class the rest of that semester. I mean, you know, it's okay to be an engineer, but there's nothing wrong with wanting clean hands and clean fingernails. So we got through that all right. (Clark, 2001, pp. 14-15)

It's worth pointing out that Clark is evidently not the only person in this environment who wants clean hands, even if she is the only woman. The technician she talks to is ready with a solution. That suggests the "problem" of not wanting dirty hands is not uniquely feminine – at least some men share this concern. Clark's story thus argues that engineering is a field where anyone, regardless of gender, can research and plan their way around dirty and physical elements. "It's okay to be an engineer, but there's nothing wrong with wanting clean hands and clean fingernails" is an example of a clearly stated lesson.

However, women can't always research and plan their way around other people. In the first conflict in this story, Clark is taken off of shoveling work by a teacher because it is physical labor and not appropriate for her. Clark objects to this because she sees herself as quite capable of

[24] Clark's maiden name was Young.

performing the work. This story is atypical from other stories here about doing physical work, in that Clark's response to the challenge (verbally objecting) doesn't produce the hoped-for outcome. One reason for this is that the real challenge in the first anecdote is not managing the physical work, but instead the sort of interfering superior I discussed as part of Interpersonal Challenges. The work of engineering might in fact be "hard" (dirty) but in juxtaposing these stories, Clark argues she can handle the dirtiness so long as other people, thinking they know best, do not interfere.

In the 170 stories I examined in this collection, very few suggest that engineering is physical in ways other than being dirty and requiring certain clothing. A dearth of such stories might suggest that these experiences are uncommon or that participants are choosing not to discuss them. One example of a different type of physical challenge is in the story from Lois Bey that began this dissertation. Bey describes asking three men "in the next lab" for assistance with bending a steel pipe, the kind of physically demanding task that is often associated with engineering. These men could have helped Bey with this physically demanding challenge – engineering is, after all, a collaborative enterprise. Instead, they define engineering work such that it requires individual actions that Bey (they erroneously believe) cannot perform. However, Bey applies the lesson that the physical aspects of engineering can be overcome through thought. The intellectual work supersedes and governs the physical work. And, as in other stories in which participants out-do their male peers by doing engineering better, Bey's coworkers suffer the consequences. Bey repeats this lesson when telling a similar story about coworkers mishandling pressurized pipes, which explode. In that story, Bey recognizes the problem and acts to prevent further damage – and again, a highly material task is resolved primarily through her careful thought.

Judy Wajcman argues that encouraging women becoming engineers is not simply a question of preparing young girls with the appropriate technical skills, "because these skills are embedded in a culture of masculinity that is largely coterminous with the culture of technology. Both at school and in the workplace this culture is incompatible with femininity. Therefore, to enter this world, to

learn its language, women have first to forsake their femininity" (Wajcman, 2007, p. 19). The argument participants make across these stories does not, for the most part, challenge this concept. We can see women forsaking aspects of their femininity in order to succeed in work, as Hickel does. Instead, they minimize that sacrifice by focusing on aspects of femininity that are less important. Ultimately, I see participants striking out a sort of compromise position. They acknowledge the physicality of engineering work, but map out a path that navigates that physicality.

LESSON 7 & 8 – ENGINEERING WORK IS NOT DONE IN A VACUUM / DON'T EXPECT OTHER PEOPLE TO GET IT

Engineering is technical work, but as Winsor's (2003) ethnographic work reveals, engineers spend much of their time discussing how to interpret data, creating plans and instructions for other engineers and techs, and representing their work to superiors – all actions that blend the social and the technical. Trevelyan similarly found that such social tasks were the most prominent aspect of engineering work described by engineers in interviews, even though such skills are not emphasized in engineering education (2007). Indeed, Wendy Faulkner argues that in engineering work the social and the technical "dimensions are in a very practical sense inseparable - hence the use of the terms 'sociotechnical' (unhyphenated) and 'seamless web' in technology studies to denote the inseparability of nominally 'social' and 'technical' aspects. Since the two are inseparable in everyday engineering practice, the boundaries drawn between them are inevitably arbitrary" (Faulkner, 2007, p. 337).

Nevertheless, Faulkner's studies show that engineers insist on drawing clear boundaries between social and technical work, and asserting that only technical work counts as "real engineering," (2007, p. 335). The social/technical dualism is another gendered complementary paired value, and again the distinction "maps" onto gender-stereotyped identities and works to

reify women's divisions from engineering.[25] Even then, it's not just men that draw this distinction. VanAntwerp and Wilson found that women engineers also strongly emphasized the motivation to "apply and work with technology" in their careers – other motivations were present, but technology work was the defining motivation. They suggest that participants downplayed social elements because they "did not consider these skills and activities to represent 'real' engineering, and so there was some hesitancy to discuss these in the context of one's engineering job" (2018, pp. 252–253).

However, in these stories participants do not downplay the social elements of their work. When participants discuss their technical achievements, they often describe how those achievements are applied and take effect, which inevitably involves other people. Specifically, those other people are often positioned as oppositional because they do not understand the engineer's important work. These two lessons are closely intertwined in these stories: the work must be explained, negotiated, or managed in some way because it is beyond the understanding of others. Thus, I discuss them together. Stories articulate a variety of ways of handling the situation of someone not understanding. At the same time, not *all* aspects of engineering are sociotechnical in these stories. Because other people generally don't get the work, the action of performing calculations is usually solitary. This allows participants to argue that engineering allows one to take individual responsibility and pride in their work.

A good example of the sociotechnical nature of this work is provided by Diane Peters. I first discussed this story (about the client who wants to put their hands by the cylinder with the knives) in Chapter 4, but I am re-printing it below. There I described it as an Interpersonal

---

[25] Wajcman identifies two forms of masculinity (1991), one "based on physical toughness and mechanical skills," the focus of the previous lesson, and the other based on "the professionalized calculative rationality of the technical specialist" (pp. 143-44), the focus of these lessons. As Cynthia Cockburn insightfully points out, claiming that engineering aligns with both forms of masculinity requires some tricky rhetorical maneuvering: "At one moment, in order to fortify their identification with physical engineering, men dismiss the intellectual world as 'soft'. At the next moment, however, they need to appropriate sedentary, intellectual engineering work for masculinity too" (1985, p. 190). Male engineers get to have their cake and eat it, too.

Challenge, but it also contains technical elements; it is a sociotechnical story. Peters starts her story with an Orientation (the element of the story that previews the story and orients the reader to the point of the story), which in this case seems quite distinct from what follows: "Everybody, I think, in engineering has a few stories of somebody handing you a massive problem and saying, 'You have plenty of time, we don't need the answer for a few hours yet.'" The story that follows is *not* about being assigned a big project. But it *is* about other people who are not engineers failing to understand what is involved in engineering work and making assumptions about how that work can and should be done. This orientation previews the point of the story rather than the details.

In this story Peters demonstrates that she has technical knowledge about how to use and maintain a piece of large machinery. The knowledge she possesses is not complex, indeed it seems like the most obvious possible bit of technical knowledge: avoid contact with a "cylinder with the knives." And yet, that is what her client wants to do, because he lacks even the most rudimentary technical understanding. But in this story, Peters (and her fellow engineers working on this kind of equipment) know that "customers don't really understand various things" and so take precautions against that, physically barring people from touching "the cylinder with the knives." But implementing that technical solution requires being "diplomatic." Although, as I discussed in Chapter 4, in this case being diplomatic is primarily a matter of being clear and direct, Peters also describes herself as willing to take "a while to explain," and build trust with her clients. Thus, other people's lack of knowledge necessitates sociotechnical work from Peters.

AL: So, do you have any good stories?

Diane Peters: Oh, everybody has stories. You work long enough, you get a lot of stories. Some of the best stories are in dealing with customers and some of the things that they want. Everybody, I think, in engineering has a few stories of somebody handing you a massive problem and saying, "You have plenty of time, we don't need the answer for a few hours yet." (laughs) I've had stories of customers who don't really understand various things. They'll ask questions and you just kind of have to be diplomatic. Some of the best stories have to do with

safety. It's always been a concern of mine in machinery and I had one customer once call me up and say, "You know, I'd like to know how to get these particular parts out of the machine." And I said, "Well, you can't take them out." And he said, "But I want to take them out. They keep me from getting my hands in by the cylinder with the knives." And I said, "Precisely. That is their purpose." (laughs)

AL: (laughs) Absolutely. Oh my goodness.

Yeah, it was quite interesting. It took a while sometimes to explain to people that, "No you really don't want to do that. Trust me. It's not a good idea." (Peters, 2007, p. 10)

"Being diplomatic" is one tactic that participants take when confronted with people who don't get the technical work. As we see in Peters story, it's best not to hold people's ignorance against them; instead it is best to expect and plan around that problem. Sharpe calls this "giving it to them in layman's term's" (2007, p. 47) in her oral history. Winsor (2003) found engineers displaying patience most often when working with non-engineers and subordinates, and that finding is supported by the stories here.

However, engineers are not always in a position of power over those who don't get it. As a result, in other stories expressing this theme, superiors might ignore or undo work that is performed by the engineer. In those cases, "being diplomatic" doesn't suffice, and often there is no path to a solution except to have reasonable expectations.

For instance, Lois Cooper tells a story about designing the layout of the 91 freeway, a major freeway in California. Early in her oral history Cooper explains that freeway planning is a complex mathematical problem. She effectively illustrates the complexity of this problem with a jargon-heavy passage that begins: "To design and build a freeway, you have to calculate the alignment. And everything is based on coordinates, sines and cosines. And so the world is divided up into this coordinate system. And so you when you're building a freeway, or designing a freeway, you may draw a long line, or a tangent, and then you're going to put a curve in the road,

and then another tangent, and maybe a curve going the other way…" (2005, p. 19). Cooper succeeded at this work because of her particularly strong math skills (Cooper's undergraduate degree is in mathematics) and "they started giving the problems to me. And I would go through it very meticulously and find where they made the mistake" (2005, p. 20). Having established the technical merits of her work, Cooper then tells the following story about how this work is done within social constraints. In this case, the social element of the work directs the way Cooper performs her calculations – and that leads directly to poor results.

> One of my jobs – I think that was my last design job, working on the 91 Freeway from Eucalyptus to the Orange/Riverside County line; those with the limits. And I was just talking to somebody about that the other day. And it kind of irks me. We built this freeway – then we'll get to the bike paths. We build this freeway with a hundred-foot median. The side of the freeway was steep. And on that side was the Santa Ana River, and on this side we've got this steep cliff.
>
> But we also wanted to have a scenic freeway. And so we had this hundred-foot median. And one of the things I was asked to do is to calculate the grades on the eastbound lanes such that if you're driving on the eastbound side you can see over the westbound wall, and see the scenic beauty of the area. Well, we did that – you know, I did that. And since I've been retired, they took away the scenic beauty part – in Sacramento. It was no longer a scenic freeway, and they put a transit-way down the median. (laughs) And when you look out over on the north side, you see houses all over the place.
>
> And there's a river down there. I know, and they knew, on the 100 year flood, the freeway is going to flood. I mean, the 100 year storm, the freeway will flood. Oh, don't put that over the air. (laughs) But now they got houses all over there. But it gets to be political, a lot of times, with what goes on. Actually, we could have built the freeway wider if it hadn't been for the scenic route stuff.

> And now they're complaining. Almost every morning when I listen to the radio there's an accident down there. (Cooper, 2005, p. 25)

Cooper begins this story with an abstract, a narrative element that announces the beginning of the story to the audience and previews the point or evaluation. Included in that is "one of my last design jobs," which reinforces Cooper's credibility and efficacy as an engineer (Cooper is, as a rule, clear that she is technically highly competent). With that, she establishes that the conflict is between her technical expertise and some less-competent outside force. It's not clear who the "we" that "wanted" certain outcomes in this story is, but clearly that request was made with little understanding of the technical work, such as the steep cliff that would have constrained and complicated the calculations; or the tension between engineering a roadway that is safe for storms and morning traffic, and a roadway that is scenic. Because it "got political" they ended up with a freeway that was neither scenic, nor safe. This example of the ways in which other people don't 'get it' has a negative outcome, rather than a positive one.

Another example of this sort is offered by Jan Williams, who describes designing an energy-efficient infrastructure for an industrial campus, solving a variety of problems that arose because "they… never thought about the big picture." But Williams admits "I mean, will they ever actually build everything? Will they ever actually do that? That's the bane of planners and why engineers almost universally hate planning… because engineers like to see the results of their work and it drives them insane that you think of a hundred things and only two of them ever get built" (2009, p. 37). Williams advises that engineers in her line of work can't get attached to the idea that things are going to be done right, no matter the quality of the work, because the implementation of those ideas will involve social work.

Cooper's and Peters' stories don't have much in common – Cooper's is about a project that did not realize it's potential, while Peters' is about a clients' behavior. But across these stories the lesson is not that there is one right way of handling people who don't get the work. Rather, the lesson being advanced by these experienced women engineers is just that engineering is socially situated. It comes from social needs and is implemented through social interactions.

At the same time, my analysis of these stories uncovered instances in which, when discussing technical work, participants break from the above trend, stripping away the social to focus on the purely technical. This is a final consequence of other people not getting the engineers' work: the most technical and challenging aspects of the job require individual work and individual thought. As a result, these are also the aspects of the job in which engineers can and should take individual pride.

Cooper suggests this aspect of engineering work when she says "And one of the things I was asked to do is to calculate the grades on the eastbound lanes such that if you're driving on the eastbound side you can see over the westbound wall, and see the scenic beauty of the area. Well, we did that – you know, I did that." Cooper initially says "we" before revising to "I" when discussing her calculations. Although the consequences of how those calculations were treated was outside of her responsibility, Cooper can at least take *individual* pride in the work that others don't understand. In Cooper's story, "we" want and "they" ask. But "I" do. She takes individual, personal responsibility for that accomplishment.

The quintessential example of this is provided by a long story from Yvonne Brill.[26] In the following story, Brill describes producing this breakthrough. She calls in help where needed, but that help consists of "checking" her work. Other than that one unnamed person, no one other than

[26] Brill is a well-known figure in aerospace engineering. She graduated in 1945 from the University of Manitoba with degrees in chemistry and mathematics, but despite that her skills were in demand for wartime technical work (making her one of many women who found their way into engineering "sideways.") After graduation she was recruited to Douglas Aircraft in California. She spent her career at multiple aerospace firms including NASA, excepting a period she spent raising her children full-time. Brill is the recipient of many awards, including a Lifetime Achievement award from SWE and the National Medal of Technology and Innovation, awarded directly by Barack Obama in 2011. Brill is responsible for numerous innovations in rocketry , particularly the hydrazine resistojet, a key to "satellites than can fly themselves… satellites using her invention are the backbone of our worldwide communication network" (Teitel, 2013). Brill passed away in 2013, and a controversy about her *New York Times* obituary made the national news. The obituary (Martin, 2013), in listing her accomplishments, placed her "mean beef stroganoff" before her engineering contributions and described her as "the world's best mom" who was "also a rocket scientist." The obituary was critiqued for de-emphasizing her remarkable engineering accomplishments and was eventually revised.

Brill features in this story. Still, it holds together as a story, with Brill describing a difficult situation, her actions in response, and the positive outcome she produced.

> But when I looked at it from the satellite standpoint, we were using solid apogee motors, so when you inject, you have to have good pointing accuracy, which wasn't really the case in those days. (laughs) And often, for example, the whole — after the apogee motor had burned out, you might find your spacecraft drifting in the wrong direction to the station you wanted it to be at. And you'd have to fire a chemical propulsion system pretty quickly to stop it while you still had it in your ground vision, and send it the other way.
>
> So that convinced me you definitely needed chemical propulsion. And the electric propulsion engines that were being worked on had such high power requirements they couldn't really be used. The thrust levels you needed were not compatible with the power levels that the poor spacecraft could provide.
>
> And so it just occurred to me — I started think well, there's got to be an easier way — something called hydrazine with a Shell 405 catalyst, where hydrazine decomposes exothermically, it gives off heat when it decomposes, when you put it over this catalyst bed. It does it instantaneously, and you can start and stop the engine as many times, and get small impulse bits, that you need for attitude control. It was just becoming the vogue.
>
> And I had remembered reading that — well, your exhaust products from hydrazine are either ammonia — they're ammonia and hydrogen and nitrogen. And the ammonia is a fairly small, lightweight molecule, hydrogen is very lightweight. The nitrogen, I thought, well, might be a drag in this equation of the square root of the temperature over the molecular weight.
>
> But if you could put a heater on the hydrazine, when the hydrazine decomposes it automatically takes you to a temperature of about 2,000 Fahrenheit.

> And if you just used a simple heater, it seemed to me how, up to the limit of materials, that you could get a lot more ISP.
>
> So I did the calculations. And I had somebody that I knew who was capable of checking them check to make sure that my numbers were right before I proposed it. And then I did a whole analysis on my own time, really. I came in nights and weekends and sized the systems and proved that, for this Voice Broadcast Study, if you wanted to put electric propulsion, which had these great ISPs – I proved that you definitely needed chemical propulsion to start and stop the satellite if it was drifting in the wrong direction; or to get a change in orbit or location as well, you need to do it quickly, so you had to have the two systems on board. (Brill, 2005, p. 24-27)

As someone who is definitively a non-scientist, I struggle with the technical elements of Brill's story. But I interpret the narrative as one in which Brill combines well-known chemical reactions (hydrazine decomposition) and readily available materials (a simple heater) to solve a problem that other people knew existed but had not solved (the need for a fast, reliable propulsion system to keep satellites in orbit). As important as Brill's work is, when it comes down to accomplishing the task, it is Brill alone who "did the calculations." Brill emphases her ownership of the work by stating that she did it on her "own time" and saying that she "proved" the functionality (scientists are normally associated with "proving" principles, and engineers with applying those principles; by saying she "proved" a concept Brill takes intellectual ownership of it). Although the concepts and materials and need all previously existed, Brill alone understood their relationship and took action, and thus is alone in the accomplishment.[27]

---

[27] This is a further corollary of the lesson that other people don't get it: don't overlook a possible solution because it seems like someone else should have thought of it. A lot of the best ideas are there, waiting for someone to uncover them.

Lois Bey tells a story that clarifies the role of other people in technical work. Bey, who is throughout her oral history always willing to wade into an argument, positions other characters as oppositional or at best bystanders. In the following story, Bey positions herself as an independent genius (something Bey does, with humor, throughout her oral history). She is surrounded by clients who stand around in "utter silence" before recognizing the value of her ideas.

> Lois Bey: And so I sat in the conference room without about ten or twelve men, including the head of their maintenance department, telling me that they were trying to weld shut these jackets. And I says, "They're brass. They have to be braised. You can't weld them." And the maintenance man says, "I know it." I showed all the data that they didn't need them. Because they had two units.
>
> One was completely down, and they were getting behind in production, and the other one was leaking. They had to get them back up.
>
> And of course, my boss wanted to sell them new first stage throats with jackets, which would be cast iron, because they didn't need bronze, and the bronze would be ten times the cost of cast iron, like 4,000 versus 40,000.
>
> LK: Wow.
>
> LB: So I couldn't convince them to run them off, so I got mad. This Swedish-German temper can get mad. And I said, "The hell with it. Rip off your jackets; wrap your throats with copper tubing. Run your steam through your copper tubing. Insulate the copper tubing, and when that leaks, rewrap it." I had utter silence, and one engineer said, "Brilliant idea. That's what we're going to do." And that's what they did do. (Laughter)
>
> LB: The next time I was out at Abbott on a call, I'd met the head of their maintenance department, Lindstrom. He says, "I have an opening. Do you need a job?" But I would go and try to help companies in doing it. And of course my boss was angry, because I didn't sell them new throats. I said, "So what? We've got

> Abbott's business one hundred percent. They won't deal with our competitors, because Abbott doesn't trust our competitors, they trust me." And I said, "We've got one-hundred percent of Abbott's business." "Oh." (Bey, 2003, pp. 55-56)

Bey's story does not contain a very clear evaluation or lesson component directed at the audience, like Peter's line "They'll ask questions and you just kind of have to be diplomatic." Nevertheless, Bey's story exemplifies every aspect of this lesson. In it, Bey is individually responsible for the idea that solves the technical problem her clients face and she takes evident pride in her idea. But she is surrounded by other people who don't fully understand her work and must be persuaded, and so in practice her work is sociotechnical rather than purely technical. She attempts to be diplomatic by "show[ing] all the data," but eventually she resorts to a more insistent rhetoric in order to get her ideas implemented. And then, in the coda to her story, Bey reiterates the lesson: once again someone else (her boss) doesn't "get" the implications of her work (guaranteed business) until Bey explains it.

Although this is a self-aggrandizing tale, that serves Bey's claim that her work is something that merits pride. What's clear across these stories is that Bey and other storytellers are not simply describing achievements. Instead, they are claiming that engineering allows them to take ownership of and receive recognition for ideas, and that women engineers should do so. Bey's cleverness is hers to own and value. At the same time, her cleverness has to be realized in interaction with other people.

I also choose to end my analysis with this particular story because it shows so much of what makes stories effective for these kinds of claims. This is a short narrative, told in a way that is entertaining and amusing, which invites us to sympathize with Bey. It helps us see the challenges she faces: people who don't understand her work and a boss who doubts her abilities. But, without erasing or minimizing those challenges, it is convincingly triumphant – we can see both her frustration and her pride simultaneously. Moreover, it models the specific actions Bey takes to achieve success. It's the kind of story that can help women become engineers and persist in engineering.

CONCLUSION

The significance of these few stories can again be clarified by discussing what is not included in this collection. Engineering is generally considered to be a collaborative profession, which is one of the reasons it is important for more women to be in engineering, so that they can contribute to that collaboration. However, I can find no stories in which participants collaborate on solving a *purely technical problem* with peers. The "somebody" who checked Brill's work is the closest to such a collaboration I can find. There are stories in which other people support the participants' work, or assist with representing that work to an audience. But they don't *do* the work. Instead, the focus of these stories is on *individual* technical achievements followed by *collaborative* implementation.

However, it's also true that highly-technical stories are relatively rare in this collection. Brill's invention of the hydrazine engine is perhaps the most technical description of solving a technical problem in the 170 stories in this set. Compared to other stories in this collection, Brill includes a wealth of technical details (hydrazine, square root of the temperature over molecular weight, ISPs, etc) in a way that is comprehensible. Even then, Brill condenses what was surely months of work into the short sentence: "I did the calculations." These kinds of stories might be avoided by participants because it is difficult to make these things accessible, and too much technical detail could be both confusing and intimidating, and so participants favor stories about other kinds of conflicts. Or, alternatively, they choose to focus their energies on discussing the kinds of conflicts that are more specific to women's situations.

As Bey's story suggests, a larger focus on these stories is on how work is received, understood, and represented to others. These social elements of the work are often frustrating, sometimes amusing, but important. The work is done in context, for people. That's a blessing and a curse. It's also a way in which these stories challenge the idea of what is "real" and "not real" engineering work.

CHAPTER 6

INTRAPERSONAL CHALLENGES

This chapter focuses on narratives involving Intrapersonal Challenges, those in which the storyteller struggles to make difficult career decisions, handle the intellectual and emotional challenges of their work, and to address the personal and professional needs that come along with being an engineer. To understand the stories in this chapter, it is best to keep in mind the audience for these stories. As I discussed in my Methods chapter, the available evidence shows that both participants and SWE saw young women on the cusp of engineering (potential and new engineers) as the primary audience for their histories and stories. Both participants and SWE also saw one important purpose of their words as supporting those women and encouraging them to participate in engineering. That audience and purpose are particularly crucial to the stories in this chapter. In many of these stories, the speakers reflect on their own time in the position of a potential or new engineer, and model how to develop into a successful woman engineer by making correct career choices. That is to say, they describe themselves as similar to their audience.

This chapter explores the Lessons presented in these Intrapersonal Challenge stories, but to a large degree those Lessons are varied expressions of a single, primary lesson: that women can and should succeed in engineering. The questions that come up again and again in these stories are some variation of, "Can I do this? Should I do this?" The answers are always "Yes, of course." Participants do help us understand *why* and *how* "I can do this," but asserting that success can and should be seized is primary. That's one way these stories are distinct from others in this collection. When faced with a problem like a broken machine, participants do less to justify fixing that machine – it's a given that the machine should be fixed. When faced with a problem like a man trying to embarrass or humiliate a woman engineer, participants do less to justify resolving that situation – it's a given that the man should be overcome or avoided. The stories in this chapter need to do more to justify themselves, to prevent the audience "begging the question." Choosing engineering is hard, and these stories work to justify that choice while also

explaining how to make it. As a result, while looking at specific claims that women engineers make about how to handle these Intrapersonal Challenges, we should keep in mind that those claims are made as part of a larger goal of arguing to young women that they should consider engineering as a career choice.

These stories do offer specific lessons about ways of handling a lack of surety about engineering careers. Confidence (along with related concepts like surety and risk) is a recurring theme in these stories and in research about women choosing engineering. In Lesson 9 and 10, participants argue that engineering can and should be chosen even if a woman lacks confidence. First, in Lesson 9, confidence is shown to be less relevant to engineering as a career choice than careful, rational self-interest. Second, in Lesson 10, participants argue that confidence can come after experience. In Lesson 11, I turn to the claims participants make about rejecting non-engineering options. Here, participants tell stories that emphasize the power and pleasure of rejecting expectations. They direct particular attention to teaching as the quintessential non-engineering career, in part because it is a symbol of limited options in contrast to engineering's diverse options. Finally, in Lesson 12 we consider the important role of mentors in making career decisions. In these stories, mentors serve primarily to deliver lessons much like the ones delivered by participants in Lessons 9, 10 and 11. In other words, mentors serve a specific function: they tell the storyteller to, as one participant puts it, "take this job" (Dunbar, 2002, p. 27).

LESSON 9 – YOU HAVE NOTHING TO LOSE

One of the primary challenges women considering engineering face is that, as I stated in previous chapters, women are less likely to feel comfortable claiming technical expertise – but they are very aware that engineering requires the confident assertion of technical knowledge. Surveys and interviews with women and girls suggest that the masculinization of the field results in girls entering college being less confident than men in their technical abilities, regardless of their qualifications (Wynn & Correll, 2018). Women engineering students are as interested in engineering as male engineering students, and do equally well in course grades as male students, but women see themselves as less competent than men, which impacts their likelihood

to stay with the work (Jagacinski, 2013; Patrick et al., 2018; Smith et al., 2013b). Women who choose engineering regardless of these issues tend to enter with a lower expectation of success (Fowler & Meadows, 2013), have a lower self-perceived ability than men (Cech et al., 2011; Pinelli et al., 2013), and are more likely to focus on avoiding failure than achieving success (Jagacinski, 2013), reflecting an overall more negative mindset about their experiences in engineering. In other words, the masculine culture of engineering, women's confidence that they can succeed in engineering, women's low representation in the field are linked phenomena.

In the stories in this collection, participants argue that in fact, potential engineers can see engineering and themselves in ways that alter this dynamic. In this Lesson participants claim that, contrary to the apparent expectations of women and girls, engineering success does not require a great amount of confidence, because it presents a low-risk career choice. Good sense more than confidence is required. This reduction of risk can be maximized throughout an engineering career by making choices that hedge against possible negative outcomes, that open more doors than they close.

One example of this comes from Maggie Hickel. In this story, Hickel narrates from her first exposure to engineering through to her decision to become and stay an engineer. Hickel begins the story with no information about engineering, having never considered the possibility of being an engineer at all. Over the course of the short story, she assesses new information as it becomes available, and consistently makes what seems like the most conservative possible choice: she opts to preserve her ability to make or change her choices for as long as possible. In that way, Hickel repositions engineering as the field that requires the *least* confidence, and provides the most career options.

> I remember being in high school and going to a session by the University of Iowa. And I went to the math program first and the professor there told everybody in the room, "Unless you want to be a math teacher you can't do much with a math degree." So I thought, well I'll go the engineering one. I was with my mom at the time. And I was the only girl in the session. And this professor was saying, you

> know, talking about engineering, and you needed math and you had to be good in science, etcetera, etcetera. And I can remember some of these boys raising their hands saying, "Well, I'm not good in math. Do you think I can still be an engineer?" And, "I never took physics, can I still be an engineer?" And I kept thinking, "I did that. I did that. I guess I could be an engineer!" So I thought, well, I'd give it a try.
>
> So I thought, Well, I'll just go the University of Iowa because there's lots of opportunities. And started in engineering, because if you don't start in engineering it was harder to get into engineering than get out of engineering. So I thought, I'll start in engineering and if I didn't like it, I'll go be a teacher. And I guess the rest is history because I stayed in engineering. (Hickel, 2007, p. 3)

Hickel makes a series of decisions in this story. First, she rejects math because it would limit her career choices to teaching math. She then realizes that engineering would make use of her existing expertise. Then she selects a major that allows her to become an engineer but *also* allows her to become something else, including a teacher. The presentation of this story emphasizes the logic of the choices. She presents these like an equation or programming language IF/THEN statements: IF one wants anything other than math teaching, THEN one should choose a non-math degree. IF one has taken physics, THEN one can be an engineer. IF one wants the option of being an engineer, THEN one should start in the engineering program. With the conditions met, the program completes: *become an engineer.* In this story, Hickel models being logical in her career choices, and the lesson for the audience is clear. IF one wants to have career choices, THEN one should consider engineering.

In contrast to Hickel, "These boys" in the story demonstrate the kind of confidence that is expected of budding engineers. When Hickel claims the boys asked questions like "Well, I'm not good in math. Do you think I can still be an engineer?" she shows them to be comparatively confident in their interests. They apparently can see themselves in the role even without related experience. In contrast, Hickel apparently asks no questions. She explores and considers rather than speaking.

Of course, in this story Hickel shows some confidence, in that she knows she has taken math and science classes – more, in fact, than her male peers, it seems. Hickel does not say anything about how she feels about those courses, leaving unanswered whether she flourished in those courses or even liked them. By stripping this information from her story, and instead relying on that simple statement of the fact of her experiences, Hickel removes the question of confidence from the equation (and, again, this is an equation.) Because Hickel (like many other school-age girls) has already taken the material, it risks her nothing to pursue engineering *for now*, and so it is smart to do so. The sentiment "Well, I'd give it a try" is one that recurs through these narratives and that I will discuss further in the next Lesson.

In these oral histories, stories about choosing engineering are mixed with stories in which participants must make a decision about their career, such as choosing between two job options or employers. As with Hickel's story, such stories minimize the need for confidence by showing participants making career choices that increase options and reduce risk.

In the example below, Bonnie Dunbar[28] tells a story about taking her first career steps towards becoming an engineer. In this case, Dunbar knows what she wants, but not how to get there. As is often the case in these stories, she is provided an opportunity while she currently has work, and she must decide between these options. Ultimately, Dunbar is able to make a choice that, like Hickel, keeps her career options open into the future. She opens doors, without closing others. In this story, she discusses her first application to the astronaut program. When she was denied, she was forced to make a difficult decision about her career:

---

[28] Bonnie Dunbar is a NASA astronaut and a prominent woman engineer. Dunbar has flown on five space missions for a total of 50 days in space. Her engineering career began with a M.S. in Ceramics Engineering from the University of Washington in 1975, and she has since held prestigious positions at governmental organizations, nonprofits, research centers and universities. However, her time as an astronaut is understandably a focus in her oral history, and she describes having the goal of being an astronaut from a young age. She also discusses her interest in engineering, her career choices, and her activism work. While Dunbar's achievements are singular, when she walks through her career movements her motivations are relatable.

BD: Well, I had heard from Dr. John Buckley, who was at Langley and had reviewed our program at the University of Washington -- I had heard from him in the early '70s, that they'd probably be selecting women for the Space Shuttle program. And the formal announcement for that first class came out in 1977.

And I applied for that class while I was an engineer at Rockwell.

And I was a finalist. I was invited down to Houston to go through the physicals, and so forth. But I wasn't selected for the '78 class, but they offered me a job. (Laughs) So I went back to my Rockwell management, and said, "Well, they've offered me a job. What should I do?" And at that time I was the youngest in my group. I think there's sixteen years that separated me from the next oldest person. So I was the least experienced. And there was some real concern that they would be doing a reduction in force, or a RIF as the Shuttle program wound down. And so my boss told me, he said, "Even if we don't RIF, your opportunities for getting promoted are going to be pretty limited in this group for quite some time because of the high age -- you know, experience level." He said, "Why don't you take this job" -- it was as a payload officer in Mission Control -- "and if you don't like it, you can always come back. You have a place here." But he also knew I wanted to do whatever I could to enhance my opportunities to reapply for the next class.

And the job was being offered by George Abbey, who was at that time director of what was called Flight Operations, which was both mission control and the astronaut office. And he offered me the job, and I came back to NASA in July of 1978 as a flight controller payload officer. (Dunbar, 2002, pp. 26-27)

This story could have gone a very different direction, given that it begins with an apparent failure. At this point in her narrative, Dunbar has already established repeatedly her interest in becoming an astronaut, and in this story she fails to qualify for the training program despite coming close. However, Dunbar laughs about the outcome because, while failing at her original

goal, she succeeded in an unexpected way and received an unsought-for job offer. That surprise job offer is the Challenge that spurs the story. This is not a story about handling failure; it is instead a story about making difficult choices between multiple viable options – a characteristic of these stories.

The primary lesson Dunbar delivers here is that it is specifically because she has a large amount of security as a job engineer that she is freed to make bold and exciting choices. Often, in these stories, that means the choice to go into engineering. In this specific case it means freedom to become an astronaut. Dunbar has multiple good options. She can stay at NASA, which may open up future additional opportunities, or she can return to Rockwell if necessary, where she has a perpetual "place." It's the very fact that she has both options that allows her to risk going to NASA, and eventually astronaut training. Again, confidence or ability is not mentioned in Dunbar's story of a critical career junction. Instead, the freedom to make bold choices follows from having multiple good options.

In response to that Challenge, Dunbar takes two actions. She asks her boss, "What should I do?" and then follows his advice to "Take this job." Dunbar can do this because "you can always come back." Dunbar points out her youth because it's an important piece of context for this story. Her youth influences her actions in the story, while also building a connection with her audience of young women. Because she's young, and new to engineering, she needs to be told that she has nothing to lose. By telling a story in which she hears, accepts, and acts on that advice, Dunbar is also relaying that same advice to her audience of young, inexperienced potential engineers.

Developing multiple good options, and thereby maximizing their job security, is a value demonstrated throughout these stories. That value is evident in Ivy Hook's story which I quoted in full in Chapter 5, about becoming involved in the Space Shuttle development (due to its length I won't reprint it in full here.) Hooks is faced with a mysterious opportunity that comes to her unsolicited. Her first thought is that it's a prank by a man, which suggests a certain difficulty or danger associated with pursuing this opportunity – "pranks" are not usually lighthearted fun for

women engineers, but rather a tool for aggressive exclusion by men (Faulkner, 2009a; Malone, 2010)). Hooks thinks and researches, and ultimately arrives at the usual place: she decides she has nothing to lose by following up on this. This leads her to the "totally awesome" opportunity to work on the Space Shuttle and "go find out about" new things (2003, p. 30-32).

At the end of that long, multi-part story, Hooks discusses her role on the team.

> And I was really the generalist. And so very early on, I was off trying to figure out how you put air-breathing engines on this to land it like an airplane, because all of our propulsion guys were experienced in jet engines and things like that, not -- I mean, launch-type big engines, not aircraft engines. And I was the only one that flew, it looked like. And I did, I had a pilot's license, so they said, "Well, you know some of that stuff. Go find out about that." And then things had to separate. And then there were going to be jet firings on these things where you had to deal with the exhaust plumes. And I did a bunch of work in exhaust plume during my years. That was something the guys didn't want to do, so they gave it to me to do. And I found it really interesting, so it didn't bother me. Again, it was one of those, I didn't know what to do, but I'd find out.
>
> And all that general knowledge of every system and subsystem that would fly suddenly made a huge payoff, because I had some knowledge of all of them. I could look at putting things together and doing some of the things that involved all that. So it's about as fun a thing that could have happened to anybody in their career. (Hooks, 2003, pp. 32-33)

Here, Hooks demonstrates a culmination of the kind of reasoning demonstrated by Hickel, who considered majoring in engineering, and Dunbar, who made job decisions as a young, early-career engineer. In this story, Hooks makes choices that enhance and develop her job security; rather than having nothing to lose, she makes herself a mid-career engineer who can't lose. As a generalist with knowledge of many systems on a massively complex, long-term

project she has positioned herself for to get “a huge payoff” (2003, p. 32). When a key value is having and maintaining multiple career options, understanding a variety of problems is one way of accomplishing that goal.

It is worth noting that while being in a can’t-lose career is a benefit of choosing engineering, that does not mean that engineering is easy. Bonnie Dunbar moves from a position she knows to a new role, in a new organization, as a flight controller payload officer. Such changes are common in career stories – participants opt for the new and unknown, positions which enhance their security but expose them to new and significant challenges. Hooks has to do the work that “was something the guys didn’t want to do,” although she says even those things are interesting. In her telling she is unbothered by these things, but she nevertheless includes that in her story. In this way participants do not minimize the difficulty of being an engineer, while nevertheless highlighting the security that comes with being an engineer.

LESSON 10 – YOU NEVER KNOW UNTIL YOU TRY

Not every participant here knows what they want with the same surety as Bonnie Dunbar. A common Intrapersonal Challenge is some form of crisis of confidence or confusion about wants and needs, and in these cases participants in these oral histories show that being exposed to engineering is a way towards surety – they figure out what engineering is, and how to do it, and that they can succeed at it, all after they start doing it. In particular, one thing they figure out is that as an engineer they can rely on diverse (technical and social) skills they value possessing. Thus, these stories also respond to confidence issues by arguing that one should “give it a try” (Hickel, 2007, p. 3) even if one lacks confidence.

Diane Peters offers the shortest, most succinct story about choosing engineering. In this story, Peters’ initial choice of engineering as a college major is made not because she has certainty, but rather because she needs to pick *something*. Only after that choice is made does she gain confidence in it.

> But I had never thought of engineering. And then when I was thinking about colleges and majors my father said, "Diane, I know engineers at work, and I've seen what they do, and I think you might like it." So I said, "Well, I've got to put something down as what my prospective major is." So I said, maybe engineering–check that box, took a pre-engineering course, and decided, "Yep, this is it. This is fun. I'm going to be a mechanical engineer." (Peters, 2007, p. 3)

"I thought I might as well try, and so I did, and I discovered I liked it and kept at it," might seem like a pretty unremarkable lesson, but the very mundanity of that claim serves Peters' goal of minimizing the magnitude of the decision and making engineering seem appealing. A recurring sentiment across the 170 stories in this collection is, as Suzanne Jenniches says, "Why not?" (Jenniches, 2003, p. 18). Similar statements include: "Well, I don't know, I might" (Brill, 2005, p. 61); "Well, I've got to put something down" (Peters, 2007, p. 3); "Well, I'd give it a try" (Hickel, 2007, p. 18), "So I took the interview" (Brill, 2005, p. 42). No other story seems to elicit a shrugging "Well," from participants as much as stories about making career choices, from "Well, I'm not sure" (Graham, 2003, p. 8) to "Well, sure" (Jenniches, 2003, p. 3). "I might as well" shows a lack of early-career surety which might be familiar to an audience of young women on the cusp of engineering.

In the case of Peters' story, she offers very little information about this important life choice. She quotes directly just a few words from her father, apparently all it takes to move her from "I had never thought of engineering" to "Check that box," which downplays the magnitude of the decision. The paucity of details serves the point, because it shows that not a lot of information or details are needed to take that first step and try it out. Neither is a lot of certainty need to take that first step. Peters gains certitude only after her initial work with engineering, and it doesn't take much exposure, just a single pre-engineering course. The rapid move from ambivalence to certainty encourages other women to try engineering as well.

Some of those other stories give more detail on this decision-making progress. One recurring element in these stories is that engineering can be a way to realize the full extent of a person's abilities, both technical and social. Because this is best discovered by trying the experience out, it's an idea that encourages women to choose engineering. The interlinking of the technical and the social has been a theme throughout the previous chapters. We've seen participants rely on technical skills to solve social problems, and show the ways technical solutions are socially situated. In stories about their own career decisions, participants show that the interlinking of the technical and the social in engineering is a good reason to become an engineer, but this unfortunately is not evident to non-engineers (including, initially, the participants themselves).

The first example of this comes from Jan Williams.[29] In the story below, engineering is positioned as the way for Williams to realize her maximum personal potential, which she cannot realize until after she tries it. This story starts with William as a directionless person, then through a somewhat circuitous path Williams arrives at engineering as the way to realize her potential and raise her confidence in her engineering abilities. This story describes Williams' first encounter with engineering and decision to return to school to pursue an engineering degree. Before this story, Williams attributes her success in engineering management to her "broad skill set" and her strong writing skills (2009, p. 24).

> I was pretty much interested in everything. I was good at writing. My English teachers liked me. I got basically all A's. (laughs) And I remember my

[29] Williams is a mechanical engineer who has had a long career in engineering at Sandia National Labs in Albuquerque where, at the time of this writing, she still works. As she describes in this story, Williams lacked direction early in her career and earned an engineering degree after returning to school to get a second bachelor's. Her engineer expertise includes "equipment and piping and plumbing for HVAC applications, or for any kind of specialty piping. I ended up sort of specializing in cryogenics a little bit" (p. 9) and she has worked in engineering management for much of her career. Williams has been an active member of the Society of Women Engineers. She created the Albuquerque professional section and is a SWE Fellow. Williams was also able to raise two children while working as an engineer, including a son with special needs. In her oral history she frequently mentions her "extraordinarily supportive" husband and the ways he enabled this work (p. 6).

Spanish teacher – I was ahead, accelerated in Spanish, and I remember her telling me one time, "The hard thing for you is going to be to pick what you want to do." And it was very prophetic. I did not know what I wanted to do. When I went to college I didn't have exceptionally good college counseling. Nobody looked at me and said, You know, you have a lot of across the board skills, you ought to think about math and science, you ought to think about engineering. No one said that to me. On that basis, I didn't do any career interest inventories. It's probably my own fault. But I ended up going to the University of California, Davis mainly because my boyfriend went there. (laughs)

And my dad died when I was a sophomore and I was on Social Security for dependents. And I ended up—I had been a math major and I was totally sick of it by my junior year and knew it wasn't the right thing for me. And I ended up majoring in Spanish. Graduated in '78 from UC Davis. Ended up through a long sequence of events in the Midwest. Ended up by complete serendipity and that strength of my math courses working at an engineering firm. And then after a year or so there it was like, "Jeez, I can do what these guys do." (laughs) And went back to school at the University of Missouri-Kansas City. (Williams, 2009, pp. 3-4)

Williams starts this story by directly stating the challenge, or "hard thing," that is being addressed in this story, which is to "pick what you want to do." Williams was initially directionless, "ending up" with a degree in Spanish, "ending up" in the Midwest, and "ending up" at an engineering firm. In contrast with those happenstance outcomes, her realization that she can do engineering is direct and emphatic, much like Peters' exclamation that "Yep, this is it." As a reason to choose engineering, "I can do what these guys do" says little about the kind of work engineers do or what Williams enjoys about that work. Williams' "across the board skills" (what she calls her "broad skill set," elsewhere in her oral history) are her reason for choosing engineering. The story is not about the work of engineering, but instead about Williams' potential. Because she *could* do so many things, she was unsatisfied until she *engaged* all of things.

Williams moves from someone who has unrealized potential to someone with sudden confidence in her abilities to achieve in a challenging profession, but exposure to engineering was the first step.

The realization of potential is a recurring moment in stories about choosing engineering. Other participants, in their stories, say things like "They don't have any use for me" (Clark, 2001, p. 50) or "What do they need a chemist for?" (Brody, 2012, p. 11). These exclamations speak to participants' unrealized (as in, both unknown and unachieved) potential. Following these exclamations, storytellers go on to try engineering or try some new aspect of engineering, and in each case they explore new depths of their capabilities.

We can see another, similar version of this claim from Suzanne Jenniches.[30] Jenniches' initially decided to get an engineering degree just to improve her standing in her then-current career as a high school teacher. In the following story, Jenniches has begun taking night classes towards an engineering degree, and she tells this story to explain her decision to leave teaching and *become* an engineer. She clearly begins in a position of uncertainty and self-doubt. In learning about the possibilities of engineering she moves to self-knowledge and self-actualization.

> And so in my classes I met a number of people who were also in the evening college but working during the day, and they happened to be working at Westinghouse. And so they kept saying, "Oh, you ought to come to Westinghouse. You really ought to come and work as an engineer at Westinghouse." And I said, "Well, this is the dumbest thing I've ever heard. What would a defense contractor

---

[30] Jenniches is a past president of the Society of Women Engineers. She spent 30 years of her engineering career at Northrop Grumman Corporation, where she became the first woman to hold many executive-level positions, including Vice President and General Manager of Government Systems Division. In her oral history, Jenniches describes being raised by hardworking parents who were owners of a small-town service station. Her parents supported her technical interests, and "every Christmas I would get a power tool as a present from my father" (p. 3). Nevertheless, Jenniches was unaware of engineering as a possible career choice and ended up becoming a high school biology teacher. She describes applying to an Environmental Engineering degree after receiving an advertising flyer from a college because "This was the first year of Earth Day. I was a biology teacher, I was teaching ecology… I thought, 'Oh, perfect… I'll go off and get this advanced degree,' because I knew they liked teachers to have advanced degrees" (p. 8.)

want with a schoolteacher? And what could a schoolteacher do for a defense contractor? It doesn't make sense to me."

Well, they just kept after and after. And so finally one Christmas when the schools were closed but the company, Westinghouse, was open, I went and worked for two weeks, no pay, just went to work, to see what it was – what was it that an engineer did. Well, at the end of two weeks, I had not a clue as to what an engineer did. However, I knew that there were people who really enjoyed what they were doing. They were very committed and passionate about what they were doing. They seemed to feel energized by doing – and they were test engineers, was actually where I was working.

And so I made the decision to leave teaching after four and a half years and to become an associate engineer with Westinghouse because I didn't have an engineer degree at that time, I was still in the process. And so I started at the lowest of the low (Jenniches, 2003, p. 11).

Exactly like Williams, Jenniches' initial doubt about her abilities fades as she is "energized" by her work. Engineering was the means through which she literally realized her own potential. And like Williams, engineering used all of Jenniches' skills. In a paragraph following this story, Jenniches explains that "the skills that I had as a teacher, as a communicator, organizer, the skills that I got from my engineering education were fundamental basic skills that help me have the flexibility and the confidence to go out and tackle problems" (2003, p. 11). Jenniches partially retells this story later in her narrative and clarifies that her fellow students invited her because "they saw in me characteristics that they thought would make me a good employee" (2003, p. 13). Thus, it's not Jenniches alone who sees the need to have communication and organization and other non-technical skills. But Jenniches herself couldn't know her own value and the relevance of those skills until after she "went and worked for two weeks."

There are interlocking and mutually supporting elements in the stories included in Lessons 9 and 10, particularly around the motif of variety or diversity: of work roles and of professional skills. Engineering rewards diverse skills, participants choose positions that enhance that variety of skills, which increases their security, which allows them to choose more diverse and interesting work, which uses and develops their diverse skills, which further allows them to choose more diverse and interesting work, and so forth. The way these ideas interlock and overlap across stories helps us see the reasons that participants argue it is worth giving engineering a try, regardless of one's confidence in that decision.

LESSON 11 – TAKE PLEASURE IN REJECTING EXPECTATIONS

Organizational studies scholarship about career choices describes *pull* forces as those which attract the individual to some particular organization or career; *push* forces drive an individual away from other organizations or careers. Most career choices involve both sets of forces (Henley & Dawson, 2012; Kirkwood, 2009; McAulay et al., 2006; Schjoedt & Shaver, 2007). This distinction is useful for making sense of stories here about choosing engineering. Lessons 9 and 10 describe *pull* forces towards engineering. Lesson 11 deals with the *push* forces away from other career options.

There's very little research available that explores push forces for women engineers. One qualitative analysis of undergraduates' reasons for staying in an engineering program explored some push forces. This study found that women and men shared some reasons for staying in engineering, including the rewards offered by the degree (a clear *pull* force). However, women were more likely than men to report staying due to an "aversion to quitting" or a desire to prove themselves (41% to 26%), and more likely than men to stay because the other options were less appealing (27% to 5%) (Litzler & Samuelson, 2013). The authors of this study interpret these survey numbers to mean that women have a more negative attitude about engineering – essentially that they are less motivated by *pull* factors. However, these oral histories suggest an alternative interpretation, which is that women are thinking more about the career options they did not choose and why – that *push* factors are a powerful motivator for women engineers' career

decisions. That is the first element of the Lesson offered in these stories: participants advise that choosing engineering means pushing against other possibilities, and this push can and should be an important motivation. An important, related claim is that teaching is contrasted with engineering: where engineering opens options, as we saw in the previous Lessons, teaching is associated with constraints and should be rejected.

One way we can tell that the push matters to participants is that they tell stories in which they emphasize the fun of rejecting non-engineering options. One example of this is in a story from Jan Williams. In this story, which picks up the choosing engineering thread from her previous story, she uses humor to reject traditional career options, as embodied in her conservative Irish Catholic relative.

> I don't know if I mentioned this to you ever, but the engineering firm I worked at when I first thought, "You know, I can do this—." I went to the personnel department and told them what I was thinking of and the guy in the personnel department said, "Well, why don't you just get your masters in Spanish and go teach?" (laughs) And my husband was furious when he heard that. I mean, he was just a good old boy and he didn't mean any harm by it but that was your pretty typical Midwestern response at the time. So it was a bit unusual. And that's actually a quote from a relative of mine who happens to be a Catholic bishop in South Africa. When I told him I was studying engineering—he's Irish—he said [in Irish accent], "It's a bit of an unusual profession for a woman, isn't it?" (laughter) And the answer is, "Yeah." And on top of which, you know, of course he thinks that women working is the demise of the American family because of his fairly—not only is he very Catholic, he's very conservative otherwise. You know, even compared to American culture, generally. So yeah, he had a little hard time with that. (laughs) That's a classic understatement from the Irish people. (laughs) "A bit of an unusual profession for a woman." (Williams, 2009, p. 11)

Williams actually tells two short stories here, although they begin with a similar Challenge. In each she is confronted with someone who thinks she should choose a more traditional feminine option; in each she rejects them with pleasure. It's not easy to go against cultural expectations, but Williams makes it seem easy here. In fact, it's easier for her to navigate those expectations than it is for her husband, who gets "furious" while Williams laughs it off. It's in the second story where Williams makes very clear the pleasure she takes in rejecting expectations. This is not an Interpersonal Challenge like we saw in previous chapters – Williams' uncle has no material bearing on her career and does not need to be humiliated like, say, an interfering teacher. Instead, this is an Intrapersonal Challenge and Williams' action in response is internal: she adopts an attitude of bemused detachment. She renders the conflict into a humorous story in a variety of ways: she uses his accent, laughs aloud, describes him with an understated "Yeah, he had a little hard time with that," and repeats his statement as a final punchline on the story. She argues that rejecting him and his mores is a choice that can be made joyously.

Eleanor Baum[31] tells a story in her oral history that strongly emphasizes the significance of rejecting gendered career choices. This is also a story about a disagreement with a family member, in this case Baum's mother. Baum precedes this story by telling the listener that she is "the only child of parents who left Europe during the Holocaust" who had strong expectations for her. They emphasized that "you have to be in a position to support yourself" and as a result "they pushed me very, very hard to become an elementary schoolteacher" (2003, p. 2). However, in the following story, Baum interprets the imperative to "support yourself" differently than her mother, making an unusual but ultimately sound choice for engineering.

---

[31] Eleanor Baum is an electrical and aerospace engineer. She began her career in aerospace, but finding herself in an "awful, awful job" she returned to school to earn a master's degree and a PhD in Electrical Engineering. Baum joined the engineering department of the Pratt Institute in New York in 1965; by 1984 she became dean of Pratt's school of engineering, the first ever woman dean of engineering. Baum's husband is a physicist and academic, and she attributes their success in marriage, including raising three children, in part to the flexibility of their mutual careers. Baum has been active in pushing for more professional flexibility for all engineers and increasing women and minority involvement in STEM, including as an active member of professional organizations such as SWE.

> Well, I did not have experiences – I was born in 1940, by the way. Although I did not have experiences with technology, I was very good in math and science when I was in high school. And I took these advanced science courses with mostly men. I don't remember other girls in those classes. And when asked what they were going to do, a lot of these guys said they wanted to be engineers. My mother was pushing very, very hard for me to be an elementary schoolteacher, and if I really didn't want to be an elementary schoolteacher, how about a high school math teacher.
>
> I was always one of these really good kids. I did what I was told. You know, all of my parents' hopes and dreams were in me, so I had to behave. This was my big rebellion. One day she asked, after weeks of 'The Joys of Being a Schoolteacher' kinds of articles under my pillow, "So where do I want to go to be a schoolteacher?" And I said, "You know, I think I'm going to be an engineer." And her reaction was horrendous. She gasped, immediately said, "You can't do that. People will think you're weird, and no one will marry you." (laughter)
>
> True story! This was great. This was power. So I said, "Okay." I went into school and went through the same routine with my guidance counselor and got a very similar reaction, except she wasn't worried about my getting married; I wasn't her daughter. I decided to be an engineer. And that's a ridiculous reason to choose a career. (Baum, 2003, p. 2)

Baum spends the first half of this story laying the foundation, explaining that her mathematics skills grouped her with the men in her school. She helps us understand her parents, who are sympathetically described as Holocaust survivors with their "hopes and dreams" in their only child. Nevertheless, Baum emphatically rejects those expectations with laughter. Once again, this career choice provides little indication of what Baum wanted or liked about engineering – she says that she "was very good in math" but never says she particularly enjoyed it. Instead, in this version of this story, Baum seems motivated largely by the joys that are found in rebellion.

While she says that it's "ridiculous" to choose a career on the basis of rejecting family expectations, her attitude in this story seems to contradict that self-deprecating coda. Instead, she takes clear pleasure in just choosing not to be a teacher. And, more broadly, she takes pleasure just in asserting her will to be "weird," demonstrating her "power" to make her own choices.

Baum's mother's expectation that she become a teacher is typical of these stories. Teaching is the career 'option' that seems to loom largest over these women as an ever-present symbol of gendered career expectations. While choosing engineering, women in this collection are equally *not choosing* teaching, and their stories are often as much about rejecting teaching as accepting engineering (even for those – like Baum – who end up engineering educators). Teaching works well as this symbol because it is associated with a variety of values that are coded as traditionally feminine, including caretaking, educating, and self-sacrifice (especially financial sacrifice).

In addition to those traditionally feminine values, teaching also seems to be rejected because it is a limiting or limited career choice. Again and again, participants construct teaching as one of a strict set of career options, in a short, direct statement of fact. This is particularly striking when contrasted with the openness and options that characterize engineering. Examples of this construction include: "Because at that time I only thought there were three professions. You were either a teacher or a secretary or a nurse. And it was a process of elimination" (Anderson-Rowland, 2008, p. 4); "You became a schoolteacher, you became a nurse." (Baum, 2003, p. 39); "You know, you run a family business or you're a schoolteacher, you know, that's about the only jobs" (Hooks, 2003, p. 2); Irene Sharpe, whose older sister was a teacher, was told, "You just follow in your sister's footsteps" (Sharpe, 2001, p. 6); "I was technically oriented, so the two choices that were sort of open to me as a young person was to be a nurse or to be a teacher" (Jenniches, 2003, p. 3). Maggie Hickel, who considered a career in teaching before realizing she "couldn't stand kindergarten kids" (2007, p.2) offers a slightly more positive variation: "Yeah, they thought was pretty cool, to go into engineering. So, I think they would have been okay if I was a teacher, too, you know?" (Hickel, 2007, p. 3) These examples are often situated in these

oral histories as part of the situation or setup of career choice stories. Baum is the only storyteller to say that rejecting teaching means claiming "power"; she's the only one to use that particular word. But, clearly, teaching is not associated with either "power" or pleasure, and many participants are happy to have found another option.

LESSON 12 – MENTORS ARE USEFUL IN TELLING YOU TO GO FOR IT

Although these Challenges are primarily internal, that does not mean that participants act entirely alone in addressing them. As some of the above stories have shown, other people can play an important mentoring role for participants. The role of these supporting individuals is examined in this Lesson. Scholarship on mentorship emphasizes that mentors serve a variety of important functions. In contrast, in this collection of stories, mentors have an important place but almost entirely serve a single function: they encourage participants to "take the job." Participants here tell stories where mentors deliver to their younger selves the same Lessons that participants themselves deliver in Lessons 9-11.

Literature reviews of mentorship scholarship show mentorship to be a not clearly-defined construct (Haggard et al., 2011). One influential definition describes mentoring as providing two kinds of support: career-related or technical support such as sponsorship, coaching and protection, and psychosocial support, which includes "those aspects of a relationship that enhance an individual's sense of competence, identity and effectiveness in a professional role" (Kram 1985, p. 32, qtd. in Allen et al., 2004; Chesler & Chesler, 2002; Noe, 1988). Haggard et al. say researchers typically focus on the instrumental/technical aspects of mentorship in their definitions, usually ignoring the psychosocial functions, and as a result there is less understanding of the psychosocial functions of mentorship (Haggard et al., 2011). This conclusion is echoed by Allen et al., who end their meta-analysis of mentorship studies by suggesting that "empirical research is needed that examines the link between mentoring and professional identity and self-competence because this is discussed in mentoring theory but has not been the subject of much research attention" and more work is needed that "articulates the process by which

mentoring influences outcomes" (Allen et al., 2004). Neither Allen et al. nor Haggard et al. are specifically focused on women and mentoring.

Research on mentorship for women in engineering suggests that a focus on instrumental or technical mentoring is a feature of not just mentorship research, but also mentorship application, and that this is problematic for women in engineering. Chesler & Chesler's studies reveal that in science, mathematics and engineering, mentoring proceeds "on the basis of a male cultural style," which is defined as a focus on the instrumental and technical needs over psychosocial needs and a commitment to a "heroic journey" facilitated by instrumental mentoring and support (Chesler & Chesler, 2002). This mentoring focuses on "challenging… posing tasks… and stressing independence," i.e. the development of a "heroic engineer" through a trial-by-fire (Broome & Peirce, 1997; Chesler & Chesler, 2000, p. 33). This can be particularly challenging for minority women in engineering. Buzzanell et al.'s interviews with minority women engineers show a pattern of "caution, ambivalence, and their lack of faith in the formal mentoring system" (Buzzanell et al., 2015, p. 452). That's related, at least in part, to the way that mentoring has focused on one-on-one model that can fail to accommodate differences of identity and perspective. An inability to imagine beyond the well-engrained masculine "master narratives" (Buzzanell et al., 2015) of mentoring can prevent mentoring from providing needed support.

Nevertheless, mentorship is often emphasized as an important way of supporting women on the cusp of engineering. Research in the college setting have supported peer-mentoring programs that connect women students with older students and professionals as a way to improve feelings of belonging and self-efficacy, and retention (Clarke-Midura et al., 2017; Dennehy & Dasgupta, 2017; Poor & Brown, 2013). Other apparent benefits of peer-mentoring include increased confidence in writing, increased knowledge of professional risk, loss of isolation, heightened perspective, community and trust, and commitment to others (Chesler et al., 2013). In contrast to the above studies, this work suggests that mentorship of women in engineering offers psychosocial support.

The stories in this collection argue that mentors provide primarily psychosocial support, and that can come from either men or women. The role of mentors is perhaps best understood by considering it in relief, examining what is not present. With only a single exception (discussed later), mentors do not provide technical support, i.e. tell participants how to act or resolve problems. In the previous chapters, I examined the ways participants overcame significant challenges, including discrimination and complex technical issues. The influence of mentors was never an apparent theme in those stories, and mentors do not typically step in to explain how to solve these problems, which seem so endemic to the experiences of women engineers.

Instead, mentors are depicted as conveying information and encouragement which result in participants making the choices depicted in Lessons 9 and 10. To say that another way, when taking advice is an important action taken by the storyteller, the result of the story is almost always some form of career advancement. Mentors urge you to success, and tell you success is possible, but don't tell you how to succeed. Although this is limited in scope, it is an important function. Some participants know what they want and pursue it; but to other participants mentors to serve this role are essential. Participants frequently describe themselves as "lucky" to have received this advice, acknowledge that not everyone does have a mentor who can deliver this lesson, and attribute much of their career direction to that mentor.

Some of the stories previously discussed demonstrate this Lesson. Bonnie Dunbar takes advice from a boss who tells her to "take the job," when she was unsure about whether to take that risk. That boss is not the only person in Dunbar's life who filled that role. She also tells a short story about choosing her major, a decision which is influenced by a math teacher. Dunbar did well on her math and science SAT standardized tests, but her suggested careers didn't include engineering because, as Dunbar later learned, that was never a possible suggested career for women. Luckily, Dunbar had told a math teacher about her goal of becoming an astronaut. She relates the following conversation:

> "But my boyfriend at the time and I shared scores, and I had higher scores than he did in spatial ability, but they said he should be an engineer. So when I was

> accepted to the University of Washington, and they sent a piece of paper back saying, "What college do you want to matriculate to," I took it to Mr. Anderson. And I told him, "Well, you know, I want to do all of these different things." I loved English literature, but I wanted to build spacecrafts, I wanted to fly in space. And he said, "Well, I think you ought to select engineering." And I said, 'Well, but you know, my SAT things that -- didn't say engineering." He said, you know, "Disregard that. Check engineering." That's how I ended up in engineering. It was the best choice for me. I mean, I have no regrets. But it was all serendipity at that time. I was very, very lucky." (Dunbar, 2002, p. 8)

Mentors (or anyone filling this advice-giving role) are often portrayed like Dunbar's teacher, as giving curt, direct instructions. In this story, that curtness shows in "Disregard that. Check engineering." Other examples include "Show up" (Clark, 2001, p. 50), "go off and do this new job" (Jenniches, 2003, p. 19), "Shut up… just go and ask for it" (Brody, 2012, p. 29) and "Take it" (Fletcher, 2003, p. 49). Rather than reading these as direct quotes, these are better understand as ways to characterize mentors as unambivalent and certain. They provide *direct* directions. Relatedly, in these stories the storytellers position themselves, the younger version of them in the story, as receptive to those directions.

Dunbar's story also shows that although mentors may be limited in function, they are critically important. Mentors almost inevitably provide the advice to "Check engineering," but that is important advice. Note that, like Jenniches and Williams, Dunbar has diverse interests (she "loved English literature" and also "wanted to fly in space") but unlike them she does not have an opportunity to try engineering. Instead, Dunbar's teacher acts as a proxy for the hands-on experience Dunbar lacks, pushing in the same direction. Dunbar knows that not everyone has an opportunity to have a mentor who urges them to go for it. As Dunbar later elaborates, "So that chance conversation where I shared that dream with him, you know, changed the course of my education" (2002, p. 20). Participants see themselves as lucky if they have someone to fill that role.

The quintessential story about mentor experiences from this collection is told by Bernice Brody.[32] Brody tells this story at the end of an extended discussion of mentorship and support, during which she explains that mentors can provide "support, confidence… loyalty" (2012, p. 28). She also bemoans that women are, in her opinion, too likely to say "'Oh no, you have to make sure that they're a good fit, and the best candidate, blah, blah, blah.' You know? And you have to be fair, fair, fair, fair, fair." During her career, she learned that "it's okay to be an advocate for someone… that provides a person to be able to blossom" (2012, p. 29). Brody deals as directly with the idea of the "good old boys club" as any storyteller here. After discussing mentorship in the abstract, she describes the following encounter in which she received a sought-for promotion. In this story, Brody is the one who earns the "big success" but her mentor is the one who teaches her the success could and should be worked for.

> Okay, can you talk about some of the big career successes or challenges that you've had, and what you have learned from them?
>
> B B: Yeah, I think one of them was this. I wanted to go from what we call band 9 [salary range] to a band 10. And it was this male mentor who said, "Ask for a promotion." And I went, "Wait a minute, I just got promoted to band—I came in to this job, what do I want to do the next job for?" He's like, "Shut up. It's $40,000 a year in your paycheck. Just go and ask for it." Very—you know, okay. So, I went to him [the boss] and he said, "Well, you're going to be doing another job totally than this one, if you want to be a band 10." And that was my year of misery. But in the

[32] Bernice Brody is, according to her LinkedIn, "Joyfully Retired!!" after 33 years at IBM (Brody, n.d.), where she was an engineering project manager and executive. Brody is one of many women to come into engineering 'sideways' – she earned her B.S. in Chemistry in 1979. In her oral history she discusses having limited options at that time, and even though chemistry "probably wasn't the best option for me… an opportunity in engineering wasn't really presented to me at all" (p. 9). However, Brody felt supported by friends, family, and professors in her program and throughout her career, which she felt helped her persist in the field and eventually move to engineering. She was active in the Society of Women Engineers, including serving on the Board of Directors. She describes SWE as synergizing with her career and supporting development of her professional skills. In her oral history she frequently discusses the importance of having and being a mentor who advocates for women and minorities.

> end I was a band 10, and I still am so it was worth it in the end. First of all, I think I was two or three years into the corporation, and I was meeting with some people from corporate and I was going through a project. And you know, they were saying that for me to be just three years in the corporation, that they couldn't believe it. That I was running this program and that I was able to be so competent at it, that they were very pleased. So, I think that that was, you know, an early success.
>
> And you know, with most careers—I don't know about some careers, but my career was a lot of early successes, which built on and built my confidence.
>
> Because, like I said, I was very naïve, right? And there weren't a lot of experiences for women to gain that self-confidence. It was always what we call the imposter syndrome, you know. They're going to figure out that I'm not really as good as they think I am eventually, you know? And that was very much my whole career until I started learning that there is an imposter syndrome. Once you have the facts, you can overcome it. But, you know, so I had these successes. (Brody, 2012, pp. 28-29)

This story demonstrates many of the Lessons evident in this chapter. First, it shows how Intrapersonal Challenges are distinct from Interpersonal and Technical challenges. Here, Brody tells a story in which the primary challenge, from the start of the story, is that she wants to earn more money than she currently is. That is not framed as a material need or pressing lack of resources, nor as something which is being unfairly held back from her – it is entirely internal. When Brody talks at length about "what you have learned" from the experience at the end of the story (the Evaluation element), she tells us the story is about her feeling that "I'm not really as good as they think I am." Her ambition and her lack of confidence are in conflict.

We also see elements of the previous lessons about how to handle these kinds of challenges. Brody doesn't exactly say that she has nothing to lose, but the story does suggest that. She only "asks" for a raise, doesn't demand, and her boss reacts reasonably. Even if it

resulted in “a year of misery,” Brody tells the story in a way that suggests there’s no harm in asking, which her mentor apparently knows. Moreover, Brody doesn’t know why the next job is something she should want, until she tries it. She initially asks “I came in to this job, what do I want to do the next job for?” but her mentor encourages her and once she’s in the role she finds it to be a source of confidence. That confidence is the more valuable reward than the money. She says the work was “worth it” because “first of all” it provided her with recognition and respect that she could see and that “built my confidence.” Specifically, her corporate superiors “were very pleased” with her accomplishments. It’s that recognition that she calls the “early success.”

And finally, we see the role that Brody’s mentor plays. He helps her navigate that challenge by urging her to “Just go and ask for it,” a clear articulation of the “take the job” lesson that mentors provide. He seems to serve the role of being someone who can give her the facts, so that she can overcome them. But at the same time, he disappears from the story after giving that advice, he does nothing apparently to help her navigate the “year of misery” she endures to accomplish that goal. Admittedly, Brody provides little detail on that year of misery, because this is a story about overcoming a lack of confidence, not overcoming a difficult workload. In these stories that is exactly the type of challenge to which mentors are suited.

Overall, these mentors are giving the same advice that the storytellers are giving about career choices. They model the people giving that advice as clear, unambivalent, and correct in giving it. And participants model themselves as younger women, hearing and pursuing the advice they are now dispensing.

There is one exception in these oral histories to the above Lesson about mentors. Lois Bey describes taking advice from “an older man, very, very nice” named George, who is an experienced chemist. When Bey knows him, he has moved from a high-paying chemistry position to a lower-paying, less prestigious chemistry tech role in order to spend more time with his ailing spouse. He is knowledgeable and well-respected, but his career path is atypical of someone in Bey’s industry, and he’s able to offer Bey a perspective that is distinct from anyone else in these narratives.

> And he told me a story -- he helped me -- and simply he told me, "Men are physically stronger than women, that you have to admit. They can lift heavier objects and do it." But he says, "Men also have the tendency to use their physical strength to do things that could be done easier by thinking out the problem first." He says, "You're smart. Think out what has to be done first, and then do it that way." And he taught me how to lift a seventy-pound carbon dioxide fire extinguisher from the floor and put it on the lab bench, which is fine. I always remember George's advice. (Bey, 2003, pp. 66-67)

This is the advice that takes Bey into her story in Chapter 1, in which she bends the metal pipes by "thinking out the problem," and refuses to share her technique with her unhelpful male coworkers. This advice is unusual because it helps Bey navigate Interpersonal and Technical Challenges, rather than Intrapersonal Challenges. Bey follows this with multiple stories in which she steps in to solve problems the men can't, because they refuse to think creatively about physical challenges. It's unclear why Bey is the only participant to offer a story of this sort, although possibly other participants want to avoid describing engineering as a field which requires "physical strength." That message would conflict with the more-common claim that engineering is a field that is easily and safely explored.

CONCLUSION

There is arguably a circularity to these arguments. Some of the above claims might be paraphrased as: when someone tells you to be an engineer, believe them. When someone tells you not to be an engineer, enjoy telling them off. You should always consider engineering an option. You won't know if you like engineering until you do it. These claims cover a variety of scenarios, and whatever the starting challenge, all lead towards the argument that women should "take this job." However, that is the strength of this collection of stories. These various claims are made across the breadth of these participants, rather than made by a single person. They model a variety of experiences and a variety of ways one might feel about engineering and how to respond to each of those feelings to move towards success.

Moreover, these aren't just abstract rhetorical claims. By paraphrasing these stories as "When someone tells you to be an engineer, believe them," context is lost. These are the real lived experiences of these women, so when we see them make these claims we are seeing the disparate ways women can encounter and experience engineering, and how they can respond to those experiences to persist in the field. Rather than conflicting, these are complexly interacting claims that say something true about engineering both individually and collectively. Across these stories, we can see that choosing engineering because the field utilizes and develops diverse skills is an intimidating reason to choose engineering, but it's also a satisfying one. Participants can take some pleasure in rejecting teaching and upsetting the apple cart because, in doing that, they gain security and control of their careers. They choose the job course that minimizes their economic risk, so they can risk doing something non-traditional.

CHAPTER 7

CONCLUSION

Participants in these oral histories told a variety of stories: stories from their earliest schooldays to the height of their careers, and everything in between; stories that took place from the 1930s to the 1990s; stories in which they interacted with family, coworkers, mentors, or no one at all. They encountered manipulative men, systemic discrimination, novel technical difficulties, and their own confusion and worries, challenges that I grouped into three overlapping categories: Interpersonal, Technical, and Intrapersonal. These stories showed women acting in response to these challenges by learning and researching, managing information, solving and calculating, joining and applying, interpreting and understanding, delegating, demanding, and asserting. And they achieved the respect of their coworkers, new and exciting career opportunities, and the invention of new machines and processes, along with other outcomes. While they often struggled, most stories they chose to tell ended in some form of success.

I navigated these many, varied story components by using a system of coding developed from the "phronetic iterative approach," as synthesized by Sarah J. Tracy (Tracy, 2019, p. 29). This is an iterative process of working from data to theory by labelling segments of text with "essence-capturing" (Saldaña, 2016, p. 9) codes, abstracting to categories and eventually theory, while reading and writing reflectively. This approach facilitated my thinking about these stories as a series of challenges, responses and actions, taking in place in context, with shared elements. Coding and writing eventually led me to develop themes and, eventually, theory from the data, which I articulated as "Lessons."

A cursory reading of this list of twelve "Lessons" is unlikely to surprise any careful watcher or practitioner of the field of engineering. When simply listed One through Twelve, the titles of these "Lessons" offer little new to our understanding of engineering. But it is a central tenet of this dissertation that these "Lessons" cannot – *must not* – be represented separately from the stories from which they are drawn. In a review, these "Lessons" cannot capture the interest or nuance that is present in the stories.

It is only as a collection that these stories meet a pressing need: the need for an understanding of engineering and women engineers that creates possibilities for change. They meet this need first by encompassing systemic oppressions, individual actions and the relationship between them (to avoid problematizing women and placing the responsibility for change on them), and second by supporting heterogeneity in our understanding of engineering (in order to avoid essentializing women and essentializing technology). I hope this dissertation has contributed to this understanding through the 170 stories from participants I have discussed.

I want to make clear that I have not claimed to lay out point-by-point instructions for success for women interested in engineering. Instead, I've only tried to explain what participants claim has worked for them in their careers. These twelve "Lessons" aren't a key to addressing every woman engineer's challenges. But the power of stories is that they have the potential to illustrate that there is no single path to success in engineering. Rather than instructions, these stories present a map of many possible avenues.

STUDY LIMITS

There are limits to this study. The first, and most significant, is that this work was produced without the involvement of engineers. My knowledge of engineering work is second- or third-hand. I don't feel the lack of engineering involvement invalidates my conclusions, all of which were reached through careful thought about rhetoric and communication, my own areas of expertise, rather than through technical reasoning. However, it is very likely that I could have strengthened these conclusions if I had involved engineers in the process of this research. At minimum, engineers might have helped me articulate my conclusions in a form that is responsive to the needs of engineers. Although I discuss possible policy and practice recommendations

below, I think that developing this dissertation into something useful for engineers will require the involvement of engineers.[33]

This is indicative of the larger problem that this work was produced through the efforts of just one researcher. A more collaborative approach is typical of feminist studies and common in research that depends on coding of data, and would certainly have been appropriate for this study. While having multiple coders would have complicated my highly iterative approach to coding this data, the conclusions would arguably be strengthened by some inter-coder reliability. However, the nature of dissertation research presents a considerable impediment to these ideals.

More research could be done to extend my analysis within this data set. I have worked with approximately one-third of the oral histories in SWE's archive, and research on the remainder of the oral histories would likely add additional nuance and further understanding of the variety of experiences of women engineers. I also believe more data would make this work more persuasive to a potential audience of engineers.

More importantly, the available data included only three African American participants, and no other non-white participants. As feminist investigations into the intersection of race and gender reveal (beginning with Kimberlé Crenshaw's articulation of intersectionality), women of color experience "sexism in the context of racism" (Houston, 2015, p. 48), an interlocking matrix of domination. In Chapter 4 of this dissertation, in the section "That's always the first thing, is the race issue," I focused on the perspectives of the African American participants included in my data set (Lois Cooper, Irene Sharpe, and Yvonne Clark) and especially on their own comments on the way racism and sexism combined in their lives. In addition, I included multiple stories from each of those participants in this dissertation, and those stories can be read with attention to both race and sex. However, I did not highlight intersectionality in my analysis of their stories, outside

[33] There may be opportunities to build these connections in the future, for instance through presentation of this material at the yearly SWE Conference.

of the "That's always the first thing, is the race issue" section. My method depended on synthesizing my data and finding similarities and connections across stories – with only three non-white participants I was unable to locate trends as I did in the full data set. As a result, my conclusions speak primarily to the experiences of white women engineers, and only to elements or aspects of the experiences of non-white women engineers. The extremely small number of non-white women engineers throughout the 20th century makes including their perspectives a challenge in research such as this, but that perspective deserves greater focus in future projects.

IMPLICATIONS FOR WRITING, RHETORIC AND LITERACIES

This dissertation adds to our understanding of rhetoric in engineering work, an understudied area. In her study of rhetoric and literacy in an engineering workplace, *Writing Power*[34], Dorothy Winsor claims that engineers have a complex relationship with rhetoric. Winsor believes engineers reject "the rhetorical view of knowledge" (2003, p. 4) and believe that "facts speak for themselves" (2003, p. 59) as part of a general "devaluation of language and particularly of writing in the field of engineering," (2003, p. 4). This aligns with the stereotype of engineers as poor communicators. But the same time, she reveals that much engineering writing is persuasive, and that skilled engineers are extremely savvy in their efforts to "to persuade others to accept their notions of what counts as accurate knowledge, and thus gain some measure of control over knowledge production" (2003, p. 59) in order to shift projects towards their goals, and negotiate with management for funds and resources. Engineers do effectively deploy rhetoric, despite what they may say.

My study extends this understanding. The participants in SWE's Oral History projects demonstrate a rhetorical expertise that includes using narrative to make claims about themselves and their chosen career. Clearly, these women engineers are capable of using more than statistics as evidence (the 1974 "Profile of a Woman Engineer" in Chapter 1 notwithstanding).

---

[34] One of very few book-length studies of engineering rhetoric (as opposed to writing) in the WRL field.

They tell work stories that are cohesive, honed, well-told, and often simply *fun*. It seems certain they do so outside the context of being interviewed by SWE as well. In their oral histories the participants indicate that they are telling stories that are both important and familiar, which they enjoy telling regardless of how many times they've been told before. They often precede stories with comments such as "That's one of my favorite stories" (Brody, 2012, p. 39, and Hickel, 2007, p. 10 offers the same comment word-for-word), "And that's kind of an interesting story" (Hooks, 2003, p 53) and "And this is another funny story, too" (Bey, 2003, p. 94). Such comments serve as an orientation, a tool to announce the beginning of a story. But they also highlight the importance of the story that follows to the teller. Stories that are well-received are likely to continue to be told and re-told, improving over time at making the tellers' intended identity claims (Ibarra & Petriglieri, 2010). Thus, the well-told stories in this collection are both a result of and indicative of the importance of these stories to the participants (Polkinghorne, 1988). In sum, there is every reason to see these stories as a display of rhetorical skill that the storytellers carry with them outside the strictures of an oral history interview, and into their professional and personal lives.

There's also evidence that some participants see stories as a way to fill the need I identified in Chapter 1, a need for "many, varied, accessible and persistent models of women in engineering, actively engaging in engineering practices" to help "other women to see themselves as engineers, and especially as successful engineers." Diana Madden, for instance, felt the lack of such stories in her own career and in her oral history describes trying to provide that model in her stories. When asked by her interviewer Troy Eller, whether she "would have benefitted" from a mentor, Madden replies: "I think so. I think with my relationship with my mentee, I think she greatly benefited hearing from my personal stories. She had actually started out kind of in the same field but now she's in environmental, and so I think that that's helped her understand what kind of goes on in that field and what not" (Madden, 2009, p. 15). In this case, Madden's stories of actively engaging in engineering practice in her own field (Electrical) helped her mentee recognize that she should move to a different field. Being a woman engineer means being in a position where you are always generating "all those stories" (Lucietto, 2007, p. 19) and "stories

you could tell about being one woman in a sea of men" (Brody, 2012, p. 66); or, as Diane Peters says, "everybody has stories. You work long enough, you get a lot of stories" (2007, p. 10). Madden's comments and others like it in these interviews reveal that participants see these stories as valuable for their ability to articulate the field and their position in it.

One of the benefits of the Society of Women Engineers is that it can be a medium for such stories. Elizabeth Bierman describes SWE events as an opportunity to "hear a new story" from more experienced engineers (Bierman, 2008, p. 30). Peggy Layne offers the clearest articulation of this when she says, "that's really why I come to SWE now. It's not so much to go to the sessions or learn new skills, but to reconnect with people that I've met over the last 25 years. See how they're doing and what directions their careers are going, which is always fascinating to hear and ever-changing. We're still writing that story" (Layne, 2010, p. 38). I selected Layne's quote for the title of this dissertation because it best encapsulates the ongoing effort of these participants to use stories to both model and create change in their profession.

I hope these stories can drive further interest in the rhetorical work done by engineers. Despite the investment of considerable time, energy and resources women's participation in engineering remains low and there isn't a clear consensus on how to effect positive change. Efforts to improve the position of women in engineering come from many sources: from nonprofit organizations (such as Girls Who Code, Black Girls Code, and SWE), professional organizations, education, and public policy (such as Britain's Women into Science and Engineering [WISE] program). And research on this topic comes from a vast array of disciplines: feminist social studies, business/organizational studies, K-12 education, history, and engineering education; research approaches range from the purely quantitative to the highly qualitative. In some cases these various disciplines overlap or build on each other. But in many cases they hold totally different assumptions and do not engage in cross-dialogue. This remains a thorny and tangled issue despite decades of work.

Researchers of rhetoric and composition have an opportunity to contribute to this effort. One of our strengths is our willingness to work across disciplinary boundaries. I intentionally

researched and wrote this dissertation with little concern for disciplinary boundaries, and I don't think that would have been possible without my training as a rhetoric and compositionist. It was that interdisciplinary approach that helped me recognize that a need for heterogenous stories of women in engineering was evident across disciplines.

Specifically, this dissertation suggests changes to some attempts to make engineering appeal to girls and women, specifically those which emphasize the 'softer side' of engineering (or STEM more broadly, depending on the program) – those qualities that overlap with traditional ideas of femininity, such as an engineer's capacity to help people, to collaborate, or to protect the environment. These approaches are well-meaning, and there is research which suggests women desire "computing with a purpose… connecting computing to other fields and working within its human and social contexts" (Margolis & Fisher, 2002, p. 52), or that girls prefer to engage with engineering in gendered ways, for instance opting to create medical or other "helpful" devices in group projects (Bystydzienski & Brown, 2012). Interventions based on this view include the nonprofit organization Black Girls Code, which emphasizes the role of the Arts in Science and Technology, transforming STEM into STEAM (Cherry, n.d.) and Harvey Mudd College, which reorganized their computer science education around the principle that women students "think more about their careers in terms of its social relevance, and how their work could help the world,"(Xia, 2017).

However, the claim that engineering is a way to help the public or to be socially valuable does not align with the day-to-day experience of doing engineering work that we see in these stories. Nor is it honest to paint engineering as an even playing field for all genders. Instead, participants in these stories stress the personal satisfaction of solving difficult problems, of discovering their own capabilities, and relying on their particular expertise, across a variety of contexts. Scholars such as Wendy Faulkner have argued that rather than emphasizing the "softer side" of engineering, a more honest approach may be to emphasize the diversity of employers,

work activities, and even identities that engineers can benefit from (Faulkner, 2014; Lohan & Faulkner, 2004).[35] This dissertation supports that conclusion.

SOCIAL IMPLICATIONS

The implications of reimagining the gender and engineering relationship extend well beyond academia. Changes in engineering can lead to broad social implications as well. In "Caught in the Wheels: The high cost of being a female cog in the male machinery of engineering" Cynthia Cockburn asserts that:

> We cannot leave things as they are. Why? Because, like or not, we now live in a world in which power lies in the economic ownership of these technical forces of production (and of distribution, reproduction and war) and in the practical control of these things… We have to learn technical skills. If we are to learn, we have to get in there. It cannot be done at a distance. (1999, p. 131)

This need is perhaps best exemplified by computer code, the product of much of the work done by computer and electrical engineers. Claudio Herbst argues that "code informs technologically mediated interactions" (2009, p. 145) and thus creates opportunities for equality or discrimination during those interactions. In the decade since Herbst wrote, ever more of our interactions are "technologically mediated" in ways we take for granted, and the work of engineers informs those interactions. Herbst's call cannot end with coding. The technologies, tools, and even the physical infrastructure which have a material impact on our everyday lives are created by engineers. "Machines carry the word of those who have invented, developed, perfected and produced them. They carry it with them, written in the hardware" (Callon, 1998, qtd. in Chabaud-Rychter, 1994, p. 78). Currently men are "writing" those words, far more than women. Supporting

[35] To that end, scholars of engineering and gender have increasingly rejected the "leaky pipeline" metaphor (which has been used for decades to represent the way women were "lost" from engineering as they moved from grade school to college and then into the workplace.) This metaphor suggests that engineering has only a single path, which every successful engineer follows to its singular conclusion. It also draws a sharp division between "success," or staying in the pipeline, and failure, or leaking out.

women becoming “designers” rather than just “users” of technology (Blair et al. 2011) means supporting rewriting our world.

The one thing we all must do is avoid fatalism or retreating from the issue. The interviews in this collection show women “getting in there” as Cockburn asks, and succeeding, in small ways in their day-to-day challenges. Those small successes add up to long careers in engineering that serve as valuable models. Hopefully this dissertation raises the profile of their efforts and accomplishments.

REFERENCES

Allen, T. D., Poteet, M. L., Eby, L. T., & Lentz, E. (2004). Career benefits associated with mentoring for proteges: a meta-analysis. *Journal of Applied Psychology*, *89*(1), 127.

Anderson, E. (2017). Feminist epistemology and philosophy of science. In E. N. Zalta (Ed.), *The Stanford Encyclopedia of Philosophy* (Spring 2017). Metaphysics Research Lab, Stanford University. https://plato.stanford.edu/archives/spr2017/entries/feminism-epistemology/

Anderson-Rowland, M. (2008, November 7). *SWE Storycorps Interviews—Mary Anderson-Rowland interview* (T. Eller, Interviewer; LOH002110.1) [Interview]. Walter P. Reuther Library, Detroit, MI. https://ethw.org/Oral-History:Mary_Anderson-Rowland_and_Troy_Eller

Bamberg, M. (2004). Narrative discourse and identities. In J. C. Meister, T. Kindt, W. Shernus, & M. Stein (Eds.), *Narratology beyond literary criticism* (pp. 213–237). Walter de Gruyter.

Bamberg, M. (2011). Who am I? Narration and its contribution to self and identity. *Theory & Psychology*, *21*(1), 3–24. https://doi.org/10.1177/0959354309355852

Bamberg, M. (2015). Narrative practice and identity navigation. In J. F. Holstein & J. F. Gubrium, *Varieties of Narrative Analysis* (pp. 99–124). SAGE Publications, Inc.

Banks, A. J. (2006). *Race, rhetoric, and technology: Searching for higher ground*. Lawrence Erlbaum ; National Council of Teachers of English.

Barker, R. T., & Gower, K. (2010a). Strategic application of storytelling in organizations toward effective communication in a diverse world. *Journal of Business Communication*, *47*(3), 295–312. https://doi.org/10.1177/0021943610369782

Barker, R. T., & Gower, K. (2010b). Strategic application of storytelling in organizations toward effective communication in a diverse world. *Journal of Business Communication*, *47*(3), 295–312. https://doi.org/10.1177/0021943610369782

Baum, E. (2003, April 1). *Profiles of SWE Pioneers Oral History Project, Eleanor Baum interview* (L. Kata, Interviewer; LOH001952.2) [Interview]. Walter P. Reuther Library, Detroit, MI. https://ethw.org/Oral-History:Eleanor_Baum

Bejerano, A. R., & Bartosh, T. M. (2015). Learning masculinity: unmasking the hidden curriculum in science, technology, engineering and mathematics courses. *Journal of Women and Minorities in Science and Engineering*, *21*(2). https://doi.org/10.1615/JWomenMinorScienEng.2015011359

Belenky, M. F., Clinchy, B. M., Goldberger, N. R., & Tarule, J. M. (1986). *Women's ways of knowing: The development of self, voice, and mind*. Basic Books.

Benford, R. (2002). Controlling narratives and narratives as control within social movements. In J. Davis (Ed.), *Stories of change* (pp. 53–78). SUNY Press. http://site.ebrary.com/lib/alltitles/docDetail.action?docID=10587074

Berg, A.-J. (1994). Technological flexibility: Bringing gender into technology (or was it the other way round?). In C. Cockburn & R. F. Dilic, *Bringing technology home: Gender and technology in a changing Europe* (pp. 94–109). Open University Press.

Bey, L. (2003, April 16). *Profiles of SWE Pioneers Oral History Project, Lois Bey interview* (L. Kata, Interviewer; LOH001952.3) [Interview]. Walter P. Reuther Library, Detroit, MI. https://ethw.org/Oral-History:Lois_Bey

Bix, A. S. (2004). From "engineeresses" to "girl engineers" to "good engineers": A history of women's u.s. engineering education. *NWSA Journal*, *16*(1), 27–49. https://doi.org/10.1353/nwsa.2004.0028

Blair, K., Fredlund, K., Hauman, K., Hurford, E., Kastner, S., & Witte, A. (2011). Cyberfeminists at play: Lessons on literacy and activism from a girls' computer camp. *Feminist teacher*, *22*(1), 43–59. https://doi.org/10.5406/femteacher.22.1.0043

Boje, D. M. (1991). The storytelling organization: A study of story performance in an office- supply firm. *Administrative Science Quarterly*, *36*(1), 106–126. https://doi.org/10.2307/2393432

Boje, D. M. (2001). *Narrative methods for organizational & communication research*. SAGE Publications, Ltd. https://doi.org/10.4135/9781849209496

Bray, F. (2007). Gender and technology. *Annual Review of Anthropology*, *36*, 37–53.

Brill, Y. (2005, November 3). *Profiles of SWE Pioneers Oral History Project, Yvonne Brill interview* (D. Rice, Interviewer; LOH001952.4) [Interview]. Walter P. Reuther Library, Detroit, MI. https://ethw.org/Oral-History:Yvonne_Brill

Brody, B. (n.d.). *Bernice Brody | LinkedIn*. LinkedIn. Retrieved March 25, 2020, from https://www.linkedin.com/in/bernice-brody-8028983/

Brody, B., & Brody, J. (2012, November 9). *SWE Grassroots Oral History Project, Bernice Brody interview* (T. Eller, Interviewer; LOH002111.15) [Interview]. Walter P. Reuther Library, Detroit, MI. https://ethw.org/Oral-History:Bernice_Brody_and_Jeff_Brody

Broome, T. H., & Peirce, J. (1997). The heroic engineer. *Journal of Engineering Education*, *86*(1), 51–55. https://doi.org/10.1002/j.2168-9830.1997.tb00265.x

Burton, A. (2005). Introduction: archive fever, archive stories. In A. Burton (Ed.), A*rchive stories: Facts, fictions, and the writing of history* (pp. 1–24). Duke University Press.

Buzzanell, P. M., Long, Z., Anderson, L. B., Kokini, K., & Batra, J. C. (2015). Mentoring in academe: A feminist poststructural lens on stories of women engineering faculty of color. *Management Communication Quarterly*, *29*(3), 440–457. https://doi.org/10.1177/0893318915574311

Bystydzienski, J. M., & Brown, A. (2012). "I just want to help people": Young women's gendered engagement with engineering. *Feminist Formations*, *24*(3), 1–21. https://doi.org/10.1353/ff.2012.0027

Cech, E., Rubineau, B., Silbey, S., & Seron, C. (2011). Professional role confidence and gendered persistence in engineering. *American Sociological Review*, *76*(5), 641–666.

Chabaud-Rychter, D. (1994). Women users in the design process of a food robot: Innovation in a French domestic appliance company. In C. Cockburn & R. F. Dilic, *Bringing Technology Home: Gender and technology in a changing Europe* (pp. 77–93). Open University Press.

Chesler, N. C., & Chesler, M. (2000). Dilemmas in the mentoring of faculty women in engineering: 'The heroic journey" versus “the caring community.” *Second Stage Transformation: Creating A New Vision In The 21st Century*. WEPAN National Conference.

Chesler, N. C., & Chesler, M. A. (2002). Gender-informed mentoring strategies for women engineering scholars: On establishing a caring community. *Journal of Engineering Education*, *91*(1), 49–55. https://doi.org/10.1002/j.2168-9830.2002.tb00672.x

Chesler, N. C., Single, P. B., & Mikic, B. (2013). On belay: Peer-mentoring and adventure education for women faculty in engineering. *Journal of Engineering Education*, *92*(3), 257–262. https://doi.org/10.1002/j.2168-9830.2003.tb00766.x

Clark, Y., & Sharpe, I. (2001, June 29). *Profiles of SWE Pioneers Oral History Project, Yvonne Clark and Irene Sharpe interview* (L. Kata, Interviewer; LOH001952.6) [Interview]. Walter P. Reuther Library, Detroit, MI. https://ethw.org/Oral-History:Yvonne_Clark_and_Irene_Sharpe

Clarke-Midura, J., Poole, F., Pantic, K., & Allan, V. (2017). Playing mentor: A new strategy for recruiting young women into computer science. *Journal of Women and Minorities in Science and Engineering*, *23*(3). https://doi.org/10.1615/JWomenMinorScienEng.2017019307

Cockburn, C. (1985). *Machinery of dominance: Women, men and technical know-how*. Pluto.

Cockburn, C. (1992). The circuit of technology: Gender, identity and power. In E. Hirsch & R. Silverstone, *Consuming technologies: Media and information in domestic spaces* (pp. 32-47). Routledge.

Cockburn, C. (1999). Caught in the wheels: The high cost of being a female cog in the male machinery of dominance. In D. A. MacKenzie & J. Wajcman (Eds.), *The social shaping of technology* (2nd ed., pp. 126–137). Open University Press.

Connors, R. J. (1992). Dreams and play: historical method and methodology. In G. Kirsch & P. A. Sullivan (Eds.), M*ethods and methodology in composition research* (pp. 15–37). Southern Illinois University Press.

Cooper, L. (2005, November 5). *Profiles of SWE Pioneers Oral History Project, Lois Cooper interview* (D. Rice, Interviewer; LOH001952.7) [Interview]. Walter P. Reuther Library, Detroit, MI. https://ethw.org/Oral-History:Lois_Cooper

Corlett, M. (2016). *Why the CAR/STAR interview method is so effective*. https://blog.staffingadvisors.com/2016/07/07/car-star-interview-method-effective

Cortazzi, Martin. (1993). *Narrative analysis*. Falmer Press.

Creating an effective resume. (n.d.). Bucknell Career Development Center. Retrieved May 31, 2019, from https://www.bucknell.edu/documents/CDC/Creating_An_Effective_Resume.pdf

Crenshaw, Kimberle. (1989). Demarginalizing the intersection of race and sex: a black feminist critique of antidiscrimination doctrine, feminist theory and antiracist politics. (PDF). University of Chicago Legal Forum. Retrieved November 2, 2020 from https://philpapers.org/archive/CREDTI.pdf

Cunningham, C. M., & Crandall, H. M. (2014). Social media for social justice: Cyberfeminism in the digital village. In S. V. D. Iverson & J. H. James (Eds.), *Feminist community engagement: achieving praxis* (pp. 75–91). Palgrave Macmillan.

Daiute, C., & Lightfoot, C. (2004). Editor's introduction. In C. Daiute & Lightfoot, *Narrative analysis: Studing the development of individuals in society* (pp. vii-xvii). Sage Publications, Inc.

Daniels, J. (2009). Rethinking cyberfeminism(s): Race, gender, and embodiment. *WSQ: Women's Studies Quarterly*, *37*(1), 101–124. https://doi.org/10.1353/wsq.0.0158

Davis, J. E. (2002). Narrative and social movements. In J. Davis (Ed.), *Stories of change* (pp. 3–30). SUNY Press. http://site.ebrary.com/lib/alltitles/docDetail.action?docID=10587074

Dennehy, T. C., & Dasgupta, N. (2017). Female peer mentors early in college increase women's positive academic experiences and retention in engineering. *Proceedings of the National Academy of Sciences*, *114*(23), 5964–5969. https://doi.org/10.1073/pnas.1613117114

Dill, B. T., & Kohlman, M. H. (2012). Intersectionality: A transformative paradigm in feminist theory and social justice. In S. N. Hesse-Biber (Ed.), *Handbook of feminist research: Theory and praxis* (2nd ed., pp. 154–174). SAGE Publications, Inc.

Dunbar, B. (2002, March 2). *Profiles of SWE Pioneers Oral History Project, Bonnie Dunbar interview* (L. Kata, Interviewer; LOH001952.9) [Interview]. Walter P. Reuther Library, Detroit, MI. https://ethw.org/Oral-History:Bonnie_Dunbar

Elbaz, F. (1990). Knowledge and discourse: The evolution of research on teacher thinking. In C. Day, M. Pope, & P. Denicolo (Eds.), *Insights into teachers' thinking and practice* (pp. 15–42). Falmer Press.

Eller, T. (2009). *The SWE Grassroots Oral History Project toolkit*. SWE Conference. http://societyofwomenengineers.swe.org/images/history/Grassroots_Article.pdf

Eller, T. (2012). Publicity, recruitment, and history: Society of Women Engineers. *Centaurus*, *54*(4), 299–304. https://doi.org/10.1111/j.1600-0498.2012.00275.x

Eller, T. (2018, February 22). *Interview with Troy Eller* [In Person].

Eubanks, P. (2004). Poetics and narrativity. In C. Bazerman & Prior (Eds.), *What writing does and how it does it: An introduction to analyzing texts and textual practices*. Lawrence Erlbaum Associates.

Evetts, J. (1998). Managing the technology but not the organization: Women and career in engineering. *Women in Management Review*, *13*(8), 283–290. https://doi.org/10.1108/09649429810243144

Faber, B. D. (2002). *Community action and organizational change: Image, narrative, identity*. Southern Illinois University Press.

Faulkner, W. (2000a). The power and the pleasure? A research agenda for "making gender stick" to engineers. *Science, Technology, & Human Values*, *25*(1), 87–119. https://doi.org/10.1177/016224390002500104

Faulkner, W. (2000b). Dualisms, hierarchies and gender in engineering. *Social Studies of Science*, *30*(5), 759–792. https://doi.org/10.1177/030631200030005005

Faulkner, W. (2001). The technology question in feminism: A view from feminist technology studies. *Women's Studies International Forum*, *24*(1), 79–95. https://doi.org/10.1016/S0277-5395(00)00166-7

Faulkner, W. (2007). "Nuts and bolts and people": Gender-troubled engineering identities. *Social Studies of Science*, *37*(3), 331–356.

Faulkner, W. (2009a). Doing gender in engineering workplace cultures. I. Observations from the field. *Engineering Studies*, *1*(1), 3–18. https://doi.org/19378620902721322

Faulkner, W. (2009b). Doing gender in engineering workplace cultures. II. Gender in/authenticity and the in/visibility paradox. *Engineering Studies*, *1*(3), 169–189. https://doi.org/19378620903225059

Faulkner, W. (2014). Can women engineers be "real engineers" and "real women"? Gender in/authenticity in engineering. In W. Ernst & I. Horwath (Eds.), *Gender in science and technology: Interdisciplinary approaches*. Majuskel Medienproduktion GmbH. https://www.oapen.org/download?type=document&docid=463250#page=168

Fletcher, A. (2003, April 4). *Profiles of SWE Pioneers Oral History Project, Ann Fletcher interview* (L. Kata, Interviewer; LOH001952.12) [Interview]. Walter P. Reuther Library, Detroit, MI. https://ethw.org/Oral-History:Ann_Fletcher

Foor, C. E., Walden, S. E., & Trytten, D. A. (2007). "I wish that I belonged more in this whole engineering group:" Achieving individual diversity. *Journal of Engineering Education*, *96*(2), 103–115. https://doi.org/10.1002/j.2168-9830.2007.tb00921.x

Fowler, R., & Meadows, L. A. (2013). *Assessing gender differences in first-year student motivation*. 16.

Frank, A. W. (2015). Practicing dialogical narrative analysis. In J. F. Holstein & J. F. Gubrium, *Varieties of narrative analysis* (pp. 33–52). SAGE Publications, Inc.

Freeman, M. (2004). Data are everywhere: Narrative criticism in the literature of experience. In C. Daiute & C. Lightfoot (Eds.), *Narrative Analysis: Studying the development of individuals in society* (pp. 63–86). SAGE Publications, Inc.

Frehill, L. M. (2004). The gendered construction of the engineering profession in the united states, 1893–1920. *Men and Masculinities*, *6*(4), 383–403. https://doi.org/10.1177/1097184X03260963

Gabriel, Y. (2004). Narratives, stories and texts. In D. Grant, C. Hardy, C. Oswick, & L. Putnam (Eds.), *SAGE handbook of organizational discourse* (pp. 61–78). Sage Publications.

Gardner, P., & Gross, L. (2014). *Recruiting trends 2013-2015* (43rd Edition; p. 111). Michigan State University. http://www.ceri.msu.edu/wp-content/uploads/2012/11/TRecruiting-Trends-11-25-13-FINAL.pdf

Geisler, C. (2004). *Analyzing streams of language: Twelve steps to the systematic coding of text, talk, and other verbal data*. Pearson Longman.

Glaser, B. G., & Strauss, A. L. (1967). *The discovery of grounded theory: Strategies for qualitative research*. AldineTransaction.

Goodson, I. F. (2013). *Developing narrative theory*. Routledge. http://lib.myilibrary.com.ezproxy1.lib.asu.edu/Open.aspx?id=395613

Graham, L. (2003, June 3). *Profiles of SWE Pioneers Oral History Project, Lois Graham interview* (L. Kata, Interviewer; LOH001952.16) [Interview]. Walter P. Reuther Library, Detroit, MI. https://ethw.org/Oral-History:Lois_Graham

Griffin, D. (2009, October 16). *SWE Grassroots Oral History Project, Denise Griffin interview* (T. Eller, Interviewer; OH002111.5) [Interview]. Walter P. Reuther Library, Detroit, MI. https://ethw.org/Oral-History:Denise_Griffin

Haas, A., Tulley, C., & Blair, K. (2002). Mentors versus masters: Women's and girls' narratives of (re)negotiation in web-based writing spaces. *Computers and Composition*, *19*(3), 231–249. https://doi.org/10.1016/S8755-4615(02)00128-7

Haggard, D. L., Dougherty, T. W., Turban, D. B., & Wilbanks, J. E. (2011). Who is a mentor? A review of evolving definitions and implications for research. *Journal of Management*, *37*(1), 280–304. https://doi.org/10.1177/0149206310386227

Haraway, D. (2011). A cyborg manifesto (1985). In I. Szeman & T. Kaposy (Eds.), *Cultural theory: An anthology* (p. 454). Wiley-Blackwell. https://link.springer.com/chapter/10.1007/978-1-4020-3803-7_4

Harding, S. (Ed.). (1987). *Feminism and methodology*. Indiana University Press.

Harding, S. G. (1986). *The science question in feminism*. Cornell University Press.

Hatmaker, D. M. (2013). Engineering identity: Gender and professional identity negotiation among women engineers. *Gender, Work & Organization*, *20*(4), 382–396. https://doi.org/10.1111/j.1468-0432.2012.00589.x

Heidegger, M. (2009). The question concerning technology. In C. Hanks (Ed.), *Technology and values: Essential readings* (pp. 99–113). John Wiley & Sons.

Henley, A., & Dawson, C. (2012). "Push" versus "pull" entrepreneurship: An ambiguous distinction? *International Journal of Entrepreneurial Behavior & Research*, *18*(6), 697–719. https://doi.org/10.1108/13552551211268139

Henwood, F. (1998). Engineering difference: Discourses on gender, sexuality and work in a college of technology. *Gender and Education*, *10*(1), 35–49. https://doi.org/10.1080/09540259821087

Herbst, C. (2004). Then and now: Gender, code and literacy. *Social Semiotics*, *14*(3), 335–348. https://doi.org/10.1080/1035033042000285121

Herbst, C. (2009). Masters of the house: Literacy and the claiming of space on the internet. In K. Blair, R. Gajjala, & C. Tulley (Eds.), *Webbing cyberfeminist practice: Communities, pedagogies,and social action* (pp. 135–152). Hampton Press.

Hess, C., Gault, B., & Yi, Y. (2013). *Accelerating Change for Women Faculty of Color in STEM: Policy, Action, and Collaboration*. Institute for Women's Policy Research.

Hickel, M. (2007, October 26). *SWE StoryCorps Interviews–Maggie Hickel interview* (K. Peterson, Interviewer; LOH002110.5) [Interview]. Walter P. Reuther Library, Detroit, MI. https://ethw.org/Oral-History:Maggie_Hickel_and_Katie_Peterson

Hooks, I. (2003, April 9). *Profiles of SWE Pioneers Oral History Project, Ivy Hooks interview* (L. Kata, Interviewer; LOH001952.18) [Interview]. Walter P. Reuther Library, Detroit, MI. https://ethw.org/Oral-History:Ivy_Hooks

Houston, M. (2015). The politics of difference: Race, class, and women's communication. In L. F. Rakow (Ed.), *Women making meaning: New feminist directions in communication* (pp. 45–58). Routledge.

Hughes, G. (2001). Exploring the availability of student scientist identities within curriculum discourse: An anti-essentialist approach to gender-inclusive science. *Gender and Education*, *13*(3), 275–290. https://doi.org/10.1080/09540250120063562

Ibarra, H. (1999). Provisional selves: Experimenting with image and identity in professional adaptation. *Administrative Science Quarterly; Thousand Oaks*, *44*(4), 764–791.

Ibarra, H. (2003). *Working identity: Unconventional strategies for reinventing your career*. Harvard Business School Press.

Ibarra, H., & Barbulescu, R. (2010). Identity as narrative: Prevalence, effectiveness, and consequences of narrative identity work in macro work role transitions. *The Academy of Management Review*, *35*(1), 135–154.

Ibarra, H., & Petriglieri, J. L. (2010). Identity work and play. *Journal of Organizational Change Management*, *23*(1), 10–25. https://doi.org/10.1108/09534811011017180

Jagacinski, C. M. (2013). Women engineering Students: Competence perceptions and achievement goals in the freshman engineering course. *Sex Roles*, *69*(11/12), 644–657. https://doi.org/10.1007/s11199-013-0325-9

Jenniches, S. (2003, May 29). *Profiles of SWE Pioneers Oral History Project, Suzanne Jenniches interview* (L. Kata, Interviewer; LOH001952.19) [Interview]. Walter P. Reuther Library, Detroit, MI. https://ethw.org/Oral-History:Suzanne_Jenniches_(2003)

Jorgenson, J. (2002). Engineering selves. *Management Communication Quarterly : McQ; Thousand Oaks*, *15*(3), 350–380.

Keller, E. F. (1983). Gender and science. In S. Harding & M. B. Hintikka (Eds.), *Discovering reality. Feminist perspectives on epistemology, metaphysics, methodology, and philosophy of science* (pp. 187–206). Kluwer Academic Publishers. http://ebookcentral.proquest.com/lib/asulib-ebooks/detail.action?docID=3035986

Khapova, S. N., & Arthur, M. B. (2011). Interdisciplinary approaches to contemporary career studies. *Human Relations*, *64*(1), 3–17. https://doi.org/10.1177/0018726710384294

King, N., & Horrocks, C. (2010). *Interviews in qualitative research*. SAGE.

Kirkwood, J. (2009). Motivational factors in a push-pull theory of entrepreneurship. *Gender in Management: An International Journal*, *24*(5), 346–364. https://doi.org/10.1108/17542410910968805

Kirsch, G. (1999). *Ethical dilemmas in feminist research: The politics of location, interpretation, and publication*. SUNY Press.

Kirsch, G., & Sullivan, P. A. (1992). *Methods and methodology in composition research*. Southern Illinois University Press.

Kvande, E. (1999). `In the belly of the beast': Constructing femininities in engineering organizations. *European Journal of Women's Studies*, *6*(3), 305–328. https://doi.org/10.1177/135050689900600304

Labov, W. (1997). Some further steps in narrative analysis. *Journal of Narrative and Life History*, *7*(1), 395–415.

Labov, W. (2013). *The language of life and death: The transformation of experience in oral narrative*. Cambridge University Press.

Labov, W., & Waletzky, J. (1967). Narrative analysis: Oral versions of personal experience. *Journal of Narrative and Live History*, *7*(1), 3–38.

Layne, M. "Peggy." (2010, November 5). *SWE Grassroots Oral History Project, Peggy Layne interview* (T. Eller, Interviewer; LOH002111.7) [Interview]. Walter P. Reuther Library, Detroit, MI. https://ethw.org/Oral-History:Peggy_Layne_(2010-2)

Litzler, E., & Samuelson, C. (2013). Deciding to stay: The intersection of sex and race/ethnicity. *2013 IEEE Frontiers in Education Conference*, 1812–1818. https://doi.org/10.1109/FIE.2013.6685150

Lohan, M. (2000). Constructive tensions in feminist technology studies. *Social Studies of Science*, *30*(6), 895–916. https://doi.org/10.1177/030631200030006003

Lohan, M., & Faulkner, W. (2004). Masculinities and Technologies: Some introductory remarks. *Men and masculinities*, *6*(4), 319–329. https://doi.org/10.1177/1097184X03260956

MacKenzie, D. A., & Wajcman, J. (1985). *The social shaping of technology* (1st ed.). Open University Press.

MacKenzie, D. A., & Wajcman, J. (1999). *The social shaping of technology* (2nd ed..). Open University Press.

Madden, D. (2009, October 15). *SWE Grassroots Oral History Project, Diana Madden interview* (T. Eller, Interviewer; LOH002111.9) [Interview]. Walter P. Reuther Library, Detroit, MI. https://ethw.org/Oral-History:Diana_Madden

Malesh, P. M. (2009). Sharing our recipes: Vegan conversion narratives as social praxis. In S. M. Stevens & P. M. Malesh (Eds.), *Active Voices* (pp. 131–145). SUNY Press. http://site.ebrary.com/lib/alltitles/docDetail.action?docID=10588905

Malone, E. A. (2010). Chrysler's "most beautiful engineer": Lucille J. Pieti in the pillory of fame. *Technical Communication Quarterly*, *19*(2), 144–183. https://doi.org/DOI: 10.1080/10572250903559258

Marszalek, J., Linnemeyer, S. A., & Haque, T. (2009). A COX regression analysis of a women's mentoring program in engineering. *Journal of Women and Minorities in Science and Engineering*, *15*(2). https://doi.org/10.1615/JWomenMinorScienEng.v15.i2.30

Martin, D. (2013, March 30). Yvonne Brill, a pioneering rocket scientist, dies at 88. *The New York Times*. https://www.nytimes.com/2013/03/31/science/space/yvonne-brill-rocket-scientist-dies-at-88.html

Masters, T. (2010). Reading the archive of freshman english. In A. E. Ramsey, W. B. Sharer, B. L'Eplattenier, & L. S. Mastrangelo (Eds.), *Working in the archives: Practical research methods for rhetoric and composition* (pp. 157–168). Southern Illinois University Press.

Maynard, M. (1994). Methods, practice and epistemology. In M. Maynard & J. Purvis (Eds.), *Researching women's lives from a feminist perspective* (pp. 10–26). Taylor & Francis.

McAulay, B. J., Zeitz, G., & Blau, G. (2006). Testing a "push-pull" theory of work commitment among organizational professionals. *The Social Science Journal*, *43*(4), 571–596. https://doi.org/10.1016/j.soscij.2006.08.005

Meiksins, P., Layne, P., Beddoes, K., Masters, S., Roediger, M., & Shah, Y. (2017). SWE 2017 literature review. *SWE Magazine*, *Research 2017*. https://viewer.aemmobile.adobe.com/index.html#project/630f08d4-cacf-4cf0-bfb7-c77938722044/view/swe_main/view/swe-research-2017

MellstrÖm, U. (1995). *Engineering Lines: Technology, time and space in a male-centred world.* Department of Technology and Social Change.

MellstrÖm, U. (2004). Machines and masculine subjectivity: Technology as an integral part of men's life experiences. *Men and masculinities*, *6*(4), 368–382. https://doi.org/10.1177/1097184X03260960

Morris, S. L., & Rose, S. K. (2010). Invisible hands: Recognizing archivists' work to make records accessible. In A. E. Ramsey, W. B. Sharer, B. L'Eplattenier, & L. S. Mastrangelo (Eds.), *Working in the archives: Practical research methods for rhetoric and composition* (pp. 51–78). Southern Illinois University Press.

Nelson, D. J., & Rogers, D. C. (2003). *National analysis of diversity in science and engineering faculties at research universities*. National Organization for Women.

Noe, R. A. (1988). An investigation of the determinants of successful assigned mentoring relationships. *Personnel Psychology*, *41*(3), 457–479.

NSF. (2017). *Women, minorities, and persons with disabilities in science and engineering, 2017* (p. 25). National Science Foundation, National Center for Science and Engineering Statistics.

Oldenziel, R. (2009). Multiple-entry visas: Gender and engineering in the U.S., 1870-1945. In P. Layne, *Women in Engineering: Pioneers and Trailblazers* (pp. 35–77). American Society of Civil Engineers.

Omoth, T. (n.d.). *How to get more results with a C.A.R. resume*. TopResume. Retrieved May 31, 2019, from https://www.topresume.com/career-advice/how-to-get-more-results-with-a-car-resume

Paasonen, S. (2011). Revisiting cyberfeminism. *Communications*, *36*(3), 335–352.

Patrick, A. D., Borrego, M., & Prybutok, A. N. (2018). Predicting persistence in engineering through an engineering identity scale. *International Journal of Engineering Education*, *34*(2A), 351–363.

Pawley, A. L., Schimpf, C., & Nelson, L. (2016). Gender in engineering education research: A content analysis of research in JEE, 1998-2012: Content Analysis of Gender Research in JEE. *Journal of Engineering Education*, *105*(3), 508–528. https://doi.org/10.1002/jee.20128

Pawley, A. L., & Tonso, K. L. (2011). Monsters of unnaturalness: Making women engineers' identities via newspapers and magazines (1930-1970). *Journal of the Society of Women Engineers "60th Anniversary Edition," 60*, 58–58.

Pederson, A., & Bierman, E. (2008, November 7). *SWE StoryCorps Interviews—Elizabeth Bierman and Alison Pederson interview* (LOH002110.2) [Interview]. Walter P. Reuther Library, Detroit, MI. https://ethw.org/Oral-History:Elizabeth_Bierman_and_Allison_Pedersen

Peters, A., & Lucietto, D. (2007, October 26). *SWE StoryCorps Interviews—Anne Lucietto and Diane Peters interview* (LOH002110.7) [Interview]. Walter P. Reuther Library, Detroit, MI. https://ethw.org/Oral-History:Anne_Lucietto_and_Diane_Peters

Pinelli, T., Hall, C. W., Brush, K. M., & Perry, J. B. (2013). *Are there gender differences in how male and female interns and their mentors rate workforce skills in STEM fields?* 27.

Polkinghorne, D. E. (1988). *Narrative knowing and the human sciences*. State University of New York Press.

Polkinghorne, D. E. (1995). Narrative configuration in qualitative analysis. *International Journal of Qualitative Studies in Education*, *8*(1), 5–23. https://doi.org/10.1080/0951839950080103

Polletta, F. (1998). "It was like a fever ..." Narrative and identity in social protest. *Social Problems*, *45*(2), 137–159. https://doi.org/10.2307/3097241

Polletta, F. (2006). *It was like a fever: Storytelling in protest and politics*. University of Chicago Press.

Poor, C., & Brown, S. (2013). Increasing Retention of women in engineering at WSU: A model for a women's mentoring program. *College Student Journal*, *47*(3), 421–428.

Powell, A., Bagilhole, B., & Dainty, A. (2009). How women engineers do and undo gender: Consequences for gender equality. *Gender, Work & Organization*, *16*(4), 411–428. https://doi.org/10.1111/j.1468-0432.2008.00406.x

Powell, K. S., & Jankovich, J. L. (1998). Student portfolios: A tool to enhance the traditional job search. *Business Communication Quarterly*, *61*(4), 72–82.

Profiles of SWE pioneers: an oral history project (Folder LOH 001952). (n.d.). Society of Women Engineers Archive, Walter P. Reuther Library, Wayne State University, Detroit MI.

Ranson, G. (2005). No Longer "One of the Boys": Negotiations with motherhood, as prospect or reality, among women in engineering. *Canadian Review of Sociology & Anthropology*, *42*(2), 145–166.

Reinharz, S. (1992). *Feminist methods in social research* (Vol. viii). Oxford University Press.

Resumes with impact: Creating strong bullet points. (n.d.). Columbia University Center for Career Education. Retrieved May 31, 2019, from https://www.careereducation.columbia.edu/resources/resumes-impact-creating-strong-bullet-points

Rhodes, P. (2016, April 13). Paul Ricoeur and narrative identity. *Psychology Today*. https://www.psychologytoday.com/us/blog/post-clinical/201604/paul-ricoeur-and-narrative-identity

Rice, D. (2008, Summer). StoryCorps. *SWE Magazine*, 16.

Ricoeur, P. (1981). Narrative time. In W. J. T. Mitchell (Ed.), *On narrative* (pp. 165–187). University of Chicago Press.

Riessman, C. (2002). Narrative analysis. In A. M. Huberman & M. B. Miles (Eds.), *The qualitative researcher's companion* (pp. 216–270). SAGE Publications, Inc.

Saldaña, J. (2016). *The coding manual for qualitative researchers* (3E [Third edition]). SAGE.

Sandrin, S., & Borror, C. M. (2013). *Student perceptions and interest in engineering: Effects of gender, race/ethnicity, and grade level*. 27.

Santino, J. (1978). Characteristics of occupational narratives. *Western Folklore*, *37*(3), 199–212.

Sarbin, T. R. (2004). The role of imagination in narrative construction. In C. Daiute & Lightfoot, *Narrative analysis: Studying the development of individuals in society* (pp. 5–20). Sage Publications, Inc.

Schjoedt, L., & Shaver, K. G. (2007). Deciding on an entrepreneurial career: A test of the pull and push hypotheses using the panel study of entrepreneurial dynamics data. *Entrepreneurship Theory and Practice*, *31*(5), 733–752. https://doi.org/10.1111/j.1540-6520.2007.00197.x

Selfe, C. L., & Hawisher, G. E. (2004). *Literate lives in the information age: Narratives of literacy from the United States*. Lawrence Erlbaum Associates.

Sentilles, R. M. (2005). Toiling in the archives of cyberspace. In A. Burton (Ed.), *Archive stories: Facts, fictions, and the writing of history* (pp. 136–156). Duke University Press.

Shih, J. (2006). Circumventing discrimination: Gender and ethnic strategies in silicon valley. *Gender and Society*, *20*(2), 177–206.

Smith, J. L., Lewis, K. L., Hawthorne, L., & Hodges, S. D. (2013a). When trying hard isn't natural women's belonging with and motivation for male-dominated STEM fields as a function of effort expenditure concerns. *Personality and Social Psychology Bulletin*, *39*(2), 131–143. https://doi.org/10.1177/0146167212468332

Storycorps—about. (n.d.). https://storycorps.org/about/

Sullivan, P., & Porter, J. E. (1997). *Opening Spaces: Writing technologies and critical research practices*. Greenwood Publishing Group.

SWE Oral history project deed of gift/release form (Folder LOH 001952). (n.d.). Society of Women Engineers Archive, Walter P. Reuther Library, Wayne State University, Detroit MI.

Taber, M. (2003, May 12). *Profiles of SWE Pioneers Oral History Project, Margaret Taber interview* (L. Kata, Interviewer; LOH001952.33) [Interview]. Walter P. Reuther Library, Detroit, MI. https://ethw.org/Oral-History:Margaret_Taber

Teitel, A. S. (2013, April 3). *How Yvonne Brill's rocket design works*. Vice. https://www.vice.com/en_us/article/mggden/yvonne-brill-shrank-the-world-was-also-great-cook

Telling your story. (n.d.). Miami University of Ohio. Retrieved May 31, 2019, from https://miamioh.edu/regionals/student-life/career-services/resumes-cover-letters/telling-your-story/index.html

Telling your story using the STAR/SOAR model. (n.d.). Center for Career Services, Colgate University. Retrieved May 31, 2019, from http://www.colgate.edu/portaldata/imagegallerywww/0c5ec2b8-5500-4c50-b897-50041d78ee46/ImageGallery/Telling%20Your%20Story%20Using%20the%20STAR.pdf

The SWE Story | Society of Women Engineers. (2012, January 10). SWE: The Society of Women Engineers. http://societyofwomenengineers.swe.org/membership/history/2454-the-swe-story

Tonso, K. L. (2007). *On the outskirts of engineering: Learning identity, gender, and power via engineering practice.* Brill Sense.

Tracy, S. J. (2019). *Qualitative research methods: Collecting evidence, crafting analysis, communicating impact* (2nd ed.). Wiley-Blackwell.

Trevelyan, J. (2007). Technical coordination in engineering practice. *Journal of Engineering Education*, *96*(3), 191–204. https://doi.org/10.1002/j.2168-9830.2007.tb00929.x

van Amerongen, R. (2014, April 7). *How to write the perfect resume—STAR competency based CV*. LinkedIn. https://www.linkedin.com/pulse/20140407100337-2150229-how-to-write-a-resume-i-enjoy-reading/

VanAntwerp, J. J., & Wilson, D. (2018). Differences in motivation patterns among early and mid-career engineers. *Journal of Women and Minorities in Science and Engineering*, *24*(3). https://doi.org/10.1615/JWomenMinorScienEng.2018019616

Wajcman, J. (1991). *Feminism confronts technology*. The Pennsylvania State University Press.

Wajcman, J. (2000). Reflections on gender and technology studies: In what state is the art? *Social Studies of Science*, *30*(3), 447–464. https://doi.org/10.1177/030631200030003005

Wajcman, J. (2007). From women and technology to gendered technoscience. *Information, Communication & Society*, *10*(3), 287–298. https://doi.org/10.1080/13691180701409770

Wajcman, J. (2010). Feminist theories of technology. *Cambridge Journal of Economics*, *34*(1), 143–152.

Webster, J. (1996). *Shaping women's work: gender, employment and information technology*. Addison Wesley Longman Publishing Company.

Williams, B. T. (2006). Girl power in a digital world: Considering the complexity of gender, literacy, and technology. *Journal of Adolescent & Adult Literacy*, *50*(4), 300–307.

Williams, J. (2009, October 14). *SWE Grassroots Oral History Project, Jan Williams interview* (T. Eller, Interviewer; LOH002111.14) [Interview]. Walter P. Reuther Library, Detroit, MI. https://ethw.org/Oral-History:Jan_Williams

Winsor, D. (1998). Rhetorical practices in technical work. *Journal of Business and Technical Communication: JBTC; Thousand Oaks*, *12*(3), 343–370.

Winsor, D. (2003). *Writing power: Communication in an engineering center*. SUNY Press.

Wynn, A., & Correll, S. (2018). Puncturing the pipeline: Do technology companies alienate women in recruiting sessions? *Social Studies of Science*, *48*(1), 149–164. https://doi.org/0306312718756766

Yang, C. (2013). Telling tales at work: An evolutionary explanation. *Business Communication Quarterly*, *76*(2), 132–154. https://doi.org/10.1177/1080569913480023