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What Late-Career and Retired Women Engineers Tell Us: Gender Challenges in Historical Context

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Abstract:

Women engineers who graduated from college in the 1970s, a time in U.S. history when women's entry into engineering seemed most promising but failed to gain traction, offer important perspectives on the challenges facing women engineers in the past and today. To that end, we surveyed 251 women engineers from that generation to understand their perspectives and experiences. We found that the challenges faced by so many of the women engineers reflect gender issues that are deeply embedded in our interpersonal interactions and social structures – so much so that progress for women in engineering has been slow despite the anticipation that as more women went into the field, things would have gotten better. Although, as many participants noted, these challenges are rooted in gender inequity at social and institutional levels, participants often recommended individual-level solutions, encouraging young women to 'just do it' and persist in spite of the challenges. Our historical framing and gender analysis of participants' responses help to explain their beliefs about why change has been slow and why, despite the continued challenges, they have persisted and encourage young women to do the same.

INTRODUCTION

Engineering is and has long been the most male-dominated educational and occupational field in the U.S. It has been seen as especially masculine for its emphasis on tinkering and technology and on being 'strong, action oriented, and ready to make a difference in the physical world of concrete realities.'[1] Yet in the 1970s, the numbers of women going into this field

[1] McIlwee and Robinson, *Women in Engineering*, 50; Dryburgh, "Work Hard, Play Hard," 678. Quotation in Dryburgh.

increased significantly; the percentage of women earning undergraduate degrees in engineering grew from less than 1% in 1970 to 9% in 1979.[2] Engineering education opened for women in the 1970s due to previous years of sustained efforts, starting *en masse* during World War II (even though engineering education for women at that time was only intended to fulfill a temporary need). At the same time, the founding of the Society of Women Engineers in 1950 both reflected and supported women's entry into engineering.[3] Other factors helping to open engineering education to women in the 1970s included a decline in the number of men going into engineering and new federal affirmative action requirements encouraging corporations to hire women and people of color.[4] As Margaret Rossiter has explained, "at this low point most engineering deans, concerned about their institutions' survival, began to do the unthinkable: they urged bright women, whom they had formerly ignored or even scorned, to apply," alongside other initiatives to draw girls and women into engineering.[5]

Many expected the number of women in engineering would continue to rise, for many reasons: an engineering workforce shortage, increases in engineering work deemed more suitable for women (less dirty and hands-on work in the field, more analytical and computer work at the desk), and the promise of high salaries – higher salaries than in female-dominated professions, higher starting salaries for all engineers with bachelor's degrees than in any other field, and slightly higher starting salaries for women engineering graduates than for their male peers.[6] However, women did not continue to flock to the profession at the rates initially anticipated, and

[2] American Association of Engineering Societies, "Women in Engineering."
[3] Bix, *Girls Coming to Tech!*, 55-130.
[4] Rossiter, *Women Scientists in America,* 41, 43; Engineering Manpower Commission, "The Future Supply," 1-6.
[5] Rossiter, *Women Scientists in America*, 43.
[6] McIlwee and Robinson, *Women in Engineering,* 2-3; Rossiter, *Women Scientists in America,* 149; McAfee, "Brighter Prospects," 83-84.

most of the present gains had occurred by the early 1980s. Due partly to men's declining degree completion in the late 1970s and 1980s, the proportion of women pursuing bachelor's degrees in engineering 'shot up from less than 1 percent in 1970 to almost 15 percent in 1985,' after which women's enrollment in engineering education plateaued.[7] Although the percentage of undergraduate degrees in engineering earned by women is now at 21.3%,[8] this number remains largely unchanged from the 20.6% of undergraduate engineering degrees earned by women in 2000.[9] These numbers do not compare favorably to other historically male-dominated professions where women also made inroads beginning the 1970s**;** for example, today, women make up a little over 50% of entering medical and law school students and nearly half of the graduates.[10]

In this study, we analyze open-ended survey responses from 251 women engineers who graduated from college in the 1970s, a time in U.S. history when women's entry into engineering seemed most promising but failed to gain traction. We answer the following research questions:

Question 1: What influenced this generation of women to pursue engineering?

Question 2: a) How do these women understand and explain the challenges they faced as women in a male-dominated field, and b) to what extent do they think that the challenges facing women engineers have changed over time?

[7] Rossiter, *Women Scientists in America*, 45-46.
[8] Yoder, "Engineering by the numbers."
[9] Rossiter, *Women Scientists in America*, 46.
[10] AAMC, "More Women Than Men"; AAMC, "Current Trends in Medical Education," in "Facts & Figures, 2016"; Olsen, "Women Make Up Majority"; NALP, *NALP Diversity Infographic: Women*.

Question 3: What advice do these women have for today's young women who are interested in or already pursuing careers in engineering?

Participants' responses reflect their perspectives on their own experiences and the experiences of women in engineering today. To understand *why* this generation of women engineers had the experiences they did and have the perspectives they do, we situate their narratives in historical context and utilize a gender analysis to explain the differences in their experiences relative to men in engineering. In doing so, we contribute to an understanding of the cultural environment in the U.S. that has produced a relatively small percentage of women who have pursued engineering, both historically and today.

We found that the challenges faced by so many of the women engineers reflect gender issues that are deeply embedded in our interpersonal interactions and social structures – so much so that progress for women in engineering has been slow despite the anticipation that as more women went into the field, things would have gotten better. What is perhaps most surprising and interesting is that although, as many participants noted, these challenges are rooted in gender inequity at social and institutional levels, participants often recommended individual-level solutions, encouraging young women to 'just do it' and persist in spite of the challenges. A historical framing and gender analysis of participants' responses help to explain their beliefs about why change has been slow and why, despite the continued challenges, they have persisted and encourage young women to do the same.

SETTING THE STAGE: HISTORICAL CONTEXT

Our participants graduated from college in the 1970s, a time when new opportunities became available to women engineers, including affirmative action initiatives intended to encourage women into engineering, alongside the job loss for experienced men in engineering during the aerospace recession at the time.[11] However, upon entry into the engineering workplace and the decades that followed, many women engineers also experienced challenges related to gender inequity in the workplace. A historical framing allows us to understand how such opportunities and challenges shaped the experiences of these women engineers in unique ways, including their perceptions of how things have changed – or in some cases, remain the same – for women engineers today.

Affirmative Action

In 1961, affirmative action was written into federal law, prohibiting discriminatory practices against people in social categories previously excluded from educational and job opportunities, based on race, religion, or national origin; in 1967, affirmative action was modified to also protect women. The goal of affirmative action was to bring women and minorities into occupations where they were historically underrepresented, such as engineering, as well as to promote workplace mobility.[12] However, it wasn't until the Equal Employment Opportunity Act of 1972 that the government had any real power to enforce the new affirmative action laws; and even then, enforcement was inconsistent.[13]

[11] Rossiter, *Women Scientists in America,* 43.
[12] Kurtulus, "Affirmative Action," 213-14.
[13] Leonard, "Women and Affirmative Action," 61-75.

Initially, affirmative action initiatives encouraged girls and women to go into engineering via university recruitment initiatives, special weekend programs and summer camps for girls and young women, and admission of women into national engineering honorary societies. Companies also sought out women through targeted advertising and through interviews at university career centers.[14] However, inviting women into the workplace was not the same as making the workplace welcoming to and good for women; affirmative action was only required in workplaces under government contract, was not uniformly enforced, and was rolled back by the federal government starting in 1981.[15] And so, gender equity in engineering classrooms and workplaces remains far from achieved.

Career Mobility and Workplace Cultures

As early as 1974, Naomi McAfee, then-president of the Society of Women Engineers (SWE), noted that though women were successfully recruited to engineering jobs, "once she is on the job, however, things change. On the average, promotions do not come as rapidly for women as they do for men."[16] In the early 1990s, many studies found that women advanced more slowly than men in engineering, and more notably so in particular industries. Women were less likely to move into high-status and high-paying positions, such as management-level positions, and thus, typically earned less than their male counterparts throughout their careers.[17] Women were more likely to hold jobs perceived as lower status 'support roles' to true

[14] Sloan, "Women engineers in the United States," 104.
[15] McIlwee and Robinson, *Women in Engineering*, 183; Etzkowitz et al., "The paradox of critical mass," 53; Kurtulus, "Affirmative Action," 218.
[16] McAfee, "Brighter Prospects," 82.
[17] McIlwee and Robinson, *Women in Engineering*; Ellis, *A National Survey*; Catalyst, *Women in Engineering*; National Research Council, *Women Scientists and Engineers*; Vetter, "Exploring the corporate climate," 85-90.

engineering positions, such as marketing, manufacturing, or sales.[18] Getting women into engineering was not enough to ensure women's success in engineering, and largely unchanged workplaces cultures thwarted women's mobility and sometimes led to women exiting engineering altogether.[19]

Maternity/Family Leave

In the eras following women's entry into engineering, the promise of affirmative action and equal opportunity was limited not only by lack of enforcement of affirmative action programs, glass ceilings (subtle, unseen, but real barriers which prevent women from advancing), and workplace cultures, but also by insufficient maternity and family leave policies. In the 1970s, the feminist movement inspired a cultural and political push toward maternity leave, but still no government policies provided for such leave.[20] As such, women were often left with no choice but to leave – and likely not to return to – their jobs when pregnant.[21] Although some advances were made, there was little successful legislation in the US surrounding maternity leave until the Family and Medical Leave Act (FMLA) of 1993.[22] Uncertainty about job security and paid leave following the birth or adoption of a child had a real impact on employed women's decisions. Maternity and family leave policies continue to be a challenge facing all employed American women, as today, "just 15 percent of the workforce has paid family leave through their

[18] McIlwee and Robinson, *Women in Engineering*, 80-81.
[19] Etzkowitz et al., "The paradox of critical mass," 53.
[20] Kelly and Dobbin, "Civil Rights Law."
[21] Kamerman, Kahn, and Kingston, *Maternity Policies,* 133-144; Smith, Downs, and O'Connell, *Maternity Leave.*
[22] Sholar, "History of Family Leave."

employers."[23] FMLA still only entitles employees to unpaid leave when working for 'covered employers.'[24]

Exiting the Profession

By the 1980s, women's higher rates of exiting engineering and science jobs in industry than men's was evident. One study showed that between 1982 and 1989, women engineers and scientists left those fields at twice the rate of men – and not just for family reasons, as many would have predicted.[25] In response to this trend, several large engineering and science companies created retention programs for women, focusing on mentoring, management training, and benefits for families, such as parental leave, flextime, and day care.[26] However, even programs designed to help women engineers advance in the workplace didn't seem to make a difference.[27] In addition to ongoing structural challenges, women engineers also felt they were not receiving the respect, recognition, and/or chances to progress they desired, which continues to contribute to women's more frequent departure from engineering today.[28] Research suggests that 37% of women who earn engineering degrees exit from the field, with about 10% never entering the field after graduation and 27% leaving the field after working in engineering jobs.[29]

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[23] National Partnership for Women & Families, *The Family and Medical Insurance Leave Act.*
[24] U.S. Department of Labor, Fact Sheet.
[25] Preston, "Why Have All the Women Gone?," 1446-462.
[26] National Research Council, *Women Scientists and Engineers*, 51.
[27] Rossiter, *Women Scientists in America*, 144-45, 150-51.
[28] Fouad and Singh, "Women's Reasons for Leaving," 1-11. See also Fouad et al., *Stemming the Tide*.
[29] Fouad and Singh, "Women's Reasons for Leaving," 4.

Another recent study provides different percentages, but also finds women are more likely than men to leave the profession, especially as they age. In particular, this study reports that '[t]hirty years into their careers (by the time women and men are in their 50s), women are half as likely as men to report that they are still working as engineers.' Corbett and Hill, *Solving the Equation,* 27.

While women exit other male-dominated professions in greater numbers than men, recent scholarship suggests that the problem is worse in STEM fields, especially in engineering.[30]

THEORETICAL FRAMEWORK: GENDER AS SOCIAL STRUCTURE AND PRODUCED THROUGH SOCIAL INTERACTIONS

In addition to placing the survey responses in historical context, we employ a theoretical framework that conceptualizes gender as a social structure. Doing so highlights the ways in which gender manifests in all levels of social organization and thus shapes individual gender identities, and is produced and maintained through social interactions and institutions.[31]

Individualist approaches to gender, taken by themselves, posit that individuals are gendered, either innately (typically perceived as the result of biological sex differences) and/or through socialization and subsequent internalization of what it means to be a man and what it means to be a woman. We agree that individuals do become gendered through socialization, but that occurs *because* of the extent to which gender is ensconced in the social structure and is therefore part of what parents, teachers, and others—whether consciously or not—teach children. Thus, we argue that individualist approaches alone cannot explain fully the way gender works in our society. For that, we need interactionist and structuralist approaches to understanding gender.

An interactionist approach sees gender, including gender inequality and the gender difference on which that inequality relies, as produced and maintained via social interactions. From this perspective, social interactions involve performances of masculinity and femininity –

[30] Cohen, "More Women are Doctors"; Glass et al., "What's So Special," 723-56.
[31] Anderson, "Theorizing Gender," 853-865; Risman, *Gender Vertigo*; and Risman, "Gender as a Social Structure," 429–50.

that is, gender is something we *do* rather than something we innately *are*.[32] Individuals respond to the gender performances of others, either subtly or explicitly, providing positive or negative feedback based on how another's gender performance meets or contradicts society's expectations. An interactionist framing also explains how men's and women's behaviors, even when enacting the same behaviors, are interpreted differently simply based on the perceived gender of the performer due to the different social expectations ascribed to men and women. We find this understanding of gender to be especially compelling and relevant to the participants' interactions with others as *women* engineers (i.e., being seen as different from male engineers), interactions that reflect culturally dominant gender ideologies, including the belief that men and women are inherently different.

A structuralist approach illuminates the pervasiveness of gender stratification that often goes unquestioned in larger social structures and institutions, such as educational institutions, workplaces, governments, and legal systems. As Barbara Risman explains, gender is embedded in every part of our society. Long-held cultural norms and values about gender simultaneously permeate individuals' thoughts and actions, interpersonal interactions, and the social organization of institutions and unspoken rules in our culture in mutually reinforcing ways.[33] In other words, conceptualizing gender as social structure acknowledges the interconnectedness of individualist, interactionist, and structuralist approaches to gender.

[32] West and Zimmerman, "Doing Gender," 125-51; Butler, *Gender Trouble*.
[33] Risman, "Gender as a Social Structure," 429–50.

METHODS

This research is part of a larger, ongoing mixed-methods study on North American women engineers who graduated from college in the 1970s. The data presented here includes participant responses to open-ended questions on a survey about (a) influences on choosing engineering, (b) satisfying experiences in engineering, (c) perceptions of challenges for new and experienced women engineers, and (d) advice for young women engineers, as well as (e) an open-ended question for participants to share 'anything else' of their choosing.

Participants were recruited via the blog and social media platforms of SWE, the Women in Engineering ProActive Network mailing list, the Women in Engineering Leadership Institute listserv, the Society of Hispanic Engineers Facebook page, and the deans of 354 Schools of Engineering, as well as snowball sampling from participants recruited from those methods. We also sought, in particular, to recruit women of color, who made up a minority of women in engineering, as well as women who left engineering and/or the workforce for significant periods since their perspectives are important to understanding the variety of experiences and trajectories for women engineers.

To be eligible for the survey, participants had to: identify as a woman and have grown up or worked in North America, earned an undergraduate degree in the 1970s, and majored in engineering or worked as an engineer at some point in her career.[34] This resulted in 251 survey responses meeting eligibility criteria. The large majority of participants identified as

[34] Participants who grew up and/or worked in the U.S. and/or Canada were included in our analysis. There were no notable thematic differences in responses between these groups of participants, and participants who grew up and/or worked in Canada made up a minority of our respondents.

White/Caucasian, majored in engineering, and worked in a variety of engineering and non-engineering fields.

We used an exploratory approach when analyzing written responses to open-ended survey questions. The three authors read and reread the participant responses using applied thematic analysis to identify recurring keywords and emergent themes.[35] Themes were coded to determine the frequency of each and whether there were co-occurring themes, and word searches were used to identify keywords that reappeared within and between participant responses. To establish intercoder reliability, all three researchers discussed the coding of responses at length until intercoder agreement was established.

DEMOGRAPHICS: WHO COMPLETED THE SURVEY?

The majority of participants earned their undergraduate degrees in engineering (82%) and math or science (14%), while 3% earned degrees in business, architecture, or the humanities and social sciences, and 1% earned their degrees in engineering management/industrial administration. Seventy-two percent of respondents earned graduate degrees, mostly in engineering or business. Ninety-one percent of participants grew up in the US; others grew up in Canada (6%) and other countries (4%).[36]

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[35] Guest, MacQueen, and Namey, *Applied Thematic Analysis.*

[36] Percentages are rounded up, so they total 101% here. Because this generation has not had their voices heard either in the U.S. or outside of it, some women engineers outside of the U.S. also responded to our survey; these women were clearly eager to have their stories told, and eligibility criteria for the survey did not include limits on country of origin. Many of the participants who indicated that they grew up in Canada or other countries outside of the U.S. appear to live in Canada now, as determined by their responses to the open-ended questions or their e-mail addresses (for those who provided them so they could be contacted for an interview). While the responses of non-American women are not central to our larger study of American women engineers, there don't appear to be any major differences in the themes and content of their responses when compared to participants who grew up in the U.S.

Participants were born between 1946 and 1958, and primarily identified as White/Caucasian (93%). Small numbers of participants also identified as Asian or Asian American (2%), Latina/Hispanic (2%), and African American/Black (2%); one participant identified as Middle Eastern and 2% identified as 'other.'[37]

Nearly half (47%) of participants were working full-time at the time of the survey, and 33% were retired; others were working part-time (8%), unemployed due to a disability or other reason (2%), participating in unpaid charity work (2%), homemakers (2%), or reported another employment status (5%). On average, participants had been in the paid workforce for 34 years (range: 8-54, std. dev. = 7.14), and two-thirds (67%) earned more than $101,000 per year in their current or most recent job.

Three-quarters of participants were married at the time of the survey, and 12% were divorced; 6% were single and had never been married, and others were partnered but not married, widowed, or separated. Sixty-eight percent of participants reported having biological or adopted children of their own, and 19% reported having stepchildren. Of the women with biological or adopted children, 38% reported leaving the workforce for extended periods of time (beyond maternity leaves) to raise children; participants with stepchildren but no biological or adopted children did not report taking such leave.

[37] The percentage of people of color in engineering today remains very small. On the historical reasons for the small number of African Americans in engineering, see Slaton, *Race, Rigor, and Selectivity*.

QUESTION 1: WHAT INFLUENCED THIS GENERATION OF WOMEN TO PURSUE ENGINEERING?

Alongside individual interests and aptitudes, social forces led these women to consider engineering when they were girls or young women. Previous generations of girls and women had been discouraged from pursuing engineering and other STEM fields, and many technological universities did not even admit women until the 1960s and 1970s.[38] The women's movement of the 1960s and early 1970s opened up space for women to engage in non-traditional roles, even those, like many women engineers, who themselves may not have been protesting for females to have those options.[39] Furthermore, the Cold War tension with the USSR encouraged the federal government to pour money into science and engineering education and space technology, which were now seen as inadequate in the United States as compared to the Soviets. Participants said they were influenced by living in "a time of space and science," inspired by the "launch of Sputnik" in 1957, "grow[ing] up in Houston during the Apollo program," and "the race to the moon." In addition to the space race, others mentioned the growing emphasis on energy and the environment in the 1970s as prompting their interest in engineering.

By the mid-1970s, schools of engineering at major universities created campaigns to bring in more women, reflecting an acknowledgment of the gendered nature of engineering that kept women out of the field.[40] Many participants who graduated from college in the mid- to late 1970s cited recruitment and affirmative action programs that opened the doors for them to enter engineering. Eleven participants mentioned attending summer university engineering camps for high school students, some just for girls. Others noted the influence of engineering scholarships,

[38] Bix, *Girls Coming to Tech!*; Miller-Bernal and Poulson, *Going Coed*.
[39] Bix, *Girls Coming to Tech!*, 262, 264; McIlwee and Robinson, *Women in Engineering*, 38-39.
[40] Bix, *Girls Coming to Tech!*, 265, 267.

'Women in Engineering' Days for high school girls at local universities, and a visit to a college calculus class by a local political figure (Janet Reno, later US Attorney General) encouraging women to pursue engineering.[41] Several respondents used the same language to explain these recruitment tactics' effects: "I was hooked." In addition, by the mid-1970s, corporations such as Kodak and GE, prompted by federal civil rights legislation and the feminist movement, placed ads in magazines such as *The New York Times Magazine* and MIT's *Tech Engineering News* actively recruiting women.[42] For the younger survey participants, engineering seemed to be an option for girls and young women in a way that it had not been in the past.

In this larger social context, participants often reported that their interests and aptitude in what were (and often still are) seen as masculine areas led them to engineering.[43] Many said that in school, they had enjoyed and excelled in math and science, and they liked understanding how the physical and mechanical world worked. They also cited a desire to solve problems, experience the thrill of the challenges in engineering, and have opportunities to help others or make improvements in the world, work collaboratively with others, and mentor, teach, and help others be successful.

Personal encounters also influenced many women to pursue engineering, which reflects the interactionist nature of gender, including support by some people to challenge gender norms by entering engineering as well as others' gendered beliefs that women did not belong in engineering.[44] For example, many participants reported being encouraged or supported by family

[41] On programs to recruit K-12 girls to engineering and assist college women in the field, see Ibid., 267-71.
[42] Kodak ad; Bix, *Girls Coming to Tech!*, 260, 62-63.
[43] Corbett and Hill, *Solving the Equation*, 56-58.
[44] This fits in with the existing literature which discusses the complicated ways that parents', teachers', peers', and others' views of engineering, and of gender and engineering, influence

members, friends, teachers, high school guidance counselors, or admissions counselors. Other participants shared more indirect influences on their decision to pursue engineering, including exposure to (mostly male) family and friends in engineering.

A number of respondents discussed a desire to buck gender trends when they were young. For example, some sought engineering careers to prove others wrong.

> My dad was a mechanical engineer and was not too comfortable with me going into engineering. He said as long as I worked in an office and worked with numbers that would be ok but he did not think I should have a job that required a hard hat for instance. I made sure when I came home from my first internship – I came home with a hard hat that said Weyerhaeuser on it.

Several respondents found engineering because they did not want to follow a traditional female role or resisted being told that women should be either nurses or teachers or in other occupations that have been perceived as feminine.

> As a child at about 3 years old I was told I couldn't do something because I was a girl and the memory stayed with me all my life. In fact it was repeated many times but I was very willful and wanted what I wanted. All the media messages were that girls got married and did teaching or hair or nursing but I wanted financial independence and a career that would provide it.

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some girls to pursue engineering and others to avoid it. See, for example, Cheryan, Master, and Meltzoff.

> My mother was a feminist who went to University of Michigan during my junior high years in the sixties. She decided her 99%tile [ACT] and [SAT] math daughter was meant to be an engineer. I just wanted to be a math teacher. My counselor thought I should be a nurse! There is nothing nurse-like about me! I decided to try it [engineering] since I figured I could get a good job.

Interestingly, the far majority of the respondents said that today they agree with the statement, "I identify as feminist,"[45] yet very few mentioned the specific influence of the women's movement or feminism in their responses to open-ended questions, and some specifically said that they thought it was counterproductive to note differences between women and men.

For many women, the appeal of career prospects and the increased earning potential engineering offers were motives for pursuing engineering. The economic opportunities available to them as engineers were particularly important for meeting some women's goals of independence and being able to support themselves financially.

[45] Participants rated their level of agreement with the statement, "I identify as a feminist" with scores ranging from 1 (strongly agree) to 7 (strongly disagree). Of the 246 participants that rated their level of agreement with this statement, the average score was 2.48 (sd = 1.49), indicating relative agreement with the statement. In particular, 80% indicated *some* level of agreement (strongly agree, agree, or somewhat agree); 9.8% were neutral; and 10.6% indicated *some* level of disagreement (somewhat disagree, disagree, or strongly disagree). Our team is in the process of interviewing forty-seven respondents, where the women's attitudes about feminism are explored in much greater detail. Seron et al. ("I am Not a Feminist") find that undergraduate women in engineering often do not identify as feminists while still recognizing their marginal place in the profession.

> I chose a degree field that ensured I could get a job and support myself. I didn't have money to continue to graduate school and Chemical engineering allowed me lots of flexibility in the type of job I could do.

Participants also noted the transferability of skills to other opportunities as invaluable, explaining that engineering 'opens so many doors and choices for careers.' It is noteworthy that, at least in their responses to open-ended survey questions, they did not link their desire for economic security to the feminist movement as it existed when they were in college, with its emphasis on women's financial independence. However, one respondent, who left the paid workforce after years in the construction industry once her first child was born, used feminist language, explaining that "I never felt trapped in the home knowing that I could always return to the work force and support myself if my children needed."

For one woman, a combination of many of the factors mentioned above encouraged her to pursue engineering. She cited her enjoyment of math and science, supportive parents, encouragement from a family friend whom she thought was an engineer (ironically, she later learned this family friend was actually a nurse!), as well as her high school chemistry teacher as influential:

> [M]y chemistry teacher encouraged me to apply for a [National Science Foundation] summer program the summer after my junior year in high school. I went, six weeks long, about 7 girls, 42 boys. At Ohio State, three states away from my home. The summer we landed on the moon; watched i[t] on TV in dorm basement with group. Came back wanting to be an engineer.

Like this respondent, many reported that social forces, including interpersonal interactions and sociocultural shifts in science and engineering, combined with their own interests, drew them to a field associated with men yet becoming slightly more typical for women when they were coming of age.

QUESTION 2a: HOW DOES THIS GENERATION OF WOMEN ENGINEERS UNDERSTAND AND EXPLAIN THE CHALLENGES THEY FACED AS WOMEN IN A MALE-DOMINATED FIELD?

Participants frequently reported feelings of satisfaction in their careers. They liked solving problems, making a difference, and making good money and being financially independent. They were also proud to be engineers, enjoying the sense of accomplishment, respect, recognition, and/or prestige of their profession, regardless of whether or not they actually worked in a position with the title 'engineer.' This woman, a high-level manager in the aluminum industry with a bachelor's degree in mechanical engineering and an MBA, was typical:

> My passion is around defining, developing and launching new products. I like that my mind was trained to think like an engineer and that I have experiences that help me ask the right questions and solve problems methodologically. I like telling people that I am an engineer. Especially young people because I want to inspire them to reach for the stars. There are not many women engineers my age around.

Given what we know about the history of women in engineering, as well as women in the workforce, it is perhaps not surprising that alongside the successes and rewards, participants' pursuit of engineering had its share of challenges and that the three challenges women cited most frequently were: 1) not getting respect, 2) not fitting in, and 3) work/family balance.

Challenge #1: Not Getting Respect

The most frequently cited challenge was not getting respect from peers and supervisors. This was also stated as not being taken seriously, not being heard, not having people believe that women can be engineers, and having to prove yourself repeatedly.

> The greatest challenge for me was continuing to believe in myself when all the messages I was getting was [*sic*] that I would never be taken seriously or promoted or given raises, or even hired at the same rate as men who were clearly less qualified and not as smart as I was. That get's [*sic*] seriously annoying.

> There are definitely challenges when you are "different" from the majority of people pursuing your field. Women in general are under-valued and viewed by some as being less well-qualified when they are in responsible positions.

> You have to prove yourself just because you are female and you have to work twice as hard!

The lack of respect had material consequences for the women, including slower promotions and pay inequity. While some respondents rose through the ranks in their workplaces, others talked about slower promotions and sidelining into support roles.

> I have been passed over for major promotions while far less qualified male candidates [were] … selected.

> [C]ompetent women engineers get promoted but moved to non-technical areas. I have seen this happen several times. We had a PhD Mechanical Engineer 'promoted' to run the division of people who produce the publications for our agency. Photocopying, editing, graphics, and publishing. A great use of a PhD.

> I've labored under the impression several times that I was fairly paid and then found out that men who were less senior than I made more money.

Challenge #2: Not Fitting In

The second most frequently cited challenge was not fitting in. This was also expressed as feeling left out, isolation, being an oddity, being told you don't belong, and being left out of old boys' networking. In some instances, participants suggested that the psychological challenge of not fitting in led to women leaving the field.

> The biggest challenge is being reminded that women will never be considered or accepted as true engineers. We are ‘women engineers.’ People don't refer to a man as a ‘man engineer,’ he's an engineer. We are constantly reminded that we don’t truly belong.

> On many levels, you’re never quite one of the group. It’s gotten way better, but still a lot of the old boys’ network out there.

One manifestation of this challenge, as reported by the participants, was sometimes a lack of female mentors and role models. As one participant explained, ‘There wasn’t much mentoring for me, as it was rare to even meet another woman in engineering. I had to learn alot [*sic*] by myself and no one gave me any pointers.’

A few respondents made a connection between the first challenge (not getting respect) and the second challenge (not fitting in), explaining that if you don’t fit in or are told you don’t fit in, it is much harder to gain your colleagues’ respect.

> Being listened to and taken seriously. It is hard for someone different: be it gender or ethnicity, to fit into the old boys’ club because we lose out by not being invited to lunch and just getting to know each other. When you don’t make those personal connections, you end up having to prove yourself over and over again.

> Young women engineers are still told women don’t belong in engineering or in leadership roles. I was still having to prove my capability to do the job the year I retired. And I had worked as an engineer for 35 years.

This is what Joan C. Williams *et al*. call the 'prove-it-again bias,' referring to the many studies demonstrating that "women and people of color often need to be more competent than white men in order to be seen as equally competent."[46]

The challenges of not getting respect and not fitting in reflected social interactions that produced gender inequalities in the classroom and the workplace. In particular, women said they are taken less seriously than men, even while performing as well or outperforming them, and that when women and men engaged in the same behaviors, such as working on a construction site or as a supervisor, they are perceived differently (by both women and men) because of different social expectations of women and men. Simply by being women, participants were seen as less qualified and treated as outsiders because engineering was seen as inherently masculine (i.e., not feminine or meant for women).

From subtle biases to overt discrimination, women were reminded that being a woman was seemingly at odds with being an engineer, and they received mixed messages about how they should look and act. One of our respondents said, "If you're the only woman in a department of men, you pretty much have to be 'one of the guys' and not the 'female engineer.'" But it was often hard for participants to figure out what that meant. In a 1992 study by Catalyst, a non-profit organization using research to create better workplaces for women, one human resources professional explained the challenge:

> Women have to play a game on top of a game, so they not only have to understand organizational dynamics, but have to understand how to make the transition into a male

[46] Williams et al., *Climate Control,* 12.

> organizational dynamic. [A woman engineer had to learn] How to look sort of like a man, but not really like a man, because if you get too close to that you get too threatening, and if you get too far away you are not a contender.[47]

That is, like their male counterparts, women engineers had to do work to understand the politics of their workplaces; but then as women, they had to do *more* complicated, nuanced work to try to fit in with masculine workplace and cultural standards.

Scholars call this extra layer of work that women engineers had, and have, to do 'identity work.' Identity, a combination of how people see themselves and how others see them, is formed in part through interactions with others. Engineers' interactions, as well as the structures of the places where they work, require that the women among them do additional identity work to gain respect and to fit in, or at least project they fit in.[48] Wendy Faulkner has argued that women engineers must do this extra work from the time they begin university all the way through to retirement. As she put it: "Even really senior, older women engineers told me they have to (re)establish their engineering credentials every time they encounter a new colleague, associate or client for the first time. This is an extra layer of practitioner identity work which women, and not men, have to do *throughout their careers* in order to be taken seriously as engineers."[49]

To deal with the challenges, women engineers use a variety of tactics. As Deneen Hatmaker has demonstrated, these include blocking interactions that focus on their identities as women and instead foregrounding their identities as capable engineers, as well as impression

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[47] Catalyst, *Women in Engineering*, 22-23. On the complicated image women engineers had to learn to present, see Carter and Kirkup, *Women in Engineering*, 79-82.
[48] Hatmaker, 'Engineering Identity,' 382-96; Dryburgh, "Work Hard, Play Hard," 664-82; Kvande, "'In the Belly of the Beast,'" 305-28; Faulkner, "Gender (In) Authenticity," 277-93.
[49] Faulkner, "Gender (In) Authenticity," 281.

management tactics such as proving themselves to be uber-professionals. These tactics help women to deal with what Hatmaker calls 'marginalizing interactions'—in other words, "gendered interactions that marginalize professional identity and often overly validate gender identity" in the workplace.[50] These strategies are necessary for women engineers to feel, or at least project, a sense of belonging, and to succeed in their professional environments. In fact, perceptions that women are not aggressive enough, not committed enough to their careers, and are not good bosses as compared to men have limited women's progress in many fields, not only engineering.[51] Women likely employ these tactics in male-dominated workplaces because making individual-level behavioral modifications are much easier than changing the deeply gendered interpersonal and structural challenges that necessitate such behaviors.

The challenges of not getting respect and not fitting in signal the structural gender stratification embedded in universities and workplaces where engineers study and work. The literature on tokenism, or small numbers of a subgroup of people in an occupational field, helps to explain the deeply embedded structural problems facing women engineers. As Rosabeth Moss Kanter has posited, tokens feel and are isolated from informal and social networks, feel pressure to perform because they stand out, and are stereotyped. Tokens do not cause themselves to feel or be isolated; it is the situation, not the individual, causing the problem.[52] And as Janice Yoder and others have argued, token men and women have different experiences; men often benefit from being token males in female-dominated occupations, suggesting that problems facing token

[50] Hatmaker, 'Engineering Identity,' 382-96. Quotation is on 383.
[51] Blau and Winkler, *The Economics of Women*, 292-93.
[52] Kanter, "Some Effects of Proportions," 965-90. Others have used the term tokenism to refer to superficial efforts to include minority groups.

women are not just small numbers, but also sexism. It is no wonder then that adding more women to a male-dominated occupational field does not automatically improve their situation.[53]

Our language both denotes and reinforces the structural problems facing token women, especially in 'gender-inappropriate occupations.'[54] The commonly-used term 'woman engineer,' which we also use, positions men as the reference group; as one of our respondents noted, "People don't refer to a man as a 'man engineer,' he's an engineer." This term, along with similar terminology for many types of professionals (as in women senators) and athletes (as in the Lady Lions), for example, reflects the challenges facing women in male-dominated arenas.

Challenge #3: Work/Family Balance

The third most frequently cited challenge was work/family balance. Respondents explained that this issue affects women in notably different ways compared to men. Women also discussed the implications of balancing work and family on their career trajectories. Some respondents mentioned making career decisions that allowed for better work/family balance, whereas others noted that available choices were constrained or decisions were imposed on them by supervisors.

> Young women engineers are on equal footing until they have children, then they struggle to balance work and family and compete with men who don't have the same time constraints or busy family life.

[53] Yoder, "2001 Division," 1–8; Yoder, "Rethinking Tokenism," 178–92.
[54] Yoder, "Rethinking Tokenism," 178-92.

> Good luck in your future boss not thinking you will leave as soon as you start having babies.

Another respondent explained that her choices were constricted by her (female) supervisor's perception of Chinese-American women in particular.

> Being a member of the 'model minority' I have encountered a LOT of subtle discrimination. When my mother got ill, my female boss demoted me so that 'You can take care of your mother.' I didn't have a choice.

Although many respondents reported work/family challenges, several pointed out that the issue of work/family balance is not specific to women engineers, but a problem facing many women employed outside the home, and also varies by employer and type of employment.

The challenge of work/family balance can be viewed from an interactionist lens. As seen above, in their interactions with one another, women and men in heterosexual relationships often both assume that women will do more of the caregiving work and be more flexible about paid employment as compared to men. Male and female supervisors frequently make similar assumptions about female employees. Those assumptions help to limit women employees' career options. As an interactionist approach to gender shows, though women appear to have many choices—e.g., work full-time outside the home, be a stay-at-home parent, combine work and family, and/or engage in part-time work—those choices are often circumscribed by women's and men's interactions and assumptions.

The interactional challenges surrounding the family are particularly difficult in engineering workplaces. As Gillian Ranson has argued, the 'invisibility of the family' in the 'high technology workplace'[55] results in the depiction of women as 'conceptual men,' in which "this conceptual cover is blown when they [women] become, or think about becoming, mothers."[56] The perpetuation of hyper-masculine norms surrounding behavior and performance has not only complicated work/life/family balance for women, but resulted in delaying motherhood and, sometimes, choosing not to have children altogether.

The interactional elements of work/family balance discussed above reflect the structuralist nature of gender, including the cultural norms about caregiving and (lack of) workplace supports and policies for maternity or family leave during the time in which participants were employed, norms that persist today in many ways. In particular, our workplaces are structured in ways that reward employees who have the ability to prioritize work above caretaking responsibilities or do not have such responsibilities, which adversely affects employees with caregiving responsibilities – a role disproportionately occupied by women.[57] Likewise, the US remains the only industrialized nation without a mandated maternity leave policy and has been very slow to adopt maternity or family leave policies. This, along with lack of adequate government policies surrounding childcare and flexible work hours to mitigate these issues, has created barriers for caregivers, resulting in workplaces that continue to be distinctly gendered.[58]

[55] Jones and Causer, "Men Don't Have Families," 60, quoted in Ranson, "No longer," 149.
[56] Ranson, "No longer" 146.
[57] Risman and Davis, "From Sex Roles," 741; Acker, "Hierarchies, Jobs, Bodies," 139-58.
[58] Wharton, "2014 PSA Presidential Address."

It is noteworthy that even more than other educated women their age, survey respondents were less likely to have children.[59] Was that because they did not want to have children? Because they thought they could not or should not combine work and motherhood? For other reasons? Perhaps the interactional and structural challenges facing women engineers not only limited their career options, but also their family options.

Leaving the Profession

For some participants, the abovementioned workplace challenges encouraged an exit from the engineering workplace altogether or changing places of employment, for themselves or other women engineers they knew. Some left because they were not being respected or not fitting in. For example, one respondent, who began her career as a mechanical engineer, explained:

> In the late ’70s/early ’80s, women engineers were an oddity and I faced an uncomfortably [*sic*] level of scrutiny, both personally and professionally. I quickly moved into marketing so never became an experienced engineer.

Others left after the birth of a child. Their views about this decision varied. One woman, who left paid employment in 1979 one month before her first child was born because “there was no child care available,” was glad to get out of a bad work situation.

[59] Sixty-eight percent of our respondents had biological or adopted children. It is difficult to find the percentage of American women with bachelor’s degrees of the same age as our survey respondents who had/have biological or adopted children; this source provides some data on their peers who have had biological children: Livingston and Cohn, “Childlessness Up.”

> [A]fter having to deal with a couple managers who told me, "I don't know what to do with a female engineer" and who tried to ruin my career for my "own good as you should be home 'making babies,'" I was happy to leave KAPL [Knolls Atomic Power Laboratory] for motherhood.

Another respondent, an Army officer married to a fellow soldier and the mother of two children, had mixed feelings about her decision.

> I worked either part time or stayed at home while my children were growing up but used my organization skills to run a family while making 10 moves across the country. Sometimes, I felt sad that I never got the 'big job and big pay' which was one reason I studied such a hard field, but then I feel good that my kids got to play with dirt while other kids had to go to day care and stay clean. Some[one] has to raise up the next generation.

Several women left the engineering workforce after having children to go into teaching; one explained that "the long hours that my engineer husband and I both worked would not have been manageable with children. I loved being an engineer, but found teaching [math in the public schools] to be a better fit for my family situation." Another respondent, with a PhD in chemical engineering, felt "very fortunate to work in industry, academia and be a stay at home mom." Previous literature confirms that our survey respondents were typical of many women engineers, both from their generation and more recent ones, in leaving the profession for fields

viewed as friendlier to women and/or mothers, such as marketing and teaching, or exiting the workforce altogether.[60]

Variation in Women's Experiences by Industry and Company

It is important to note that participants' careers were not homogenous. They worked for corporations and the government, as well as in academia, and they started their own businesses. Some worked for one institution for their entire careers, while others moved around a lot. A number worked in industry for many years before becoming consultants. Some worked for a short time as engineers and then left the paid workforce to raise families, or to work instead in jobs they saw as more family-friendly, such as high school teaching or library work. A few survey respondents never worked as engineers following their undergraduate education, but instead as physicians or attorneys, for example. Some rose up to high levels in their organizations, while others made lateral moves. Still others were underemployed. Some mentioned that their careers stalled; as one woman, who had a long career at consumer products corporations before working part-time as a consultant, put it, "I know I did not reach my full career potential."

While there are many similarities in participants' experiences as women engineers, some participants identified company- and industry-specific factors that shaped their experiences. In some instances, working in industries like construction and manufacturing, as well as being in management-level positions, was noted as particularly challenging for women, as compared to other industries and roles perceived to be more women-friendly.

[60] Kvande, "In the Belly"; McIlwee and Robinson, *Women in Engineering*.

> I am challenged daily as a woman in a field of construction which is typically all men. My job is one where men in construction have a tough time figuring out how come I am there (and succeeding at that!).
>
> I have had far more issues with being a female CEO, even a highly technical one, because there are unconscious biases at the very top that are difficult to eradicate.

An academic, the first in so many of the positions she held (i.e., first tenure-track woman in engineering at her university and then the first to have a baby, first female dean at two different universities), mentioned that she had "lots of barriers to overcome," though she noted the environment was more welcoming today. Some participants cited specific companies as "very female embracing" and specific fields as better for women ("some fields like biomedical and civil engineering have made more progress").

Though our participants have noted these differences, it is too simplistic to state that some workplaces and fields are always 'good' or 'bad' for women. Scholars suggest that engineering workplaces and fields that emphasize a 'nuts and bolts' engineering identity and 'aggressive displays of technical self-confidence as the criteria for success' (even when the actual work done in those workplaces and fields is diverse and not only focused on the technical) are coded as masculine and often limit women's career success.[61] Yet, those same scholars often note the diversity *within* the cultures of individual employers or fields, such as an oilfield services base with a 'macho feel' ('bad') and inclusive social activities ('good').[62]

[61] Faulkner, 'Nuts and Bolts,' 331-56; McIlwee and Robinson, *Women in Engineering*, 138.
[62] Faulkner, 'Doing Gender,' 16.

QUESTION 2b: TO WHAT EXTENT DO THE WOMEN ENGINEERS OF THIS GENERATION THINK THAT THE CHALLENGES FACING WOMEN ENGINEERS HAVE CHANGED OVER TIME?

The most frequent answer was a variation of 'progress is slow,' as one respondent put it—that while things have improved for women in engineering, many challenges continue. A smaller number of participants, however, said that gender problems no longer exist. Overall, the ratio of those who said that 'progress is slow' to those who said that gender problems no longer exist was about three to one.

'Progress is Slow'

Survey respondents most often believed that while some things have improved for women in engineering, there remain many interactional and structural challenges.

The respondents were, in many ways, pioneers because they were the first group of women to enter the field in relatively large and growing numbers. They came of age in the 1960s and early 1970s when many people thought that young women's entrance into engineering educational programs would create a 'critical mass,' whereby women would no longer be underrepresented in engineering and the climate would change.[63] That is not what happened. Instead, many respondents reported that though they are no longer "lone so[u]ls," as one woman put it, their numbers are still small and challenges remain.

[63] Bix, *Girls Coming to Tech!*, 271.

> There still remains an old boys club. There is far gr[e]ater social and professional interaction among male and female engineers, but the majority of senior managers are still male, and many of them just don't see women as competent as men. It is slowly changing, and there are many men who do not operate this way, but the old prejudices remain. It isn't as blatant or as crass as when I started, but it still exists.

> Sexism is still a barrier even if it is less overt than when I started my career. I was just speaking to women environmental engineering students at New Mexico Tech and they were encountering discrimination in their internships/co-op jobs.

Several noted a reason *why* the changes are slow; though laws now theoretically provide for gender equality, the culture has not always kept up. As one participant said, "You can pass laws but you can't change how people think." These women thought that once they were no longer tokens, the problems would disappear. Yet those barriers remain, even though the number of women in the field has increased, the choice to be an engineer is no longer considered unusual, legal protections are available now that were not available in the past, there are more "organizational allies" and "countervailing forces" (as two participants explained), and the barriers women engineers come up against are not as obvious and sometimes not as great. These women cited the persistence of many problems, including the still small number of women in the field, attitudes of men toward women engineers, glass ceilings, and discriminatory – and sometimes overtly sexualized – actions taken by men in the workplace.

Some participants also noted that although overt discrimination decreased for the most part, more subtle forms of discrimination, as well as bias, remain. They repeatedly talked about

the often subtle perceptions and attitudes found in engineering culture – that a woman in engineering is less competent, not a real part of the team, and not a leader. Some participants also suggested that the more subtle forms of discrimination and unconscious bias in engineering today may be especially damaging because, as one respondent put it, they are "stealthier" than the issues and discrimination of the past, and thus harder to identify and change.

> Bias can be quite subtle, which really hurts young women because it can take them years to recognize it, by which time they may have lost a lot of ground.

> Young women engineers are likely not aware of the biases that are still present in society. They may try hard to be like "one of the boys," which may (but may not) be counter to their true self… Progress has been made over my 30+ year career – there are now men who "get it" (but many still who do not - more dangerously, they don't recognize that they don't get it).

That is, in an era when many assume that people can pursue whatever dreams they have regardless of gender, young women do not go into engineering thinking they will face discrimination and bias and are not ready for the tangible and psychological consequences of that, and men are often unaware of their unconscious biases. Or as another woman put it: "Now women are faced with micro aggressions – little cuts and jibes that the speaker probably doesn't even realize are offensive."

Several participants also mentioned the problem of "backlash sexism among those males who feel they are losing if women win." As one explained,

> Laws and attitudes have changed significantly. (It was perfectly legal and accepted to just not hire women or fire them when they got married when I was growing up.) However, these changes are not without backlash or pushback. Learning to cope with this is ongoing, but not only for women, but for all "strangers" in this profession.

Therein lies the biggest problem; after more than 40 years with a significant, though still small, number of women in engineering, women, along with people of color and LGBTQ people, remain "'strangers' in this profession." And they are still treated as such, even while they have opportunities that their predecessors did not. Thus, today's young women in engineering are, in a sense, still pioneers.

These problems are not unique to engineering, and these subtle biases are prejudices resulting in part from a long history of overt hostility and discrimination. As a report from the National Academies of the Sciences, Engineering, and Medicine has explained, "*subtle* does not mean trivial or inconsequential; subtle prejudice can result in major adverse effects," leading girls and women, for example, to be less interested in fields deemed masculine (i.e., better suited for men) and to be seen as less competent if they pursue those fields. This presumption contributes to the glass ceiling, another phenomenon found in more than just engineering.[64] At the beginning of the twenty-first century, women who entered the professions, even male-dominated ones, and worked hard often got good jobs and were paid well. However, once they reached their thirties and had children, their wages and chances for promotion declined.[65] Even

[64] National Academy of Sciences, *Beyond Bias and Barriers*, 151-52.
[65] Kessler-Harris, *Out to Work*, 330-31.

though the gender biases found in engineering are not unique, engineering is a particularly interesting case study of bias because it has been so male-dominated for so long.

Gender: "Not a 'Thing'" Anymore

Unlike the many respondents who identified the ongoing, slow-to-change challenges for women engineers, a smaller number said that things have gotten much better for women engineers, especially as more women have entered and risen up in the field and as men's attitudes have changed. Some went further, suggesting that problems due to gender no longer exist and are "not a 'thing'" anymore, or that being a woman in engineering may even be advantageous.

> Today, young women engineers are more accepted mostly because there are just more of them. It's easier to get their foot in the door. Younger male engineers are also use[d] to working with women because they went to school with them. Therefore they don't think much of it, or why it use[d] to be such a big deal.

> Sexism was a big challenge when older women engineers were young. Now I believe that women may have an advantage.

A still smaller number of respondents did not speak about gender at all in their response to the question about challenges, and instead wrote about the challenges of engineering and work in general. According to Jane Jorgenson, often women engineers do not see gender as important to understanding their experiences or sexism as the cause of their small numbers, and they

believe that women and men have equal opportunities in engineering. Some even distance themselves from women who are not in engineering and especially those who act in stereotypically feminine ways. Jorgenson argues that for some, not seeing their experiences through a gendered lens is an assimilation strategy, an understandable way to position themselves as capable engineers who deserve to be in the field.[66]

QUESTION 3: WHAT ADVICE DO WOMEN ENGINEERS OF THIS GENERATION HAVE FOR TODAY'S YOUNG WOMEN WHO ARE INTERESTED IN OR ALREADY PURSUING CAREERS IN ENGINEERING?

'Go For It!': From 'Just do it' to Advice on How to Do It

Despite the acknowledgement of gender discrimination by many participants throughout the survey, many respondents stated enthusiastically that young women should either "Go for it!" or "Do it!," with only two women discouraging women from pursuing engineering careers. For some, the advice for young women engineers was simply to "Go for it!," whereas others went on to identify the aforementioned benefits that engineering can provide.

> Go for it! It will give you the flexibility to do almost anything. It is almost impossible to point out anything tangible an engineer didn't touch or influence in some way. It is also satisfying to see the effects of what you have done.

[66] Jorgenson, "Engineering Selves," 350-80.

> Best place to be. Despite all kinds of negative publicity, this is the best degree, hands down. Students with BS degrees in engineering can take on the challenges of any other professional graduate degree, such as law, medicine, or business, or they can select a career in engineering or another field.

Although women often posited that engineering could be highly rewarding, some respondents again noted the difficulty of not feeling included or respected within the culture. Sometimes the advice around these issues included ignoring obstacles to persevere and succeed in the long-run.

> You can do the job. However it takes strength and perseverance to do so while ignoring the naysayers.

Some respondents acknowledged gender discrimination, isolation, not fitting in, and not getting respect even more explicitly. In these cases, participants recommended fostering resilience and cultivating power in groups rather than relying on individual merit, using strategies such as being assertive, speaking out/advocating for one's own success, leaving work environments that are too hostile, and networking with other female engineers as well as male engineers in their field.

> Understand the story of women engineers, the battles they faced, the barriers they broke and how the tactics they used to move forward can help you as you progress. Use the "Old Girls Network" [-] it does exist. SWE is a good place for that, but so are other

> technical societies in your field. There are women there who might have encountered a similar situation that can help. It may be something you need to change in yourself, and it may be something external to you. Don't isolate yourself – you are not the only one with your issue.

While some wished they had known about organizations such as SWE and the IEEE (Institute of Electrical and Electronics Engineers) when they were younger, others had turned to them for a long time, such as the woman who commented that SWE was "a 'coterie' to help you through the tough times" and "a family unit."

Some respondents, even those who acknowledged gender-related barriers in their answers to previous survey questions, proposed that young women would be able to persist more effectively in their careers either by downplaying the challenges they may face in engineering as women or by playing the proverbial 'game' with their male counterparts. Others advised that gender is no longer relevant to women's experiences in engineering, or at least should not be a woman's main focus.

> There is no need to go into the job with guns blazing and a hard line attitude. You are no longer needed to fill a quota, you are needed because you can do the job. You bring something unique in your p[er]s[p]ective to engineering as intangible an asset as that is it is indeed an asset. Go for it.

When to "Think Twice" about Engineering

Contrary to the enthusiastic encouragement and advice for pursuing engineering provided by others, two participants advised women to avoid engineering altogether. Several others suggested that some women may not be suited for the workplace culture of engineering.

> Still, after all these years, it is very difficult for an emotional young woman to thrive in a 'typical' engineering environment, however there are many exceptions and it is worth trying several options before quitting. Regrettably, I would advise an emotionally dependent young woman (i.e. someone who needs the emotional support of a group of female peers, or who would feel isolated without such a group) to think twice before pursuing an engineering career just because she excels in math and science. Otherwise, go for it! It is a versatile and financially rewarding career path.

This woman, exemplifying Jorgenson's analysis, distanced herself from women with feminine qualities, adding that "[m]entally strong, socially/emotionally independent women (I include myself in this category) do not find" being in such a male-dominated field to be a challenge.[67]

Interactional and Structural Challenges, Individual-Level Solutions

Participants acknowledged extensive structural and interactional constraints, yet their advice to young women was often either gender-neutral (e.g., "Go for it!" or stating that their advice applied to both young men and women considering engineering) or relied upon individual-level solutions. As discussed above, respondents overwhelmingly said they would

[67] Ibid.

encourage aspiring women engineers to "go for it," often emphasizing perseverance, working hard, and doing or finding what they loved to be successful as engineers. For these women, advice reflected a belief in meritocracy, suggesting that hard work would provide the necessary tools for women to surmount any hurdles that may lie ahead. In some cases, women more explicitly advised that aspiring women engineers should ignore gender altogether to be successful, or to find alternative workplaces if their current jobs are unsupportive.

Such advice runs the risk of blaming individual women for their 'failures,' without acknowledging there may indeed be interactional and structural barriers to success beyond an individual's control. Similarly, advice to change places of employment ultimately doesn't challenge the problematic workplace culture. However, to operate in such a male-dominated space, the women likely had (and have) to find ways to persist in the moment, where instantaneous change to workplace culture is unlikely. Self-selection, especially among the women of this age group who persisted, may have played a role here. Women who chose engineering in the late 1960s and 1970s made what was considered to be an unusual choice. They invested their time, money, and sense of self in engineering and did not want to give up on it, so they thought strategically and found ways to stay the course in what were at times unfriendly environments. Likewise, advice, such as "don't go looking for discrimination," may not indicate that participants believed that gender was irrelevant; instead, it may reflect the reality that focusing too much attention to being a woman could jeopardize everything they had worked to achieve. Individual-level solutions allow ways for women to survive in the profession, gain some control over their work environment, and persevere in the moment.

Additionally, the firm resolve of many participants demonstrates admirable persistence rooted in the belief that women can be successful in engineering. In urging young women to own

their strengths and to stay true to themselves, especially while acknowledging likely interactional and structural challenges, respondents pointed out the potential of women engineers, something aspiring women engineers may not hear otherwise. However, although individual-level solutions might help some women to succeed, they will not help all women to do so—not because the women do not try or are incapable, but because the interactional and structural challenges are too great.

Many of the women we surveyed faced the consequences of using individual-level tactics to solve interactional and structural problems. As one explained, "our favorite quote at the time was 'you have to work twice as hard as a guy to get half the credit.'"[68] That working hard could not guarantee women career success because of the barriers they faced was so well understood it was part of their normal conversation.

Today some engineers acknowledge both the limits of individual-level solutions and the reason they implement them. As Ellyn King, a materials engineer and senior research scientist at Corning (and a woman who is younger than our participants), said to a room full of parents of middle-school girls attending a program for girls in STEM, "We need a larger cultural change, but on an individual level, pushing confidence is the best thing we can do."[69]

FUTURE RESEARCH AND LIMITATIONS

[68] Other respondents used nearly identical language to this.

Surveys of and interviews with women engineers from the 1990s also noted that to deal with the lack of appropriate networks and support systems, women would sometimes 'try to compensate for this disadvantage by working harder to prove themselves.' Catalyst, *Women in Engineering*, 17.

[69] Dr. King made this statement in a panel at Cornell University's "Expanding Your Horizons" program in April 2018. One of the authors (Ettinger) attended the program with her daughter.

Although our research here explores the nuance of gender relations that women have encountered and still face in engineering today, it is not without limitations. First, future research would benefit from including the perspectives of men to provide additional gendered perspectives. Second, while our survey did include women of color (who made up a small minority of engineering undergraduates in the 1970s), and while respondents' identities are composed of varying religions, sexualities, socio-economic origins and current socio-economic statuses, and vocational statuses, we were unable to include such intersectional analysis in this article due to the small number of responses reflecting these topics.[70]We suggest that researchers take these factors and their intersectional nature into consideration in their research methodology and recruitment of research participants . Third, though our survey provides information about our respondents' most recent job titles and some of their previous ones, it does not offer details about their full career trajectories. Therefore, we cannot determine which stories relate to which career or job, unless participants specify that in their responses to open-ended questions. Thus, we do not have enough information to explain how participants' perceptions might have been influenced by those specifics. However, our team is in the process of interviewing forty-seven women from this survey. In those interviews all of these topics, including the women's intersectional identities, are explored in much greater detail and will be analyzed more thoroughly in our future research. In addition, our findings here provide new information about the perspectives of pioneering women engineers and serve as a springboard to promote equity and greater diversity within the field of engineering.

[70] See, for example, Malcom, Hall, and Brown, *The Double Bind.*

CONCLUSION

Women engineers who graduated from college in the 1970s offer important perspectives on the challenges facing women engineers in the past and today. The beneficiaries of new affirmative action and equal opportunity programs when they began their education and careers, these women have, and had, heterogeneous perspectives and experiences. Gender is not the lens through which all of them see their experiences, and some focused on the benefits of engineering to women and in general. Many reported that once in the field, they encountered interactional and structural gender barriers to their success, citing, in particular, the challenges of not getting respect, not fitting in, and work/family balance. Yet most, even those who pointed out such challenges, encouraged young women to pursue engineering because of the rewards and opportunities the field provides. Most also found individual solutions, out of necessity, to the problems they faced. The perspectives and experiences of this generation of women engineers help us to understand how we have gotten to a place where women are still so underrepresented in the field of engineering, as well as the strategies women in the field have adopted, or sometimes felt forced to adopt, to navigate their careers and lives.

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