



Difference between Engineering Men and Women: How and Why They Choose What They Do during Early Career

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Abstract

Retention of the engineering workforce is of national importance for global competitiveness. Retention of women engineers is of particular interest because of the impact of their lower starting representation and higher attrition rate on workforce diversity. Exit rates from engineering careers are highest in the first 10 years after graduation. Thus, unlike most workforce retention research, this study focuses on participants who are still in the midst of this critical phase of their careers. We investigated what engineering graduates say about how and why they make early career pathway choices. The motivations for their choices were examined through the lens of gender differences (and similarities) while resting on the fundamental psychological framework provided by self-determination theory (SDT). SDT has demonstrated that the more behaviors are autonomously motivated, the more stable, the more fulfilling, and the more persistent those behaviors become. The current qualitative study is based on interviews with twenty-two early-career engineering graduates (eleven men and eleven women) from three geographically and culturally distinct institutions. While a majority of both men and women expressed autonomous motivations, the ways in which they were expressed imply different outcomes for career persistence. While the results presented herein do not have statistical significance because of small sample size and qualitative methodology, they do provide insight into the types of patterns that emerge from men and women in terms of how they view their careers from past, present, and future perspectives. Understanding these patterns will be helpful in identifying them among early career graduates in engineering and taking appropriate steps to support continued persistence in the field. Identification of these patterns is also helpful for designing a quantitative study that can point to the significance of gender differences in a larger population.

Introduction

What motivates men compared to women can be studied from a variety of different perspectives. Looking at the autonomy with which both men and women make choices in early career is especially useful because developing autonomy is a central goal of an undergraduate education¹ and autonomy plays an important role in predicting stability within a field or career. The higher the degree of autonomy on which an individual bases important life and career choices, the greater that individual's well-being, creative productivity, and long-term persistence.² On the other end of the motivation spectrum, controlled motivation or that deriving from external forces outside the individual is associated with progressively decreased energy in pursuing goals motivated by those forces.³ A greater look at the motivations that drive early-career men and women in engineering can provide valuable insight into why the long-term retention of women in engineering is significantly worse than retention of men in these fields.⁴ In this study, we evaluate the viewpoints of a broad range of early-career engineering graduates with attention to

how motivation to continue or not continue in engineering differs between men and women. The qualitative data from this study provides necessary information to pursue a more generalized future study that will delve deeper into the precursors to significant engineering workforce exits by women and the appropriate steps for stemming the leak from the workforce pipeline.

Background

The problem of women leaving the engineering workforce in significant numbers is of concern in the United States for several reasons. Significant shortages of engineers have been predicted for the coming years,⁵ hence calling for meaningful recruitment and retention efforts which will allow individuals, both male and female, who graduate with engineering degrees to remain in engineering careers for as long as possible. Furthermore, the fact that women drop out of engineering careers in much larger numbers than men contributes to limited diversity in these fields and can impede creativity, innovation, and global competitiveness.⁶

Unfortunately, the existing body of research does not yet provide sufficient explanation regarding the departure of both men and women from engineering careers to support interventions in the workplace to retain these individuals. We do know that women and men report leaving engineering for similar reasons as well as for different ones;⁴ thus, effective interventions can serve both men and women, or can specifically target women. Science, technology, engineering, and mathematics (STEM) differs perplexingly from other professional careers in that an advanced degree for women is more likely to *reduce* career commitments.⁷ And, contrary to popular belief, most women do not typically leave engineering careers to have children, but instead head into different careers.^{7,8}

Most career studies target women only, and mostly do so in mid to late career to understand reasons for leaving or having left engineering. A foundational study of women in STEM focused on the identification of barriers for working women's persistence, including unclear or stalled career paths.⁹ Several later studies concurred with this. In a quantitative study comparing mid-to-late career men's and women's career exit rates from STEM,⁸ dissatisfaction with pay and promotion was identified as the single determining reason for women's higher exit rates. A qualitative study of mid-career women in engineering¹⁰ and subsequent quantitative study of women engineers (about 25% in early career)^{10,11} determined that lack of pay or promotion opportunities explained the departure of most women from engineering careers. Another qualitative study of mid-to-late career Australian women in engineering identified a key reason to leave as difficulty in "recognizing the options to navigate the workplace."¹² This same study also looked specifically at reasons why women had persisted in engineering careers, determining the key characteristics to be high self-efficacy, high self-identity with engineering, and high intrinsic motivation (enjoying the challenges and novelties of the profession). Similar themes were identified in a qualitative study of engineering women of all ages, in which persistence was linked to personal factors (engineering self-identity; competing intrinsic interests) and contextual factors (barriers, relatedness, and pro-social opportunities in workplace).¹³ Understanding the prevalence of certain perceptions and barriers in the workforce is useful, but without considering men simultaneously, the contextual situations may be represented out of proportion to their influence on actions.

A few studies have looked at men and women together, allowing an opportunity to better understand what may be different between men and women. A quantitative survey of engineers reported that the most common reason for leaving engineering careers was the same for both genders: “more interesting work in another field.”¹⁴ A recent large-scale survey of engineers (N=17,000) revealed that over a lifetime, women are twice as likely as men to leave engineering, and the bulk of these exits occur for both men and women within the first 10 years.⁴ Thus many existing studies have gathered information from people many years after they have made the critical pathway decisions to persist in or leave engineering. Consequently, it seems important to look specifically at early career in order to understand potential temptations to leave *before* these tendencies turn into actual departures. Such early career studies require looking at motivation, because motivation is a critical determinant of future behavior.

Although all motivation theories share the common goal of connecting people’s behaviors to specific motivations, self-determination theory (SDT) is particularly useful because it draws important distinctions among the *types* of motivations that people experience.^{15,16} SDT identifies a continuum of motivation types, ranging from controlled to autonomous. Autonomous motivations are distinguished from more controlled motivations in that they are driven by internal rewards rather than external and reflect that an individual is self-directing his or her behaviors, resulting in greater positive outcomes over the short and long term. People who are autonomously motivated are able to participate in an activity for its own, inherent reward. On the other end of the spectrum, controlled motivations are driven more by external rewards, providing some instrumental outcome (either positive or negative) that is separate from the activity itself.¹⁷ Examples of controlled motivations in career pathways include gaining financial reward, seeking the approval of others, and finding prestige through a particular profession or position. The most controlled motivations are those that are influenced solely by *external* factors outside the individual; less controlled are those motivations that lead to the *introjected* regulation of behavior such as that associated with gaining the approval of others. On the autonomous end of the motivation spectrum, *identified* factors used to regulate behavior have inherent value to an individual’s self-identity, such as is the case with altruistic activities like a desire to serve society. Though these rewards may be extrinsic (separable from the activity), the positive psychological outcomes are those associated with autonomous rather than controlled motivations. The most autonomous of motivations are those driven by *intrinsic* rewards and involve activities pursued for their inherent interest and enjoyment. These four levels of behavior regulation¹⁶ can enable us to identify where individuals are along the controlled-autonomous motivation spectrum and thereby, deduce the stability and positive (or negative) contribution these motivations can make to well-being and persistence over the longer term view of an individual’s career.

Our study uses this continuum of autonomy to understand how autonomous an individual’s motivations are and therefore, how likely they are to thrive and persist in a chosen career. We focus on gender differences because of the large gap between the (more successful) retention of men and the (relatively poor) retention of women in the engineering workforce, and also because existing research has suggested that engineering may be particularly susceptible to departures by women because of its male-dominated status.⁸ Thus, in order to stem the tide of departure, it is important to understand not only what motivates women (and subsequently what is likely to prompt them to leave the profession), but also what is unique about these motivations when compared to male engineers at similar times in their careers.

Methods

For this analysis, 11 men and 11 women were interviewed during 2010. All interviewees earned their first engineering degrees between 2000 and 2006. This analysis is part of a larger study (described in Figure 1) that began with a screening survey designed to elicit basic demographic information and completed by 630 participants from three different higher education institutions. From this screening survey, target populations were then selected and recruited for interviews. In this study, screening survey participants were then filtered to identify those who majored in the three most populous engineering majors (civil, electrical, and mechanical engineering) among the majors represented in the entire participant pool and 78 interviews were conducted which oversampled for women but included those in early, mid, and late careers. This interview pool was further filtered to include only those engineering graduates in early career, resulting in 22 total interviews for this part of the analysis.

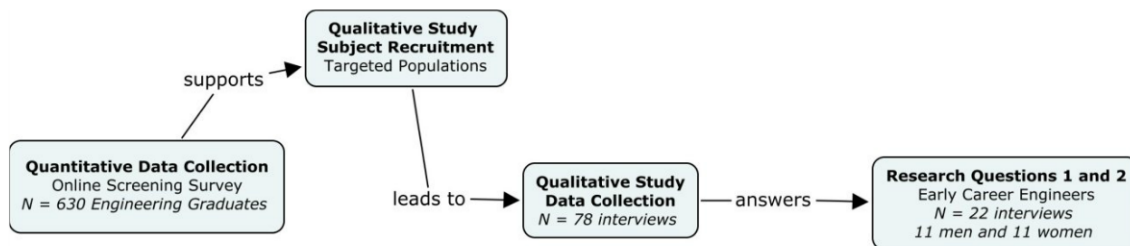


Figure 1. Research Design

The demographics of this early career interview pool are summarized in Table 1.

The interviews included questions that emphasized reasons for choosing engineering as a major, perspectives on engineering as a career, and views on the ideal career. Interviews followed a semi-structured protocol, including guiding questions and probes designed to explore motivations for choosing and persisting in engineering as well as other career options. The interview questions are summarized in Table 2 according to their relevance to the research questions for this study. Interviews were conducted either in person or by phone. In most cases, interviews were audio recorded and transcribed. When recording was not possible, extensive field notes were taken by the interviewer.

Once transcribed, the interviewees and field notes were analyzed using a grounded theory approach to identify emerging themes of what was motivating these young engineers in their career pathway choices.¹⁸ After the initial coding, motivations were subdivided into categories of increasingly autonomous regulation of behavior: (a) external, (b) introjected, (c) identified, and (d) intrinsic.

Table 1: Participant Demographics

Characteristic	Women (N)	Men (N)
Ethnicity		
Caucasian	9	9
Asian or Pacific Islander	1	2
Hispanic	1	0
Married		
Yes	8	4
No	3	7
Children		
Yes	2	2
No	9	9
Persisting in Engineering Work		
Yes	9	8
No	2*	3*
Total	11	11

* Two of the men and one of the women had never worked in engineering post-graduation.

Table 2. Interview Questions

Used to evaluate the Research Questions:

- Would you tell me about why you decided to pursue engineering?
 - Tell me about your engineering workplace experiences.
 - Tell me about critical moments for you related to engineering. What experiences have tended to draw you towards, or push you away from, engineering?
 - Describe your ideal job, if constraints were not an issue.
 - If you had all the time (or all the money) in the world, what would you be doing?
-

Not used in this study:

- Walk me through your engineering education experience.
 - In what ways, if any, has your worldview/faith/spiritual life impacted your choices regarding engineering?
 - What do you see as your roles in life? In other words, fill in the blank: "I am a _____."
-

Research Questions

Two research questions were addressed in this part of our study.

Research Question #1:

What patterns of motivation were expressed similarly by men and women engineering graduates in early career?

This question is important because considering the motivations of early-career engineers will allow insight into the career pathway decision processes at the very time when critical persistence choices are being made. Understanding what men and women have in common allows a better perspective for interpreting findings relevant to the engineering experience as a whole. Issues that are the same for men and women might be interpreted quite differently than issues that are only experienced by women. Further, interventions designed to enhance career persistence might look different, depending on the goals.

Research Question #2:

How do men and women express career-pathway motivations differently?

This question is important because women's persistence is substantially lower than men's. Once the motivations that men and women hold in common are identified, the remaining differences should then provide insight into persistence differences observed by gender.

Results

We interviewed eleven men and eleven women 4 – 10 years after they earned their first degree in engineering. Most men and most women expressed at least one type of controlled and one type of autonomous motivation for their engineering careers. For both men and women, the motivations behind their engineering career pathway decisions (past, present, and future) typically included multiple types of motivation across the spectrum from controlled to autonomous. Within each autonomy level of motivation, however, different categories of motivation were revealed that often did differ markedly with gender (Table 3).

Research Question #1:

What patterns of motivation were expressed similarly by men and women engineering graduates in their early career?

There were a number of striking similarities in the ways that male and female early-career engineering graduates discussed their motivations related to career pathway decisions. Both genders displayed all four levels of autonomy (intrinsic, identified, introjected, and external motivations), generally with comparable frequency.

Intrinsic

Intrinsic motivation is the most autonomous form of motivation and therefore the most stable and most strongly associated with a wide range of positive psychological outcomes. A majority of both genders in this study population (8 of 11 women and 8 of 11 men) expressed intrinsic motivation to pursue their engineering careers (Table 3). An additional three men who were no

longer working in engineering also spoke to their intrinsic motivation to remain in their new career fields.

Table 3: Types of Motivation Expressed by Early-Career Women and Men regarding Engineering Work

Motivation Type	Number of Women	Number of Men
AUTONOMOUS	8	8 (10*)
Intrinsic	8	8 (10*)
<i>Technology</i>	<i>1</i>	<i>6</i>
<i>Business/People</i>	<i>7</i>	<i>2</i>
<i>Problem Solving</i>	<i>7</i>	<i>2</i>
<i>Non-Engineering Career</i>	<i>0</i>	<i>3</i>
Identified	4	4
CONTROLLED	9	7
Controlled only (no autonomous)	3	1
Introjected	8	4
<i>Contingent Self-Esteem</i>	<i>7</i>	<i>0</i>
<i>Approval</i>	<i>3</i>	<i>1</i>
<i>Prestige</i>	<i>3</i>	<i>3</i>
External	6	4
TOTAL	11	11

*2 of the men had intrinsic motivation *only* for a non-engineering career path

Intrinsic motivation was identified as a passion or enjoyment for the work of engineering. Those who expressed this level of love for their work typically also expressed a confidence about it being the best (or only) path for them to pursue. For example:

So once I got on fire in late college and got an opportunity in my profession,
I've never questioned this is what I was born to do. (Brent)

Typically, intrinsic motivation is indicated by a person feeling the appeal of activities because they hold "novel, challenge, or aesthetic value."¹ Kristen expressed these aspects regarding her engineering work:

The days I work that are really good are the days that ... you did something that was difficult or was interesting and you were successful whether that means you were just making progress on it or you actually, you know, solved some problem that you were working on. (Kristen)

While the aspects of engineering that appealed most to participants varied somewhat, the consistent theme for both genders was that intrinsic motivations, the most autonomous of motivations, were expressed by the majority of both women and men in this study population.

Identified

The next level of motivation along the autonomous-controlled continuum that participants discussed in interviews was that of *identified* motivation. Men and women seemed to express identified motivations at a comparable frequency. Four of eleven women and four of eleven men expressed this for their engineering work (Table 3). (An additional three men who had already left engineering careers expressed identified motivations for their new career field.) Overall, fewer participants expressed identified motivations than intrinsic motivations. Further, while it was not clear if one of these types of motivation might have appeared first or driven the other, no person in this study population expressed an identified motivation without also expressing an intrinsic motivation.

Identified motivations are those in which the reward for an activity is separate from the activity itself, but is highly valued by the person because it coincides with his or her own sense of what is important, based on self-defined identity. In this study, participants expressed identified motivation for their career pathways in terms of a desire to serve society. It was typically expressed when the subject was asked to describe their ideal job or life activity if money, time, or other constraints were not an issue. For example, Emma's dream job would be with the non-profit organization Engineers without Borders:

... working for a group of some kind that does biomedical work, either Engineers without Borders or there's a similar group for medical technologies ... something to do with engineering, maybe not biomedical, yeah not necessarily biomedical, but some sort of engineering with the third world type, making and creating technologies to improve quality of life. (Emma)

Consistent between the genders, a comparable population of male and female engineering graduates expressed identified motivations for their engineering work, at rates lower than they expressed intrinsic motivations, and never in the absence of intrinsic motivations. Identified motivations were mostly within the theme of service to society although a few (both men and women) also discussed that they valued finding work that would make use of the time and effort they had invested in their engineering degrees:

After finishing my degree, I wanted to focus on engineering ... pick a career path by starting to use what you learned in school.... Engineering was the key where I could apply my skills and technical background. I wanted to use everything before I forgot. (Joseph)

Introjected

The next level of less autonomous motivation is *introjected*. Introjected motivation is a form of controlled motivation in which the rewards or punishments have been internalized. Three types of introjected motivation were expressed by the participants: contingent self-esteem, approval, and prestige (Table 3). Men and women expressed the only prestige motivation similarly; it was observed among three of eleven women and three of eleven men. These participants believed an engineering career in general to be prestigious, and they were motivated to obtain that esteem

from others through persisting in engineering work. Phil expressed this motivation as valuing what people outside of engineering thought of him and his work:

I just want to feel like I am having a meaningful impact on other people's lives and ideally that people who aren't in my particular area of expertise will know and recognize, you know, what I'm doing. You know, think that it's important too. (Phil)

Kristen also perceived engineering as particularly prestigious, and this was an important part of her self-concept. When she felt the prestige of her job was being questioned by the construction site workers whom she was supervising, she reported that it was the final straw that led her to leave her B.S. job in civil engineering and enroll in graduate school.

[He said to me,] 'Now, how much school did you have to go through to get that job? Because I'd like to have your job, because it looks really easy.' And I was so insulted and frustrated and angry and I thought, 'You know, I did get a college degree and I'm telling somebody what size rocks to pick out of topsoil. I don't want to do this anymore.' And I kind of came home after that day and said, 'I... I could be doing something; I could be doing something better. I don't want to do this.' And I started looking at grad schools. (Kristen)

Because it is not as likely to support long-term positive outcomes, introjected motivations like prestige are not as desirable to build career persistence among engineers. It does seem likely to be at least one of several factors, however, that influence both men and women to persist in engineering.

External

The least autonomous motivations are *external*; these seemed to present in approximately the same way for men and women participants. External motivations appeared among this population as financial incentive for engineering careers; all participants who expressed external motivations (6 of 11 women and 4 of 11 men) did so by acknowledging the importance of an engineer's strong financial compensation as motivating, in full or in part, their persistence in an engineering career. There was not an obvious gender difference in how the external motivation was expressed. Among both the men and women, some were initially interested in pursuing an engineering degree at least in part because of the prospect of a good income:

I heard engineers made a lot of money so I was like, 'Hey that's a great idea.'
(Sarah)

I'm from a very blue collar family and I knew I wanted to do well for myself. Not crazy, but I wanted a boat and whatever. I wanted a decent paying job that was interesting and I was really good at so engineering just made sense.
(Brent)

After beginning work as engineers, some indicated that the money was one of several motivating factors for them continuing:

To some extent I would say that the money is an encouragement to stay in it because it certainly pays your bills and it's a decent paying job and I think the opportunities that it brings are also a reason... (Marilyn)

For me, engineering is more, kind of something that I enjoy, but it's a means to an end, and a way to be able to do other things in life. (Jacob)

A few participants indicated that money was really the main incentive motivating them to persist in engineering careers:

So ... I guess I'm just at [my company] for the paychecks and the vacations and my heart isn't really at [my company].”(Sarah)

It is not necessarily problematic for engineers to appreciate, and in fact be motivated by, being well-compensated for their work. It becomes more of a concern if highly controlled motivations (external or introjected) are the *only* incentives for career persistence. In this study population, this was a relatively small group (3 women and 1 man). What was similar among these four participants was that both the man and women who expressed only controlled motivations also displayed lower self-confidence regarding both engineering work and their career pathway choices than those participants expressing some autonomous motivations.

For those participants who lacked the autonomous motivation, a universal expression of low self-efficacy emerged, particularly with regard to more technical tasks. For instance, Jacob seemed to be planning his career by avoiding weaknesses rather than identifying and pursuing strengths:

So I've felt that originally, 'Oh yeah, the technical track would probably be better, you don't have to deal with the people issues so much.' But the more I've thought about it the management route would be more the way I'd go just because technically I don't feel as solid in as many areas I feel would be necessary. (Jacob)

The low self-efficacy of this controlled motivations group sometimes seemed to result from a combination of perfectionism and fear of failure. Lucy, for example, took a teaching job for several years after graduation because she felt ill-qualified to work in engineering. Only the combination of also struggling in her teaching job and an engineering friend's encouragement to apply for a job in the friend's company brought Lucy back to an engineering job.

I think at that time I wasn't really feeling, like, confident and prepared to go into engineering. I think I just had some... I don't know, just kind of like, life skills or kind of like, work experience skills that I didn't really have. (Lucy)

Similarly, Sarah, after dropping out of graduate school in aeronautical engineering due to poor performance, seemed somewhat surprised that she would still be hired for an electrical engineering job based on her bachelor's degree:

So I moved back home, packed up the car and just got a temporary job while I was looking for electrical engineering jobs and... finally got an interview ... and learned about what consulting engineering was. And he hired me just – I'm not sure why – because I didn't know about what the job was. (Sarah)

Thus, while many participants expressed controlled motivations for their work, those few who also lacked the autonomous motivations, whether male or female, seemed to have much lower self-efficacy for their engineering work than those who simultaneously expressed intrinsic motivation.

Research Question #2:

How do men and women express career-pathway motivations differently?

In general, as illustrated by Research Question 1, men and women in this study expressed similar types of motivation (in terms of levels of autonomy). However, the specific manifestations of these motivational types often looked quite different between the genders. These differences appeared in the ways that women or men expressed intrinsic, identified, and introjected motivations.

Intrinsic

While it was typical of both men (8 of 11) and women (8 of 11) to speak with enthusiasm about their enjoyment of their engineering careers, a striking gender divide emerged over which aspects of engineering jobs participants focused their passions. The particular ways in which participants displayed *intrinsic* motivation sorted into four distinct categories. The first three were compatible with engineering careers: working with technology, working in roles involving business and/or interactions with people, working on complex puzzles, challenges, or problem-solving activities. The fourth category was a strong intrinsic interest in a non-engineering career field; three men revealed this motivational type, with a strong intrinsic drive to pursue work in photography, the priesthood, or as a pilot (Table 3).

Six of the men focused on their love of technology. For example:

I have never lost my love of science and technology. It is pretty fun to always work with technology and new stuff. To have that understanding, to see that gadget on the shelf, to have that understanding of how it works and why it works. (John)

... I like the engineering side. I like math. I like building stuff. I discovered later – actually, I developed a passion later...for the field, for the coursework. It wasn't as much linear algebra and math stuff; it was taking some of that and building circuits and stuff. You know, projects – taking that stuff and using it and that was really cool. So I really got excited. (Brent)

Whether interested in how things work in general, or in new gadgets and high-tech items, or math and science, or more hands-on building, these men were distinctive in that the activities they find inherently motivating and enjoyable would be best fulfilled through an engineering career. For example, other professional career fields would be unlikely to provide as much opportunity for direct and regular interaction with the technology about which many of these men expressed enthusiastic interest and passion

In a sharp contrast to these six men, only *one* woman spoke with passion about her interest in technology in and of itself. Instead, most women chose to discuss their engineering careers in terms of their interest in business- and people-related activities (7 women) or an enjoyment of solving problems and challenges (7 women). (The business/people motivation was consolidated

to one subcategory because it always appeared together for the same people, and because it was often commingled in a single participant comment.) For example, Beth was drawn to the business side of engineering both for the skills necessary to do these jobs and also by the increased opportunities such jobs created for working with people:

There's engineering involved, definitely, but we work a lot with clients, there's a little more of a business side than maybe some other research-based type jobs. So I like that as well because I definitely like engineering and want to do that but I appreciated that there was some more interaction with different people and clients as well as business stuff. (Beth)

Likewise, Kristen enjoyed preparing business-related proposals as well as interacting with clients:

I do think I would enjoy interacting with the client more... or even you know, going after proposals or going to meetings and that, that side of it. I know that that part of it can get difficult too but um, I, I like that side of it. (Kristen)

Marilyn, while reflecting on her ideal job if constraints of time and money were removed, expressed a desire to connect more deeply and personally with her co-workers much more than an interest in any particular technology:

I could spend more time with people during the day and, you know, really spend time understanding, you know, the new engineer we just hired. What does he want to do and is he doing what he wants to do and can I help him move in to that next job that he wants? Rather than saying, 'I need these three things by noon so that we can get these things done.' (Marilyn)

Regardless of the degree of technology or business/interpersonal focus of their original or current assignments, these respondents expressed career intentions to gravitate towards positions with an increasing amount of management responsibilities and interactions with other people. This pattern of intrinsic motivation also emerged with respect to a generalized interest in solving challenging problems. For example, Annie stated:

[I like] the challenge, I like a good variety of work. I would hate to come in to work every day and know exactly what you're going to do and have it be the same every day. It wouldn't be that fulfilling for me. (Annie)

Some men also expressed these non-technology types of intrinsic interests (2 men for business/personal and 2 men for challenges/problem solving). For example, Caleb reported:

I have always been driven by puzzles or complexity. I love challenge. It has to have something interesting to it. (Caleb)

By a wide margin among our interviewees, however, the technology-focused intrinsic motivation was more frequently expressed by men and the non-technology types of intrinsic motivations were more frequently represented by women.

Identified

Two distinct categories emerged by gender within the *identified* motivation. These correlated closely with either the intrinsic motivation categories of technology or with business/people. Since these intrinsic motivation categories were strongly gender-segregated, the corresponding categories in identified motivations were as well.

While almost all of the identified motivations manifested as a desire to serve others by solving problems, the ways in which men and women typically described doing this did differ. The first category of identified motivation included those who described a dream job in which one could provide a technological solution to a significant problem that would help society in general.

While still clarifying his goals, Phil indicates that he would like to work in technology to identify and solve problems whose solutions would matter to humanity:

Yeah I think my ideal job ... is not that far off of what I have, which is basically the freedom to go explore and find ... important problems that need to be solved which I think, like, energy and such are the kinds of large-scale problems that I'd like to approach, and then use my particular expertise in an area to actually hack away and build prototypes and um...chip away and see if you can find answers to those problems. (Phil)

Phil's identified motivations correlated to his intrinsic motivation – a love of technology.

In contrast to Phil, Marilyn's intrinsic motivations were oriented toward business and people rather than technology. Accordingly, when Marilyn reflected what she would do with all the time and money in the world, her identified motivations were expressed with a focus on the people she would like to serve much more than the importance of using technology to do it:

I'd probably be doing more, like, volunteer work where I could actually see that what I did was making a difference for people's lives. So, I don't know if it would be, like I mentioned earlier, the counseling thing of helping people in that way or even just keeping hands on helping people, you know, organize their lives somehow, or, I don't know. Organize some kind of a business that helps people like a Goodwill type of store or, something, somehow using I think my organizational skills but directly helping people every day and people who need help. Not just helping people have another car. (Marilyn)

Marilyn, motivated by her desire to apply her intrinsic interests in business/people, seeks to also meet her identified motivation for serving people, perhaps through the management of a non-profit store. Annie, another participant with business/people rather than technology-focused intrinsic motivation, was happy to be helping people through her work as a civil engineer, but the focus in her comments was less on the technology and more on the people whom she saw as being helped by her work:

I've spent a lot of time doing outside inspection and working very closely with the public and with the city's municipalities and for me I really enjoy that part of work. The public interaction, I guess knowing what we're doing is something positive to the people around, you know. (Annie)

Thus, while both men and women expressed identified motivations to serve others, the men, corresponding to their intrinsic interests in the technology itself, focused more on the technology they would like to use or develop to bring about solutions of value. Women, corresponding to their people-oriented intrinsic interests, were instead focused on the people they would like to be helping than on the technology they would like to use to do that.

Introjected

Finally, men and women expressed distinctly different forms of *introjected* motivation as well. Introjected motivations were commonly expressed by women (8 of 11) and less so by men (4 of 11). In addition, the specific ways in which introjected motivations were expressed was substantially different by gender. While the prestige motivation was expressed similarly by men and women, contingent self-esteem and approval motivations did vary by gender (Table 3).

Contingent self-esteem was defined as participants expressing some of their sense of self-worth from the opinions that they believed others held about their engineering work. Interestingly, this form of self esteem was expressed by 7 of 11 women, but none of the men. For example, Sarah describes wanting to continue engineering work in part because her colleagues now trust her to take on a large task:

At work I feel like I was finally trusted to take on a big project of purchasing a machine tool that was about \$800,000. And I think that was satisfying that people finally trusted me to do a project that big....I've been working on it for a couple of years So it's really rewarding to be able to do that by myself and conducting meetings by myself and finally felt like I was grown up and doing a project by myself. (Sarah)

Contingent self-esteem also included an element of ego, in which participants expressed how their engineering work was related to their self-concept. For example, when Kristen was asked about her dream job, she envisioned a position with more opportunities to be personally recognized:

The person who gets to win the big projects and gets to, you know, have their name first on the projects and gets to supervise all the other, all the other engineers and gets their hands in all the projects. (Kristen)

In various ways, contingent self-esteem tied a person's self-concept to their career productivity.

More specific than a general sense of self-worth was approval. Approval is an introjected motivation in which participants expressed pursuing engineering specifically because they believed it gained them some approval from another person of importance to them. While only a few participants expressed this motivation, there was an indication of a possible gender difference. Three of the eleven women expressed this type of introjected motivation, each in relation to receiving the approval of her father. For example, Trudy clearly felt this approval from her father because of her choice to study engineering:

[Studying engineering was a] positive for my dad for sure. He was excited that I was doing engineering. (Trudy)

One of the eleven men expressed an approval motivation, but Chien was focused on the approval from his co-workers (not his father) as a motivating factor for persisting in his engineering career:

Some employees break the software and I try to fix it quickly to make it better. It makes people happier when my products are...that's what I do. They're good that way....Because it's easy to repair quickly and make people happy.
(Chien)

Thus, while both men and women expressed introjected motivations, women were much more likely to do so. Further, men were likely to express a motivation by seeking a general sense of prestige, or in one case, approval from co-workers. Women, by contrast, were similarly motivated by prestige, but seemed much more likely to be motivated by a sense of self-esteem tied directly to engineering career performance. A minority of women (but no men) were also motivated to start or persist in engineering because of a paternal influence.

Controlled

Controlled motivations are those that are driven by an external locus of control. As categorized in this study, these would include external and introjected motivations. Certainly, a majority of both men and women expressed supportive autonomous motivations for their engineering careers. However, of the four (of 22) who expressed *only* controlled motivations, three were women and one was a man (Table 3). While these numbers are too small to be conclusive, they are suggestive of the possibility that there is a gender difference such that women are more likely to lack a supportive autonomous motivation of some sort.

Discussion:

This study has sought to identify gender-related patterns in the types of motivations that are involved in career pathway decisions of early-career engineering graduates. We have found that within the first ten years of graduation, the majority of both men and women express some form of intrinsic motivation. Because this most autonomous type of motivation is associated with a number of positive outcomes, including productivity, creativity, and long-term persistence, this finding is very encouraging in terms of the future of the engineering workforce.

However, striking gender differences were discovered in the specific ways that women and men feel intrinsically motivated for engineering work. For the seven individuals (6 men and 1 woman) who expressed a technology-focused intrinsic motivation, it was clear that they would continue to work within engineering throughout their careers; this was where they could best live out their passion through their work. In contrast, while the participants with only non-technology focused intrinsic motivations (7 women and 1 man) were also typically committed to their careers, they were not typically as committed to engineering. Most of these individuals had longer-term career plans to progress into more business-oriented or project management roles, some within and some outside of engineering.

There were several other key gender differences in motivation. Women's (introjected) motivation to pursue engineering, but not men's, is substantially affected by how their self-esteem is dependent on their perception of their engineering performance. Thus, women could be much more vulnerable to engineering career exits due to self-efficacy deficits. The hint that women are

more likely than men to experience the absence of any type of autonomous motivations also corresponds to a higher long-term attrition risk for women.

Gender-Essentialist Difference for Intrinsic Technology Motivation?

Since the gender divide for intrinsic motivations was so strong, it begs exploration of the reasons behind it. One potential explanation for this is a gender-essentialist one, that these interests of men for technology (objects) and women for social orientation are in fact gender-linked. Indeed, this is consistent with a popular conception of gender supported both empirically and theoretically. For example, recruiting campaigns to draw more women students in STEM fields often appeal to the social aspects of the job, assuming this will appeal to women better than technical appeals. In studying engineers a generation or more older than the early-career engineers of our current research, McIlwee and Robinson concluded that interests in engineering work were much more likely for men than for women to involve fascination or even obsession with technology.¹⁹ Also among an older population than our current study, Brainard found that women *students* in engineering displayed both less interest and a declining interest in engineering compared to men.²⁰ More recently, Webster's interviews with IT workers (not exclusively engineers) who were mostly about a decade older than our study population revealed that women liked IT for everything "except the love affair with computers."²¹ Faulkner has theorized that women engineers are more likely to distance themselves from technology because it then culturally forces a rejection of close social or emotional relationships, which feels gender inauthentic for most women. In contrast, love of technology for men is a way to enhance their masculine identities by granting to themselves a role of power and mastery.^{22,23}

If there is actually an essential, gender-linked difference in intrinsic technology interest, then an appropriate intervention probably includes better supporting and valuing the non-technology-focused intrinsic motivations of women. The social/technical dualism is fundamentally a part of the nature of engineering work, but how these various skills are valued is open for change. Trevelyan's extensive observations of the engineering workplace have confirmed both that (a) the "social" aspects of engineering work (communicating, coordinating, managing and influencing people, etc.) are central to most engineering job roles and (b) these social tasks are rarely credited by engineers themselves as being "real" engineering work – a label usually reserved for more clearly technical activities.^{24,25} An ethnographic study by Faulkner agreed that many engineers will describe only explicitly technical tasks as "real engineering work," but also found that engineering workplaces differ widely as to the prevalence and degree of this attitude.²⁶ Faulkner has concluded that this dualism is a gender issue: defining "real engineering" as exclusively the technical skills maintains the status quo of defining engineering with traditionally masculine traits. However, the findings of our current study suggest that perpetuating this myth of devaluing the less technical aspects of engineering may also perpetuate the higher attrition of women from the engineering workforce.

There is prior evidence that negotiating this social/technical dualism is a part of persistence for women. A study of mid-career women engineers who had persisted happily in the workforce observed that, unlike many other reports that engineers only consider strictly technical tasks to be "real engineering," these persisting women were likely to describe these field-independent skills and activities (the non-technical, or "social" skills) as the *most important* to engineering work.²⁷ It raises the question: is persistence for women (versus men) much more dependent on finding a workplace culture that fully embraces the technical/social dualism? In other words, will

the longer-term workforce retention of these early-career women engineers depend on whether they are able to integrate their intrinsic independent motivations with their understanding of engineering and their own engineering identities?

Gender Difference for Intrinsic Motivation Develops from Engineering Experiences?

While there are interventions that could and should be taken to better support engineers whose intrinsic motivation is not technology-focused, it is not conclusive that technology is truly the domain of men. In fact, all of the women in our study did express an interest in math or science, stemming from before college. Faulkner has also reports that most women are initially attracted to engineering for the same reasons as men, including being excited about technology.²⁸ Hughes found intrinsic interests in technology among her qualitative case studies of women science, technology, engineering and math (STEM) undergraduates.²⁹ Thus, it is very possible that the observed gender difference for intrinsic specific interest for engineering is not an innate gender-linked difference so much as it is somehow developed throughout the engineering experience. If men and women experience their engineering studies and workplaces differently, it could be changing their intrinsic motivations over time.

In fact, it has been well demonstrated that the social environment (specifically, the degree of autonomy support, relatedness, and competence-enhancing feedback) can affect both the development of new intrinsic interests and goals^{30–32} and the deepening of pre-existing intrinsic interests.¹⁵ Even the experience of the physical environment has been shown to impact whether people form new intrinsic interests.³³ Collectively, prior research has demonstrated that intrinsic interests and motivations are *not* necessarily static. If women are displaying significantly different intrinsic motivation patterns, as our research has indicated, it could be a result of them experiencing the social and/or physical environment of engineering differently from men.

Limitations and Implications

Limitations: We recognize that in drawing data from only three engineering majors and three institutions, the generalizability of our findings may be limited. However, the inclusion of three diverse majors in the study does allow for the representation of a wide range of early career experiences in engineering. Despite the relatively small size of the data set, we feel that our findings are valuable, as they provide insight not only into what kinds of choices early career graduates in engineering have already made but also what kinds of choices they are considering for their futures.

Implications: Overall, the presence of autonomous motivations for engineering work among early-career engineering graduates is heartening. It bodes well for the future retention, productivity and psychological well-being of these newest engineers. Unfortunately, the gender-linked differences in intrinsic motivation that were identified imply future difficulties in retention of women engineers, in particular. A majority of men express an intrinsic motivation for technology, meaning that engineering is likely to be the only career field where they can satisfy this interest. By contrast, most women express an intrinsic motivation for aspects of engineering which are important for, but not exclusive to, engineering work. In other words, women can pursue intrinsic interests in business, interactions with people, and solving challenging problems in a variety of professional career fields. This means that in order to retain women in the

engineering workforce, engineering employers may need to out-compete a number of other viable career pathways.

For retention of more women in the engineering workforce, it seems that multiple approaches are needed. First, this research could help to explain the mechanism by which identified barriers for women in the engineering workforce are such a problem. If women, in general, are intrinsically motivated towards job activities that are not unique to engineering, then there is no particular “pull” to retain women. Thus, when barriers are encountered, there is no resistance to these “pushes” that send engineering women to careers in other fields. Thus, to increase retention of women, engineering employers and academia must seek ways to:

- 1) increase intrinsic motivation for technical aspects of engineering to increase the pull to engineering, by improving the social/relational and physical environment such that new intrinsic technology-focused motivations can be “caught” and existing ones can be deepened
- 2) reduce barriers that push women into other fields, so that those with only non-technology intrinsic motivations have no reason to leave for other career pathways
- 3) revise the social/technical dualism context of engineering so that both types of contributions are appropriately valued.

Concluding Remarks

Women and men early career engineering graduates display many of the same motivations for their career pathway choices. Still, how women and men discuss what intrinsically motivates them in engineering is substantially different. Interventions to support retention of women would involve redefining the culture of engineering so that the expressed values of the profession better aligned with women’s intrinsic motivations, and improving the cultural climate so that women could experience growth in technology-related intrinsic motivations as well. Both of these interventions would have the added benefit of better retaining the men with these non-technology intrinsic motivations. Keeping more of the engineers, male or female, who love working with people, interacting with business, and all of the other “social” tasks typically not emphasized in an undergraduate engineering science course, would provide for a true diversity of the engineering workforce.

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