

AC 2010-441: "IT KIND OF CHOSE ME": AGENCY AND INFLUENCE IN WOMEN'S DECISION TO MAJOR IN ENGINEERING

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Introduction

Much of the research regarding undergraduate women in engineering approaches the issue in terms of persistence or retention, examining factors influencing women’s choices of major and career. Originally this work was driven by alarming data suggesting that women leave engineering at higher rates than men.^{1,2} More recent studies suggest that women and men leave engineering at equal rates during the college years.^{3,4}

Factors influencing persistence and attrition are often similar for men and women, but there are some important differences. For example, Atman⁵ reported data from the Academic Pathways Study in which seniors identified motivating factors in their decisions to study engineering. Intrinsic psychological factors (liking engineering as a subject or field) and intrinsic behavioral factors (liking what engineers do, e.g., play with equipment) were most important for women and men alike, followed by the opportunity to work for the social good, financial rewards, mentor influence, and parental influence. However, a significantly higher proportion of men identified intrinsic behavioral motivation ($p < .001$), and significantly higher proportions of women identified mentor influence ($p < .001$) and parental influence ($p < .05$). Interestingly, there was no significant difference in proportions identifying social good.

These findings echo those of earlier studies⁶ in which students reported interest and ability in science, technology, engineering, and mathematics (STEM), attraction to applications including helping people/society, building/designing, environmental protection, and space exploration, positive high school experiences, enjoyment of tinkering with machines, job prospects and the versatility of an engineering degree as preparation for numerous fields, and the social standing of engineers as factors influencing their decision to pursue engineering. Women reported significant sources of encouragement in their pursuit of engineering including their own interest in the subject, their parents, employment opportunities, and peers.

Gender, however, is only one lens of analysis, and some researchers have begun to consider intersectionality within engineering, that is, how multiple categories such as race, class, gender, sexual orientation, and ability influence experiences of engineering. Foor, Walden, and Trytten⁷ described the experience of one multi-racial, working-class female student in engineering, considering how race, class, and gender influenced her experience as an undergraduate. Eglash⁸ considered power relations at the intersection of race, gender, and nerd identities. Similarly, we sought to consider not only gender in our analysis, but also culture, language, family, and other influences that emerged through our interviews.

Lichtenstein and colleagues⁹ note that students’ decision-making about careers can be influenced by a wide range of factors including students’ perceptions, experiences, and even chance events, which are necessarily limited in certain ways. It is not unusual for students to experience ambivalence or indecision, perhaps reflecting the strong role of serendipity.¹⁰ Yet Lichtenstein et al.⁹ also note that studies of engineers’ career decisions are few and mostly based on quantitative surveys, which may not capture the process of decision-making.

Continuing the lines of inquiry described above, we explore the attraction of students to engineering in our setting, a private liberal arts college for women. To complement existing survey research with undergraduates, the present study uses students' responses to semi-structured interview questions to illuminate the role of agency in the decision-making process that impels them to choose an engineering major in a women's college context. Key research questions include: Why did these students choose to major in engineering? To what extent did influential others impact this choice? And, does students' agency in making the decision impact their interest in and commitment to the engineering program?

Although some contend that students enrolled in a private women's college are incomparable as a population to women enrolled in coeducational private colleges, findings from Langdon's large (N = 1016) quantitative study using data from UCLA's Cooperative Institutional Research Program suggest that findings may be largely transferrable.¹¹ Controlling for the selectivity of the institution and the geographic region, Langdon found only minor differences in socioeconomic status between women enrolled in single-sex and coeducational colleges, with students enrolled in women's colleges more likely to come from families with lower incomes. Additionally, although there were significant differences between groups in the frequency of factors identified as "very important" in selecting an undergraduate institution, the rankings of "very important" factors (e.g., "good academic reputation" and "graduates get good jobs") were quite similar with the top seven of twelve ranking in identical order. Consistent with our qualitative approach, however, our intent is not to produce widely generalizable findings, but rather to unpack these students' perceived choices and constraints, both internal and external.

It is important to note that this study uses student interviews in which questions regarding these decisions are answered retrospectively. Therefore, responses will be understood, to an extent, as the students' reconstructions of these decisions, influenced by intervening experiences. Rather than hindering the purpose of the study, this aspect of it will allow exploration of the narrative-in-progress that takes place as one's academic and professional identity is forming. Blee¹² cautions that "the events in most lives can be seen as fairly haphazard or can be arranged to look like a quest for answers to personal or social problems. We must be careful not to create explanations that become a template to which all evidence can be shaped," (p. 29) and for the qualitative analyst this is sound advice. However, psychological research suggests that individuals often do precisely that in telling their own stories, constructing a narrative identity through recounting past events or 'autobiographical reasoning.'¹³

Shaping one's own narrative may itself constitute an assertion of agency. Emirbayer and Mische¹⁴ conceptualize an iterational element of agency as "the selective reactivation by actors of past patterns of thought and action...helping to sustain identities, interactions, and institutions over time" (p. 971). This conceptualization meshes with autobiographical reasoning in its focus on the selective nature of recall. In developing their argument that agency has a temporal component and adapts to changing circumstances, the authors cite Mead's 1932 claim that we "get hold of the conditions of future conduct as these are found in the organized responses we have formed, and so construct our pasts in anticipation of that future" (emphasis added; p. 76).

There are many different conceptualizations of agency, though, and the debate in the literature regarding theoretically free actors, genderless, raceless, and classless, is at times contentious. Some feminist theorists argue that the very concept of agency is built on a foundation of the false

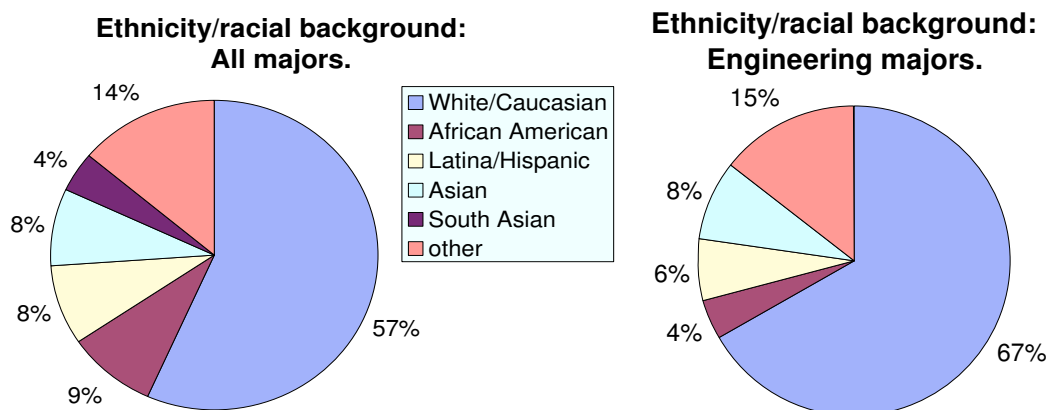
dichotomy of male instrumentality versus female expressiveness, or alternatively, action/emotion or doing/feeling, and the erroneous assumption that these are intrinsic, sex-based traits rather than expressions of the internalization of socially constructed gender roles.¹⁵ Furthermore, this conceptualization denies the complexity of social circumstance and behavior. Bartky notes that “‘action’ tout court is not incompatible with the agent’s being wholly determined by factors outside her control” (p.178).¹⁶ Here we seek to investigate how expressions of agency are embedded in narratives that often explicitly underscore the influence of others.

Methodology

Sampling and Recruitment. The study took place on the campus of a four-year private liberal arts college for women. In the liberal arts context students at the college are encouraged to explore a range of disciplines in consultation with their academic advisors, and are not required to declare a major until the end of their sophomore year. Therefore, students’ narratives often reflect decisions in process or recently made, or under reconsideration.

The registrar of the college provided a randomly generated list of students’ names for each year of the study, both engineering and non-engineering majors, the latter for the purpose of future comparative analyses. Minority students were oversampled to enhance the inclusiveness of the study. For the first year of the study, a small sample of 15 engineering majors and 15 non-engineering majors were invited to participate in the study via-email. In each subsequent year, fifty students majoring in engineering and 75 non-engineering majors each were invited. Approximately one third of invited students participated in the study each year, for a total of 119. An additional 15 students participated in a longitudinal panel, which will not be part of the present report.

Fifty-one students (43%) in the cross-sectional sample identified their major as engineering, 62 (52%) as non-engineering, and five (4%) as undecided. As the engineering program has approximately 20-25 students per class year, the participation of 51 engineering majors offers considerable representation of this group. In addition to identifying their majors, participants were asked to provide basic demographic information. The ethnic/racial backgrounds of the cross-sectional sample as a whole and engineering majors specifically are only slightly different. A chi-square test revealed no statistically significant relationship between ethnic/racial background and major among the categories engineering, non-engineering, and undecided, $\chi^2(10, N=114)=12.025, p>.05$.



Of the 44 engineering majors participating in the cross-sectional study who provided demographic information, we sampled 32 for this particular inquiry in order to conduct a thorough analysis within a limited timeframe. In order to take advantage of our opportunity to learn more about the experiences of those who are under-represented in engineering we incorporated the interviews of all (13) ethnic minority students majoring in engineering, as well as all (6) first generation college students (those who are potentially the first in their families to complete college), three of whom were also ethnic minority students. Sixteen of 31 ethnic majority (white/Caucasian) engineering majors, not including those already identified as first generation college students, were randomly selected using an online random order list generator.

Data Collection. Student researchers developed a semi-structured interview protocol with open-ended questions and allowance for follow-up questions and prompts. This interview protocol consisted of three sections: 1) Identity, which explored students' conceptions of themselves and their fields of study; 2) Path, which asked students to describe their academic choices and influences; and, 3) Process, which focused on students' experiences of learning. For the present project, we used data from the Identity and Path sections only.

Student researchers conducted interviews with student participants from the Fall 2005 through the Spring 2009 semesters. Interviews were then transcribed in electronic form, and linked to an Atlas.ti database (known as a Hermeneutic Unit or HU) for qualitative analysis. In addition, to provide context for the study, demographic information collected from participants was entered into an SPSS database to generate descriptive reports of the sample.

Data Analysis. Analysis began with structural coding, or segmenting interviews based on the structure of the interview protocol itself. This allowed us to focus our efforts on portions of the interviews relevant to particular topics. Following this initial step, we began the thematic coding process using a codebook reflecting the study's central theoretical themes¹⁷. According to MacQueen et al., "the codebook functions as a frame or boundary that the analyst constructs in order to systematically map the informational terrain of the text" (p. 32).¹⁸ For the purpose of intercoder reliability when working as a team, the authors recommend that codebooks include six basic components for each code: the code itself, a brief definition, a full definition, guidelines for when to use the code, guidelines for when not to use the code, and examples. Our codebook was consistent with these recommendations. Using verbal cues such as "no one pushed me to go to college," "I want to be a vet to help horses," "I came to college to learn more about the world, and myself," we used an emic coding approach in which themes are explored in participants' colloquial language¹⁸. We were not looking for theoretical terms from our codebook (in this example, "assertions of self") to appear in the transcripts; rather, we were looking for evidence of a feeling or sense of self-assertion, or awareness of lack thereof, expressed by the interviewee in vernacular.

We validated coding using the Coding Analysis Toolkit (CAT) based at the University of Pittsburgh's Qualitative Data Analysis Program and hosted by the University Center for Social and Urban Research. Coded text was uploaded to CAT's secure server and password-protected access permission was set up for the project's Principal Investigator (PI). At several points during the coding process, the PI assessed the coded data, marking each code valid or invalid. We then generated a report in CAT to review code frequencies and coding discrepancies. A

check of three interviews yielded only one instance of coding marked invalid. However, there were multiple instances (approximately 15) in which the PI added a code to a quotation. Based on subsequent discussions, several changes were made to the codebook, resulting in more accurate and less redundant coding.

In the Findings section below, each quotation is referenced with two numbers in parentheses, for example, (42:9). The first number refers to the document (interview) number in the Atlas.ti HU. The second number refers to the coded quotation within that document. In the example, the quotation referenced is the 9th coded quotation within document 42. These reference numbers indicate to the reader that quotations were selected from multiple interviews, as well as the order of quotations within a single interview.

Findings

It kind of chose me. In our society, some people believe that you have a predisposition to something. When I was four years old a neighbor said to my parents that I was going to be an engineer. They didn't really believe [it], and they didn't tell me this until senior year of high school when I was looking at schools with engineering programs. I had the aptitude, I had the desire, I enjoyed it, it was very visual, and it was something that I was good at, and it would pay the rent. (27:8)

Students' choices of major occurs within social, cultural, and economic frameworks, some of which they may be aware, others not. This choice becomes part of their evolving personal narratives with implications for how the past and the future are constructed. Part of this narrative is the extent to which students freely chose their academic path and the extent to which the choice was influenced by other people or external forces. In the quotation above (27:8), recalling her decision to pursue an engineering education, this student's account took the tone of a fable in which, according to her parents, a prescient neighbor foresaw her predestined professional future. McLean and Fournier refer to these connections between past events and present identity in personal narratives as 'self-defining memories.'¹³ Nevertheless, this student ultimately attributed the decision to her own strengths and preferences as well as a sense of economic practicality.

Coffey and Atkinson¹⁹ observe that qualitative analysis has the potential to "complicate" data, to expand it rather than reduce it. In some ways, our findings support those of previous studies regarding factors in students' decisions to major in engineering or choose a specialization. Many of the commonly identified factors, such as an interest in science and math, an enjoyment of tinkering with machines, and the influence of a parent, mentor, or teacher, are identified here too. We found, however, that these factors may not occur in isolation of one another. They may occur as compatible elements that create a more cohesive and potent force in the decision-making process, or as incompatible elements that trouble decision-making, as evidenced in some students' narratives of conflict and distress. It is these synergies and dissonances that provide new layers of nuance to our understandings of women's decision-making about major and career. Below we present our findings utilizing student narratives about career decision-making. We consider four interrelated themes that emerged from our analysis: student understandings of gender and women in engineering; the interaction of personal interest with the encouragement of influential others; sociocultural factors; and social impact.

Women and Gender

Obviously being a woman in the engineering field is going to be an obstacle if I choose, which I probably will, to pursue that, 'cause so few women are in engineering and stuff, so I know I'll definitely face problems there. (63:4)

I thought it was going to be very intensive in math and science and you had to be good with numbers in order to do it. And I knew that there wasn't that many women in it, so I knew that whatever place I did end up working for after I got my degree would probably be male dominated. (7:11)

The students we interviewed expressed a range of views regarding women's representation in the field of engineering. Some reported apprehensions that "engineering itself being such a male-dominated field, being surrounded by male culture, I think that will be a challenge in itself" (10:3), "...going into engineering, women are still very far and few in that field, unfortunately, and a lot of companies are becoming more women-friendly, but still a lot are male-dominated and have that mentality" (97:3), or simply, "I think if I choose engineering, obviously being a female in this field can be good, but is also bad, because you are not treated the same way" (45:3). Another was concerned that studying at a women's college would create adjustment problems beginning her career, explaining, "in the future, I guess I'm most worried about how I'll work in a coed environment; since I haven't worked with men in the engineering field at all, I don't know how that's going to go" (95:3).

For one student, family support and role modeling enhanced her confidence in her abilities. "I come from a family of a lot...of scientists and engineers and I've always been told by my mom women can do any of these things..." (8:3). For another for whom gender was not a concern, barriers to women in engineering were perceived as historical, and she expressed self-assurance in her future success. "...Engineering 100...focused on how we could be engineers and women, and showed that there is some obstacles that has happened in the past, but I always knew that I could do engineering as a woman" (49:38). A third student dismissed such concerns entirely in the quote below:

A lot of people talk about being worried about being a woman or a minority in engineering. That's not a concern of mine at all. That might change, but every experience I had with internships and such I never felt I was treated differently because I was a girl. (106:3)

This student's use of the word "girl" (106:3) in the context of women's representation in the field of engineering may suggest an undeveloped awareness of gender issues; if so, it is unlikely that she has applied a feminist lens to the situations she has encountered thus far. The conclusions she draws may then result from an unreflective acceptance of dominant gender norms, also evidenced by her use of the gendered diminutive term. In adopting the mainstream's dismissal of gender and racial discrimination, she threatens neither the engineering establishment nor her security within the boundaries of cultural norms. It is interesting to note that this student reported her ethnicity as that of the majority, white/Caucasian. In her comment regarding the

absence of racial discrimination she reveals a position of socioeconomic privilege that allows her to maintain this perception.

Math, Science, and Influential Others

“Well, I chose mechanical because my mentor was first a mechanical engineer and basically I just wanted to follow her footsteps in the beginning” (49:7), reported one student on choosing her specialization. Another acknowledged her field of study’s connection to her father’s but asserted the independence of her decision by explaining, “My dad is a chemical engineer with his master’s. I’m not doing it because he is, but we talk about it and discuss what classes he took and what I’m taking” (35:9). Although the student discounted the role of her father’s profession in her choice, her early and frequent exposure to it was likely a powerful influence.

Our data show that the decision to major in engineering in our women’s college setting typically began as an interest in math and science, but consistent with Atman’s⁵ findings regarding gender and choice of field, the input of a teacher or mentor is often what brought engineering to these students’ awareness. One student, for example, stated, “Going in I knew I was going to be an engineer... I was really interested in math and science... I started talking to teachers and they threw the word engineering, and I kind of got interested in that, I did a little research and decided to run with it” (106:6). As she recalls it, the student was interested in science and math, but learned about engineering from her teachers by taking the initiative to discuss this interest with them. Other students describe similar experiences:

I had an amazing chemistry teacher, then I had an AP Physics teacher who encouraged us to be engineers because we would be paid more, which I didn’t necessarily agree with, but I liked the idea of being an engineer. Then when I was applying to [College] they had an engineering scholarship and I thought what the hell, I’ll apply for that... (31:9)

Tenth grade, I was in biology class and we were doing research on science-related careers, and I saw an astronaut, and I asked my teacher ‘how do you get to be an astronaut?’ So it was kind of this whole evolution into, well, you know, I want to be an astronaut, and then, you know, well, I want to go into aerospace engineering, and now I am just really interested in mechanical engineering. (95:4)

I chose engineering because I’ve always enjoyed math classes and they’ve always come very easily to me... In high school I was in the pre-med program which was heavy in math and science classes so I’ve always taken those, and now they are easier for me to do than the arts. I received a scholarship in my last summer where I got a mentor and he was an engineer, and living across the street from me while I was growing up was an engineer, and she said since I had a strong science and math background I should consider engineering, so I decided I would take EGR 100 and I enjoyed it. (25:72)

In these examples, the students describe both internal factors, specifically an interest or strength in science and math, as well as external factors, particularly the guidance or encouragement of

others, leading them to engineering study. Although some of the statements evidence personal agency – “I want to be,” “I realized,” “I chose,” – this self-assertion is coupled in the narratives with the influence of others. In the quotation below, a first generation college student describes how she took on the major of the first student at the college with whom she became acquainted. It is possible that the influence of others is even greater among first generation college students, who may have had limited access to academic role models.

I arrived at [College] as a prospective student. I was put with an engineering major...and she was very encouraging about the program and she told me how much she liked it. And I told her that I was sort of thinking about it but I wasn't really sure, and she said that, you know, it's great to be on the pioneering side of things and it's definitely a plus for you when you go to apply for a job to say that you have a BS from a fancy liberal arts college that is all women's [sic] and whatever and whatever so I guess all that fancy stuff made me major in engineering here. I was originally intending on doing a double in physics and [government], but because of her I decided to choose engineering. (64:8)

Participation in specific activities or events emerged as another path toward engineering. Opportunities for exposure to engineering projects, for instance, propelled these students toward engineering study:

I really started liking math and science in elementary school...and then we did in engineering in middle school. We did all of those balsa wood bridge-building projects and tested the strength of it and how much the different bridges held, and I thought that was really interesting. And it was kind of this fall when The Art of Structural Design [exhibit] came to the museum at [College] I really enjoyed... seeing the bridges that had been built by those engineers and what they had been able to do, the design they put into the making of this everyday structure. (8:5)

I wanted to go into the arts...until the summer between my sophomore and junior year. And I went to an arts camp in New York, and around the same time I picked up this book called Nano [by Ed Regis (1995)], and I had it with me on the trip. This book Nano was about nanotechnology and the emergence of the new field, and it spoke about entropy... and a speech called “Plenty of Room at the Bottom” which was given in 1951 at Berkeley [sic]...and how we're going to be able to manipulate things on a molecular scale to create new products... And I was at the Metropolitan Museum of Art and I saw this guy called James Tingley, and he does, like, perpetual motion, like he uses machine parts in his art and like puts them together in new ways to create like perpetual motion machines, and like I spent like thirty or forty-five minutes just staring at this perpetual motion machine in the Metropolitan Museum of Art. I was like, ‘how does it work, how do you get to do that?’ And the summer after that I went to an engineering camp. (110:4)

In the quotation directly above (110:4), two events – reading the book Nano and seeing James Tingley's presentation - resulted in a shift away from the arts and enthusiastically toward engineering. For several other students, though, the choice of engineering was as much about

what they did not like to do as much as what they did. Below, two describe enjoying math and science and “hating” majors and scholarly activities associated with the humanities and social sciences. Both also had positive experiences with science programs prior to college.

I’ve always done programs even in high school that were just like math and science, this Upward Bound program...through the University of Cal-Poly, and I was really involved in that program...but I kind of got led into this field just because I hate English and I don’t really like writing, reading, and doing all that kind of fun stuff, so that steered me towards engineering since it’s physics and math. (10:4)

Well, I know I hate English, and I hate foreign languages, and I didn’t like history, so I needed something with math and science base. And senior year of high school I went to the [area university] Women in Engineering conference and I really liked it, it was good, and then when I came to [College] I originally was looking at chemistry classes and calculus classes, not engineering per se, and also a drawing class, and I didn’t get into that drawing class, so I choose Engineering 100 and that like, changed my world, I loved it, my professor...was great. (98:4)

This strong language suggests that it is important to these students to distance themselves from the other disciplines and situate themselves as strong in math and science. Contrary to the stereotype, however, some engineering students did not feel that their math or science backgrounds were strong. Yet the possible challenge that presented was not necessarily unwelcome. As stated by one student, “I really have a hard time with mathematics and so I expected to have a really hard time with engineering field, but I thought that would also make it more valuable to me, to have to overcome having, like, that difficult time...” (110:9). In the following quotation, an international student from a Caribbean country describes her expectations of beginning an engineering program without that preparation:

I knew it was gonna be hard. I was like...I expected it to be really difficult and I would really have to apply myself, just because I didn’t have that much background in science, technology back home. I knew that coming here, it was gonna be a difficult transition that would require a lot of commitment from me. So I expected it to be difficult. And I also expected it to be fulfilling, knowing that I may not have known something but now I do. (62:4)

Note that she places her lack of scientific background “back home”, and also her awareness of the “difficult transition” required. For this student, her national origin constrained her pre-college opportunities to acquire the knowledge and skills she sought to develop. From there, her path to engineering became a sort of a process of elimination via exploration of a variety of STEM fields:

I went through the stage where I was like, I don’t know what I want to major in. I came in I was like, okay I’m gonna major in computer science. Took my first [computer science] class, hated it, decided no, that’s not for me. I liked chemistry also, I was like, I’m gonna do chemistry. Took [organic chemistry], was like, no. And I mean I’ve been taking engineering, and all along my advisor was an

engineering professor, and I took this engineering path and I realized that I really liked that. I mean, I didn't know I was gonna be an engineer from the time I was growing up, no I didn't... So it was like an iterative process. I grew into it. (62:4)

Although this student took courses in a number of disciplines to try them out, her comment that “all along my advisor was an engineering professor” seems to imply that the advisor had an influence in the student’s decision. Again, the student’s interest (if not background) in math and science brought her to the threshold of engineering study, but additional guidance steered her in.

Culture, Language, Family, and Society

...It's just this stigma that I have because English is a second language, and if I continue in this country that is something I know about, and am going to have to live with. And I'm sure that in the workplace that I'm about to transfer to there will be obstacles related to me being a female and being a Hispanic female engineer, especially because this is a field that is mostly dominated by white males... (3:4)

As noted earlier, qualitative analysis allows us to “complicate” the data. Building on the previous section’s focus on gender and the influence of teachers, mentors, and parents, we now bring additional sociocultural factors into the analysis. Above, a Hispanic first-generation college student explains her concerns going into the field. In the next quotation, we see the very complex decision-making process of an ethnic minority first generation college student who is majoring in engineering and minoring in a social science. It begins with an interest in math and science, and continues to incorporate gender, language, parental influence, and mentorship:

Well, I started off with really liking math and sciences, and I was just kind of pushed towards that by my mother because that was the only thing that she could teach me that didn't have to be translated. I guess it was one of her strong points that she feels like a person should know math and should be fluent at it because that is more universal than laws or anything like that. ... We sort of had a high school form of SWE [Society of Women Engineers], it was actually called Women and Technology, and we had different people come in and give lectures and just basically like an insight into what they're doing and how they arrived at that. And I ended up shadowing a...lawyer who was originally a biologist, and that just kind of, because of her I aspired to be her because she could do both. And that's how I saw making peace with doing what my mom wants me to do and doing what I want to do. (64:5)

It is evident in this account that multiple factors contributed to her choice of a double major. Her statement about “making peace” with her mother reveals the importance to this student of balancing personal agency and her mother’s expectations by finding a career path with a dual focus. Her mother and her mentor represent two powerful female influences in her decision-making process and her choice seems to be a compromise between the two, one with which she appears satisfied.

Several students in our study recounted cultural influences in their decision-making process. In the quotation below, an international student from an Asian country describes the cultural and familial context of her decision:

...I think my ethnic background does matter. I think Asian families, a lot of them, oh, they want their kids to be [economics] majors, they want their kids to be engineering majors. So I did come from a very practical -- although my parents never imagined me being an engineer...because they all studied social science. My mom was a social worker for a long time. And then they were like, 'are you sure you like to do this,' you know, 'is this interesting?' And sometimes I go to them for advice and they say, 'I can't give you any advice, I know nothing about engineering.' I came in for myself... I knew I wanted to do science because that is something I am better at in high school... My college counselor was like 'oh they are recruiting students for study [sic] science and engineering.' So that's one big reason I came, but I did have that Asian perspective of, oh, I have to do something that can earn me a living after I graduate. I just come in like that. And I changed tremendously...after supporting you have to move on beyond just surviving... You are going to get a job anyways and then you really have to think about the bigger questions...like why are you doing this, do you really like it...how do you see yourself in many years after you graduate... And for me being interested in what I am doing is really important. (43:13)

Here we see how cultural influences and parental influences can exert pressure in different directions. Although this student feels that her choice of engineering is in sync with cultural expectations, when contrasted with her parents' departure from these expectations in their own careers it created a sense of professional dissonance within the family. Additionally, she described a move away from what she referred to as the "Asian perspective" on career toward an exploration of her own professional desires. Later in the same interview, the student remarks on that exploration within an American liberal arts setting: "I really changed my idea of what engineering is. And actually, I am starting to feel a gap between myself and some people who actually are from traditional programs... I felt less confident when I first entered the program. Now I feel that I am sorry for some people who didn't have that kind of exposure" (43:15).

Family and social influences can take the form of support, or the form of pressure that some students feel confines their choices. The passages below are from single interview with a student who seems to feel very conflicted about engineering, toward which her mother steered her. This student described feeling that her mother's recommendation to take engineering was gender-inappropriate, but she conceded, and enjoyed the introductory engineering course:

I looked at my schedule and I had an open space, and my mom had told me about engineering, like, 'you should look into it, blah blah blah.' I was like, 'no, that's for boys, what's engineering?' I actually didn't know what engineering was...so the term engineering meant nothing to me... So I took Engineering 100 and loved it, and I was like, okay, cool. I can suck it up and do it. (60:6)

This student continued to describe how her own career concerns differ from those her mother is prioritizing, and the way she intends to use her engineering education toward a teaching career.

So just through patience and persistence I'm like, okay, I'll do it, and then again my mom's like, 'don't switch your major, you're fine, you'll get the rewards after graduation...' But I really don't care about that. I mean the financial stability, I don't care. Really, I want to be a teacher, so I guess I'm engineer because I feel like it opens a door for so many other things. (60:6 continued)

Later, the same student confessed to feeling that her mother's support, both emotional and financial, is contingent upon staying on as an engineering major. She described testing the boundaries of her mother's approval:

[Engineering's] important to me because I, well part of the reason why I'm sticking through it is because sometimes I like it, sometimes I don't like it, but at the same time...sometimes I think of it this way, to make my parents happy...When I told [my mom] I declared and she was like, 'what did you declare?', I was like, 'medieval studies' to flip her out. But clearly I know that I don't really have all of her support if I were to switch majors...I feel that I have the burden of pleasing my parents still at this point in life where I can't do something that makes me truly happy, passionate-wise. What if I want to study...religion? Do that on the side, not with the \$40,000 that we spend at [College]. Get something practical here...and do your passion later on. (60:11)

It would seem based on these excerpts that this student is likely to consider leaving the engineering program at some point, or not pursuing a career in education following graduation. Her belief that engineering is a male profession, even if it has dissipated, suggests she recalls it as playing a role in her decision-making. This may speak to ongoing personal conflict regarding her perceived fit within the field. Additionally, familial pressure is running counter to the student's agency in decision-making, creating personal and interpersonal distress. Although this student is in the privileged position to avail herself of an education funded by her family, she perceives the situation as one of coercion based in her economic dependence. Yet, at least in this interview, she does not consider the possibility of relinquishing that security in order to explore other avenues.

Impact on Society

I have a large concern for the future of our planet and I think there are definite engineering solutions to that. I've always been involved in some environmental cause in one way or another since I was ten. That's just part of who I am and I've never not cared about it. (61:10)

The impact of engineering on society emerges as an important factor in students' decision-making. This can be expressed in terms of particular area of concern, often the environment. Other students describe engineering as a path to helping others.

I came to that conclusion [to major in engineering] because I really enjoy helping people and I couldn't really find a way. Engineering's awesome because it allows me, it gives me a mindset that can be used in any area pretty much. (60:4)

I mean [my engineering education] is going to cost me a lot of money to get all of this done but as far as what I'm going to get back from it, just like, the gratification of helping people to me is enough. (103:7)

When I was in high school my mother told me to choose an area of study or field of study that will help other people. So, for example, she's a nurse. And that's one reason why I didn't want to go into math or something like that... I didn't want to just sit in my cubicle and play with numbers all day, I wanted to do something to help people. (57:13)

This last quotation (57:13) reveals the influence of the student's mother and what could be interpreted as a somewhat gender-derived career decision-making process. Her mother is a nurse, which is a traditionally female helping profession, and she is encouraging her daughter to help others in her career as well. Helping others appears to have become the student's own intrinsic motivation, although she has asserted herself by following through on it via a less traditional career path for women.

Despite expressions of ostensibly altruistic tendencies, the motivation to help others may be rooted in the desire to achieve personal prominence and legacy. In the quotations below, two students denounce such desires, but by doing so reveal their importance in their decision-making processes:

(What impact does [engineering] make in society?) I feel that it is a great one, and actually that is one of the reasons why I decided to become engineer; because I always thought of myself doing something great, but not for me. I always thought of doing something that could help others. (3:11)

(Did this potential to impact society affect your choice of [engineering])? Definitely. And I guess to elaborate it, I don't want to do something that just helps me. I think that's selfish... I'm not particularly in it for the money or fame but the fact that I know that I've done something to change something... even though maybe my name might not be attached to it, I've helped something along, and when I die other people will be improving upon it... I think things should be always changing and I want to be, have some hand in that I guess, so, yes, the potential to impact society definitely has a major plus and that motivates me to pursue this field. (64:8)

Participants make self-assertive statements throughout these excerpts, but personal agency is expressed within the discourse of helping others. This suggests that individual achievement may be desired by these students although they may feel it is inappropriate to make choices based upon this desire, or inappropriate to express it. Gender may play a role in this hesitance to appear

too self-interested or prideful, but it may also be a result of institutional influence; the college at which the study is set emphasizes service to the community.

Discussion

The findings reported here illustrate the complexity of students' decision-making processes, a complexity that can only be explored in depth through qualitative research. Although we concentrated on separate themes, it is clear from the findings that in these women's lives, one can't separate the roles of personal interest, social impact, and influence of others, at both the individual and societal levels. In some ways, these sections, or any other sections we could have chosen, are arbitrary, because the students we interviewed experience these factors as interrelated.

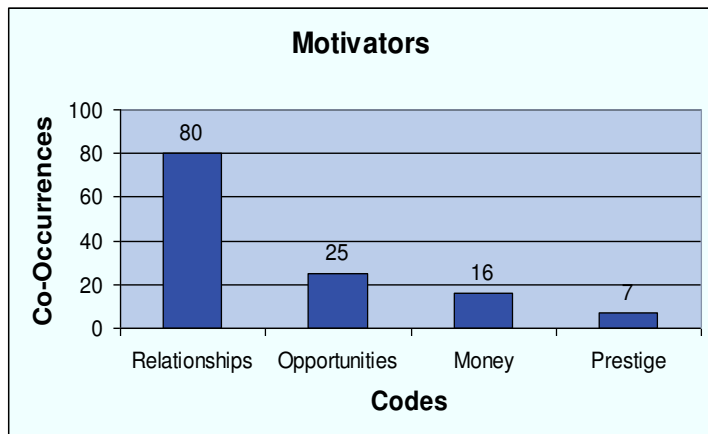
The women's college context certainly affects the findings reported here, perhaps most obviously in the narratives around women and gender in engineering. Absent are the stories documented in much of the literature of gender-based isolation from peers, or sexist jokes and unwanted sexual attention in the college environment (although some students have reported such experiences in high school and on internships). Nonetheless, these students seem to be well aware of engineering as a male-dominated profession, and many shared a sense of concern about future discrimination. While some students reflected the "loss of feminist analysis" identified by Seymour²⁰, there is for many students an expectation of equal treatment, if not a skill set for negotiating male-dominated workplaces.

It has long been established that a pre-college interest in science and math is common among engineering students. Our data show that this interest alone may not have sufficed for the women in our engineering program. The guidance of influential others was often represented as a necessary catalyst. This supports Atman's⁵ findings that women were significantly more likely than men to report the influence of parents and mentors in their decisions to major in engineering. One possible explanation for the difference Atman found is that at the level of discourse, it may be more acceptable or expected for women to acknowledge the help they received from influential others. It is also important to note that in Atman's results, far more women identified intrinsic psychological motivations (i.e. interest in science and math) than identified the influence of mentors.

The guidance of others, however, does not necessarily preclude or detract from these students' own agency any more than an ostensibly autonomous act proves the absence of constraints. As described in the literature review, feminist theorists have challenged the construct of agency as shaped by western notions of masculinity and independence. In practice, individuals do not act in a vacuum; all are subject to proximal and distal influences. Furthermore, to return to the concept of autobiographical reasoning,¹³ in relaying their decision-making processes participants may have 'edited' their personal narratives in a way that makes it seem the stars aligned, diminishing the role of agency. If there were influential others or events exerting force in other directions which the interviewee ultimately found less compelling, accounts of these experiences may have ended up on the cutting room floor, so to speak.

Regardless, it is clear from our study that many women's narratives include a strong role for influential others in their academic decision-making. The chart below depicts the co-occurrences

of the code “motivators”, which represents external forces in decision-making, with the codes representing some of these potential forces: relationships, opportunities, money, and prestige. “Relationships” is a supercode that includes the codes “family”, “peers”, and “teachers”; its co-occurrences with “motivation” outnumber the next most frequent code by more than three times.



There are several possible reasons for this phenomenon. It could be that, due to the perception of engineering as a masculine field, young women are less frequently exposed to engineering by educators in general. Therefore, a particular parent, teacher, or mentor must act purposefully to engage young women with engineering. Without such intervention, engineering as a course of study may not even enter their awareness. As stated by one student,

“had I been encouraged in this direction when I was eighteen I might have gone in this direction [earlier]; but no one ever told me, no one ever suggested it to me, it wasn’t even a thought in my head” (61:10). Several students reported a desire to become the mentors and role models they themselves may have lacked for next generation. “...I wouldn’t mind teaching an engineering class to children at a younger age. I wasn’t exposed to engineering at an early age, and I wish I had been, and I want others to have that exposure so if they find they like it they can go on and become engineers” (25:34), explained one ethnic minority student. Another student remarked, “I would want to be a mentor. I would love to be part of a school or after school program...having that role model to help you see, and motivate you, is great” (27:17).

Another possibility is that the encouragement of an influential other offers these students at minimum “permission” to break gender norms in their choice of major, or further, offers guidance and support as they proceed in their engineering education and career. This concept of “permission” relates to personal and interpersonal agency in decision-making. In and of itself, our finding that intrinsic factors are often insufficient in choice of major among the women participating in our study is quite telling. Our title quote “it kind of chose me...” expresses not only predestination, but also passivity. This theme of influential external forces leads us to a feminist line of inquiry regarding the ways in which women make decisions and act upon them, as well as how they talk about them.

In analyzing cultural and family influences, we see multiple forces at work in the process, often exerting pressure in different directions, creating dissonance. This dissonance can be resolved by granting a particular force precedent over the others, by finding a balance among them, or by constructing new narratives of self and choice in which historical events are altered or reinterpreted.

Many of our students were motivated to study engineering because of perceived potential for social impact. To some extent, students may be parroting back messages repeated frequently in the engineering program, which includes social impacts of engineering in the introductory course,

defines engineering as a career “in service to humanity” and promotes social impacts in recruitment materials and co-curricular activities. Also, because there was a specific question about social impacts in the protocol, this may have led students to identify social impacts that would not have emerged unsolicited.

The findings of Atman⁵ provide strong caution about drawing gendered inferences about our participants’ discussions about social impact, as there was no significant difference in percentages of male and female students citing this as a factor in their choice of engineering. Essentialist statements such as “women are interested in problems of social concern” are surely problematic, and our all-female data set makes clear that not all women are motivated by social impacts. However, the fact that such notions exist suggests that social impacts may be an acceptable way for female students to justify their choice to major in engineering. They may transgress gender boundaries by entering engineering, but if their motive is to help others, couching the choice in those terms may resolve some of the dissonance between gender and engineering identities.

Our data on family and culture suggest that some of our participants compromised their own goals in service of interpersonal or social equilibrium, consistent with Seymour’s²⁰ findings about female engineering students working to please others. The typical discourse of male versus female professional behavior would identify such compromise as negative, reflecting a lack of agency. However, it is exactly this process of making peace with multiple influences, and negotiating multiple identities that describes how many women come to the decision to be (or not to be) an engineer. In doing so, they act as agents of their own future.

Conclusion

These findings suggest that recruitment and retention efforts in engineering education will be most effective when they recognize the interrelationships of myriad factors at work in women’s major and career choices, combining work on science and math skills with the guidance of a mentor, a focus on language proficiency, addressing cultural expectations, and providing social support. Acknowledging women’s agency in their decisions – whether they persist or leave engineering – ultimately respects the complexity and integrity of their lives.

References

1. Adelman, C., Educational Resources Information Center (U.S.), National Institute for Science Education (U.S.) & United States Office of Educational Research and Improvement (1998). Women and men of the engineering path [microform]: a model for analyses of undergraduate careers. Washington, DC: U.S. Dept. of Education.
2. Turner, S.E. & Bowen, W.G. (1999). Choice of major: The changing (unchanging) gender gap. *Industrial and Labor Relations Review*, 52(2), pp. 289-318.
3. deCohen, C.C. & Deterding, N. (2009). Widening the net: National estimates of gender disparities in engineering. *Journal of Engineering Education*, 98(3), pp. 211-226.
4. Ohland, M.W., Sheppard, S.D., Lichtenstein, G., Eris, O., Chachra, D., & Layton, R.A. (2008). Persistence, engagement, and migration in engineering. *Journal of Engineering Education*, 97(3), pp. 259-278.

5. Atman, C. (2009). Educating the Well-rounded Engineer, Insights from the Academic Pathways Study, keynote address at the FIE 2009 Conference on October 20, 2009, San Antonio, TX.
6. Goodman, I.F., Cunningham, C.M., Lachapelle, C., Thompson, M., Bittinger, K., Brennan, R.T. & Delci, M. (2002). *Final report of the Women's Experiences in College Engineering (WECE) Project*. Cambridge, MA: Goodman Research Group, Inc.
7. Foor, C.E., Walden, S.E. & Trytten, D.A. (2007). "I wish that I belonged more in this whole engineering group:" Achieving individual diversity. *Journal of Engineering Education*, 96(2) pp. 103-115.
8. Eglash, R. (2002). Race, Sex, and Nerds: From Black geeks to Asian American hipsters. *Social Text*, 20(2), pp. 49-64.
9. Lichtenstein, G., Loshbaugh, H.G., Claar, B., Chen, H.L., Jackson, K. & Sheppard, S.D. (2009). An engineering major does not (necessarily) an engineer make: Career decision making among undergraduate engineering majors. *Journal of Engineering Education*, 98(3), pp. 227-234.
10. Mitchell, K.E., Levin, A.S. & Krumboltz, J.D. (1999). Planned happenstance: Constructing unexpected career opportunities. *Journal of Counseling & Development*, 77, pp. 115-124
11. Langdon, E.A. (1998). Who attends a women's college today and why she should: An exploration of women's college students and alumnae. In I.B. Harwarth, (Ed.) *A Closer Look at Women's Colleges* (pp. 38-61). U.S. Department of Education: National Institute on Postsecondary Education, Libraries, and Lifelong Learning; Office of Educational Research and Improvement. <http://www2.ed.gov/PDFDocs/womenscolleges.pdf>
12. Blee, K.M. (2002). *Inside Organized Racism: Women in the Hate Movement*. Berkely and Los Angeles, CA: University of California Press.
13. McLean, K.C. & Fournier, M.A. (2008). The content and processes of autobiographical reasoning in narrative identity. *Journal of Research in Personality*, 42, pp. 527-545.
14. Emirbayer, M. & Mische, A. (1998). What is agency? *American Journal of Sociology*, 103(4), pp. 962-1023.
15. Nelson-Kuna, J. & Riger, S. (1995). Women's agency in psychological contexts. In J.K. Gardiner (Ed.) *Provoking Agents: Gender and Agency in Theory and Practice* (pp. 169-177). Urbana and Chicago, IL: University of Illinois Press.
16. Bartky, S.L. (1995). Agency: What's the problem? In J.K. Gardiner (Ed.) *Provoking Agents: Gender and Agency in Theory and Practice* (pp. 178-193). Urbana and Chicago, IL: University of Illinois Press.
17. Namey, E., Guest, G., Thairu, L., & Johnson, L. (2008). Data reduction techniques for large qualitative data sets. In G. Guest & K.M. MacQueen (Eds.), *Handbook for Team-Based Qualitative Research* (pp. 137-161). Lanham, MD: Altamira Press.
18. MacQueen, K.M., McLellan, E., Kay, K. & Milstein, B. (1998). Codebook development for team-based qualitative analysis. *Cultural Anthropology Methods*, 10(2), pp. 31-36.
19. Coffey, A. & Atkinson, P. (1996). *Making sense of qualitative data: Complementary research strategies*. Thousand Oaks, CA: Sage Publications, Inc.
20. Seymour, E. (2006). The role of socialization in shaping the career-related choices of undergraduate women in science, mathematics, and engineering majors. *Annals of the New York Academy of Sciences*, 869(1), pp. 118-126.