AC 2011-724: ENGINEERING IDENTITY AND THE WORKPLACE PERSISTENCE OF WOMEN WITH ENGINEERING DEGREES

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Engineering identity and the workplace persistence of women with engineering degrees

Abstract

Based on studies of engineering students, it is recognized that engineering students who pursue engineering due to altruistic intent or intrinsic interest in engineering are more likely to persist to graduation. We sought to identify similar factors that promote persistence for women in the engineering workplace. Since we know that women leave the engineering workforce more frequently than men, identifying these factors is as important to retaining women in the engineering workplace as previous work to identify similar elements in the undergraduate years. The retention studies of women in the engineering workforce have largely focused on the structural features of the workplace, rather than on the women, themselves, who are making the decisions to stay or leave. While examining the workplace is important, identifying factors related specifically to the women is also an important and essential step to modifying or supplementing workplace culture to retain women in engineering for longer periods of time.

We hypothesized that women who strongly self-identified as engineers would be more likely to persist in the engineering workforce and those who did not would be more likely to leave the workforce. If we knew that strong engineering identities would lead to higher workforce retention, then educators could employ interventions to intentionally develop this identity in their students before graduation.

To assess the validity of this hypothesis, we conducted semi-structured interviews (similar to psychology's Identity Status Interview) of 33 women with engineering degrees, including those who persisted in the engineering workforce and those who did not. We preceded the interviews with Likert scale measures of identity taken from the engineering education literature. We conducted theme-based coding of the interview transcripts for the workplace issues known to impede persistence and for engineering identity. Further, we took a grounded theory approach for other factors that might appear in the data. Finally, we sought to determine the women's reasons for staying or leaving the engineering workforce.

Our findings revealed that strong engineering identification does generally correspond to increased persistence, while a weaker identification corresponds to increased consideration of leaving engineering. We did find, though, that some non-persisters had a strong engineering identification and some persisters had a weaker engineering identity. Thus, other factors were influencing the validity of our hypothesis. The most prominent unexpected factor was that some women were pulled by a strong desire to pursue a vocation or passion that conflicted with engineering workplace persistence, such as teaching in K-12 or staying home with her children. We have named this phenomenon a competing vocation. Two other influencing factors arose to a lesser extent: persistence was sometimes affected by the degree to which the workplace met the women's a) need for relatedness and b) expectations for employees being encouraged to help one another and/or the end customers (prosocial motivation). Thus, we found engineering identity to be an influential factor in the workplace persistence of degreed women engineers, followed by the level of workplace relatedness and opportunities to serve others within the workplace. Each of these findings has potential implications for engineering educators.

Introduction

Female engineering students have long been the focus of studies regarding recruitment and retention as researchers sought to determine how to bring in and keep female students enrolled in engineering majors and increase their graduation rates. In recent years, the focus has been expanded to investigate the experiences of these women after they graduate and perhaps enter the workforce. While it is valuable to know how to recruit women into engineering majors and get them to graduation, if they leave the field, the efforts in recruiting and retention do not pay off for the engineering workforce. Recent research on employees in Science, Technology, Engineering and Math (STEM) have shown that, indeed, the workplace experiences of men and women are often vastly different. In a survey study of engineering alumni from 25 different institutions, The Society of Women Engineers[1] found that men are 50% more likely to persist in the engineering workforce than women: roughly half of men persist whereas only one third of women do. Based on their multi-methods study of women who at one point worked in engineering, Hewlett et al.[2] concur that there is a discrepancy in retention between the genders, reporting that the quit rate for women in the engineering workforce is 39% which is "well above that of men". It is thus apparent that there are factors in the engineering workforce that are impacting women more negatively than men. Two studies[2, 3, 4] independently found these factors to include: work-life balance, hostile work environments, isolation, and family obligations as primary reasons why women leave the engineering workforce.

While it is important for engineering employers to address these known issues, it is clear that some women do persist in the engineering workforce despite these barriers. Perhaps there are some factors that moderate the effects of workplace barriers on retention. If those moderating factors were known, then that knowledge might be assistive in finding a way to reduce the disproportional impact that workplace barriers have on female retention.

The identity literature offers a potential explanation of such a moderator since identity has been connected with persistence. Ryan and Deci[5] make this link in first referring to identification as a form of internalization in which people "accept the importance of a behavior for themselves…" They go on to say that this internalization can eventually lead to "autonomous regulation" which has been "consistently… associated with greater persistence …" One aspect of the Academic Pathways Study (APS) focused more specifically on *engineering* identity and persistence in engineering students. As part of the APS effort, Stevens et al.[6] developed a framework they refer to as "Becoming an Engineer" that examines engineering student persistence from a broad perspective.

> This analytical framework involves three related dimensions that (they) track over time: disciplinary knowledge, identification, and navigation. (Their) analysis illustrates how these three dimensions enable (them) to understand how students become, or do not become, engineers by examining how these three interrelated dimensions unfold over time[6].

Based on their four year longitudinal, ethnographic study of engineering students at four diverse institutions, Stevens et al. determined that identity is the "compass that guides one to make a pathway through engineering." Stevens also found that students started referring to themselves

and other engineers as "we" and non-engineering students as "they." Thus, even as students, they were self-identifying as engineers. Loshbaugh and Claar[7] found the same phenomenon in their parallel research as another part of the APS study. Finally, also as part of the APS effort, Matusovich et al.[8] linked student engineering identification with college persistence. Through semi-structured interviews of 10 engineering student persisters and one non-persister they found that roughly half of the persisters had high engineering identification while the other half had low engineering identification yet placed a high value on earning an engineering degree. The non-persister had a low identification with engineering.

A broad range of approaches exist for measuring identity. Sfard and Prusak[9] use a narrative approach. They specifically examine the narratives for verbs such as *be*, *have* or *can* and adverbs such as *always*, *never*, *usually*. Stevens' methods with engineering students[6] aligned with those outlined by Sfard and Prusak[9]. In concert with the narrative approach, psychologist Haußer[10] uses an adaptation of Marcia's Identity Status Interview[10] which asks open-ended questions to elicit the narrative responses (e.g., "When did you decide to pursue this education/profession? Why?"). The open-ended questions allow the interviewee to respond freely without the constraints of a forced-choice set of answers. These self-formulated answers are deemed valuable in identity research since only the woman herself, who solely possesses the identity, can provide information about the nature of her self-concept. Matusovich et al.[8] also used open ended questions in a narrative approach using semi-structured interviews. They then coded the transcripts according to Eccles'[11] attainment (sense of self), interest, cost and utility constructs. In contrast, as another component of the APS effort, Chachra et al.[12] developed survey items to measure engineering identity in four areas: centrality (of engineering in the person's self image), private regard (for engineers and for being an engineer), public regard (for engineers), and identification with engineers as a group[12]. The literature thus includes diverse methods for measuring identity, and even engineering identity specifically.

Considering the evidence that some women do persist in the engineering workforce while others do not and that identity has been connected to persistence, we hypothesized that women with a strong sense of engineering identity are more likely to persist in the engineering workforce than those with a weak or absent sense of this identity. Those with a low sense of engineering identity will be more likely to leave the engineering workforce when confronted with these barriers or perhaps even in the absence of them. Intuitively it makes sense that someone who strongly views herself as an engineer would be very reluctant to quit when encountering workplace barriers since engineering is a large part of who she is. She would, therefore, work at finding a pathway to persistence. On the other hand, a woman with a weaker engineering identity would be much less reluctant to quit and less prone to put in the effort to find a pathway to persistence that would work for her.

Methods

To test our hypothesis, we needed to assess the degree of engineering persistence and identity in a cross section of women with engineering degrees, including those who persisted in the engineering workforce and those who did not. Since a woman's sense of identity is best measured by her self-formulated responses, we chose to conduct semi-structured interviews in order to make the engineering identity measurement. Further, since persistence in the

engineering workforce varies by degree, interviews fit that measure best as well. Finally, open-response interview questions are the best approach for seeking out unknown factors relevant to persistence.

To recruit participants we emailed prospective participants a request to complete an online survey to briefly assess identity and persistence in a quantitative format. We emailed the request to engineering alumni at three institutions: all engineering alumni at one small, private university in the Northwest; all engineering alumnae who graduated after 1980 of one small, private college in the Midwest; and all the engineering alumnae of a large research university in the Northwest. To recruit additional participants, we also placed announcements in various venues inviting online survey participants. The venues included a regional IEEE newsletter, a regional SWE newsletter, and a few church newsletters (since we eventually hope to consider differences according to religion). The end of the online survey asked for the participant's email address in order to contact them for further involvement in the study. All women meeting our selection criteria outlined below, and who submitted their email addresses, were contacted to request an interview. This paper discusses the 33 resulting interviews that have been transcribed and coded.

Of the 33 semi-structured interviews of women with engineering degrees, 22 of the women had persisted in the engineering workforce and 11 had not. (Two of the persisters, though, were currently in jobs only very tangentially related to engineering, and two of the non-persisters had never held an engineering job.) We selected participants so that all but a few (three) had degrees in electrical and computer engineering, mechanical engineering or civil/environmental engineering which are the most common engineering majors. (Of the other three, one participant had her degree in general engineering and two in chemical engineering.) We further limited our participants to those who earned their first engineering degree at least three years prior to the interview to allow sufficient time for assessing persistence versus non-persistence. Finally, in order to limit our study to the more contemporary issues facing women regarding the workplace, each participant earned her first engineering degree in 1979 or later, except one who earned her first engineering degree in 1973.

The online survey included items related to persistence and identity (Table I) as well as demographics. The identity items were Likert scale measures adapted from Chachra et al.[12] Due to the nature of the economy at the time, persisters included those who were currently working in engineering or who were seeking to work in engineering. Non-persisters were separated into those who never worked in engineering and those who did work in engineering at one time but no longer do so. Since it is difficult to define what is considered to be an 'engineering' job, we based our persistence determination largely on the participant's self-report of her persistence.

Approximately half of the interviews were conducted face-to-face; the other half were conducted by telephone due to distance. (About one fourth of the interviews were held in the Midwest and the rest in the Northwest.) All but two of the interviews were recorded, from which verbatim transcripts were generated. The other two participants chose not to be recorded, so field notes were taken.

Table I. Online survey: Persistence and Identity items

(Items 2 through 5 adapted from Chachra et al.[12])

1) Mark which of the following best describes your work experience since graduating. a. I am presently working as an engineer, or seeking to work as an engineer. b. I am currently choosing not to work as an engineer, but I did work as an engineer for some period of time since graduating. c. I have not worked as an engineer since graduating, but I have previously sought engineering employment. d. I have not worked as an engineer since graduating, and I have not sought engineering employment.
Indicate the degree to which the following statements are true for you. (Answer options for each statement were from 1 to 5, or strongly disagree to strongly agree.) 2) Being an engineer is an important reflection of who I am. 3) I feel strong ties to engineers. 4) I am proud to be an engineer. 5) Society views engineers as an asset.

The interviews were designed not only for measuring the participant's degree of engineering identity and persistence, but also to elicit the barriers that the woman encountered in the workforce and to note any other, unexpected factors significant to her degree of persistence. The interview questions included those listed in Table II. The first interview question is very similar to that of Haußer's Flensburg Identity Status Interview[10] and Matusovich's interviews[8]. All questions were used to induce the interviewee's narrative about herself and engineering.

Table II. Interview questions.

1) Would you tell me about why you decided to pursue engineering? 2) Walk me through your engineering education experience. 3) Tell me about your engineering workplace experiences (if any). 4) Tell me about critical moments for you related to engineering. 5) Describe your ideal job. (If constraints were not an issue!) 6) Is there anything else??

In order to analyze the interviews, we conducted theme-based coding of the transcripts. Two main categories were of interest in the coding: identity and workforce barriers.

Identity was coded in a manner consistent with methods used in the identity literature. We listened for the frequency of a) the women associating themselves with other engineers as peers[6,9], and b) the women enumerating aspects of their interests and personality that they viewed as 'engineering'[8,9]. The scoring system for identity (Table III) was created by incorporating the methods and findings from the identity literature. We broke the concept of

"we" vs. "they"[9, 6] into two codes: one that we call "sense of self as an engineer" which corresponds to the woman referring to herself as an engineer, and another which we call '"they" vs. "we"' which corresponds to the woman referring to engineers in a manner that distances herself from them. Our "sense of self as an engineer" code is similar to "attainment" in Matusovich et al.[8] Our "sense of identification with/in an engineering career" code is similar to "interest" in Matusovich et al.[8]

Table III. Identity coding scheme for coding transcripts

1. Sense of self as an engineer (2 points) Speaks of herself frequently as an engineer OR mentions it once or twice emphatically (1 point) Speaks of herself once or twice as an engineer
2. Sense of identification with/in an engineering career (2 points) Frequently mentions enjoying engineering activities or working as an engineer with little mention of downsides of the job (1 point) Frequently mentions enjoying engineering activities or working as an engineer with frequent mention of downsides of the job (1 point) Mentions at least once that she enjoys (or enjoyed) engineering activities or working as an engineer OR mentions it once or twice emphatically and little mention of downsides of the job (0.5 points) Mentions at least once that she enjoys (or enjoyed) engineering activities or working as an engineer OR mentions it once or twice emphatically and frequent mention of downsides of the job
3. 'They' vs. 'we': <u>Negative</u> score (2 points) Mentions 'they', not 'we' frequently, referring to engineers (1 point) Mentions 'they', not 'we' at least once, but not frequently

For our analysis it was important to operationalize persistence, that is, to define it in a way that could be scored consistently and accurately. Since the definition of an 'engineering job' is nebulous, we listened for details from the women as they described their current jobs and the activities those positions entailed. After conducting the interviews, but before coding, it was readily apparent that some women were working in jobs only tangential to engineering, or even very tangentially related to engineering. Further, some women left the engineering workforce due to unhappiness, but some left specifically to pursue another passion or vocation, such as to teach in K-12 or to stay home with their children. Thus, based on the women's descriptions of their current jobs and/or their reasons for opting out of the engineering workforce, their degree of persistence in an engineering role was scored based on the Persistence Scale shown in Table IV. (The four categories in the table correspond to the groupings discovered via principal components analysis applied to our coded data.) [Tangential jobs were defined as those in which the woman did use some of her engineering knowledge or experience in her role but it was

not the focus or one of the main activities of her job. An example of a job that is tangential to engineering could be someone who works in a non-engineering marketing role but interacts with a team of engineers. In this role, the woman is not responsible for the engineering work itself but does use her background and knowledge of engineering at times.]

Table IV. Persistence scale

Persisting at least somewhat strongly: 8 – 10
10 Enthusiastically persisting in a true engineering role 9 Enthusiastically persisting in a role tangential to engineering 9 Persisting in a true engineering role and planning to stay in it 8 Persisting in a tangential role and planning to stay in it 8 Persisting in a true engineering role, but considering leaving due to another passion
Barely persisting: 6 – 7
7 Persisting in a true engineering role, but considering leaving due to unhappiness on the job 6 Persisting in a tangential engineering role, but considering leaving due to unhappiness on the job 6 Happily persisting in a job that is very tangential to engineering
Not persisting: 1 – 5
5 Enthusiastically worked for a while in a true engineering role and plans/hopes to return to one 4 Enthusiastically worked for a while in a role tangential to engineering and plans/hopes to return to one 4 worked for a while in a true engineering role and plans/hopes to return to one 3 worked for a while in a tangential engineering role and plans/hopes to return to one 2 worked in a true engineering role, but left due to another passion 1 worked in a in a true engineering role, but left due to unhappiness on the job 1 worked in a tangential engineering role, left due to unhappiness on the job
0 Never worked in engineering

In coding the transcripts, we also listened for the presence of barriers known to exist for women in the STEM workforce[2,3,4]. The coding system for the known workplace barriers is shown in Table V.

Table V. "Known workplace barriers" coding scheme

2 points -- for each of the following if felt strongly 1 point -- for each of the following if felt weakly (maximum of 16 points)
o Hostile macho culture o Isolation --Lack of mentor/sponsor, left out of the 'old boys network' or feeling the need to prove herself due to her gender o Stalled or stuck in her career without guidance for advancing o Time intensive jobs o The participant has been expected to take risks at work but is reluctant to do so o The participant has been placed into job roles that are not visionary or do not hold decision making power o Children – deepening challenges on the home front o Use of flex time is seen as a negative

Finally, in order to consider other, unexpected factors that would influence the engineering workplace persistence of the women with engineering degrees, we also took a grounded theory approach[13] to analyzing our interview data. In a grounded theory approach, a theory is developed in the process of conducting research, rather than beforehand. After approximately half of the interviews had been conducted and only a high level of analysis completed, it became apparent that many participants expressed a desire to relate to their colleagues in the workplace and to help others. In some cases this desire was being met and in other cases it was not. It was clear that the degree to which these desires were met did impact the participants' feelings regarding the engineering workplace. The phenomena warranted including two broad codes for the desires to relate and to help others.

To develop the coding practices, one of the researchers independently coded five of the transcripts. Once coding of those transcripts was completed and the coding scheme appeared to be appropriate for the data, a second researcher coded one of these transcripts. This second coder documented her reasoning for each of her coding decisions. The two coders then met to compare their ratings and discuss any discrepancies. The ratings were fairly consistent between the two raters and they came to a consensus regarding how the coding should be scored. For consistency purposes, the second researcher then independently coded all of the transcripts (including the five that were done by the first researcher) to ensure reliability. The second researcher had not been part of the design and interview stages and was therefore thought to be less biased than those who had developed and conducted the study to that point.

After coding was completed, we first needed to reduce the data for analysis purposes. Factor analysis revealed that the first two identity measures derived from the transcript (Table III-1 and III-2) are significantly correlated, so we summed them to form one interview-related identity measure. Similarly, factor analysis revealed that the four identity survey items (Table I-2 through I-5) are correlated, so we summed these as well. Finally, we summed the scores corresponding to the frequency of each participant's reported workplace barriers to get an

aggregate measure of the degree to which the participant faced workplace barriers. We then labeled the measured results as shown in Table VI.

Table VI. Mapping of grouping labels to raw scores

Survey items identity score (Table I, items 2-5)		Transcript identity score (Table III-1 and III-2)		Known barriers score (Table IV)	
Raw score	Grouped value	Raw score	Grouped value	Raw score	Grouped value
≥ 18	H	4	H	≥ 8	H
15 to 18	MH	3	MH	>5 to 8	MH
12 to 15	ML	2	ML	2 to 5	ML
< 12, > 0	L	1	L	1	L
0	N	N	N	0	N

H= High, MH= Moderately High, ML= Moderately Low, L= Low, N=None/nonexistent

Throughout the research process, attempts were made to reduce bias that could have influenced the results of the study. The sample of women interviewed came from a variety of locations throughout the country and were educated at different schools. They represented each of the primary engineering disciplines and the full range of time since graduation between 3 and 27 years. The diversity in this sample was intended to reduce bias and provide a good cross-section of women with engineering degrees. While attempts were made to collect data from a representative sample, there may be bias present if those who responded were not typical. Bias also may have been introduced by having only one rater code the transcripts. While this was done to reduce bias and keep the coding consistent, it may have limited the findings. Another possible limitation is that the sample was not evenly divided between persisters and non-persisters as there was an uneven number of each who agreed to be interviewed, and our sampling of 67% persisters over-represents persisters since the long term retention rate discovered by Frehill is 33% [1].

Results

Table VII summarizes the data from all 33 interviews sorted according to the identity scores. Our participants included 22 persisters and 11 non-persisters. Of these 33 women with engineering degrees, 14 were found to have a high identity with engineering (Category A), 9 have a moderate identity with engineering (Category B) and 10 have a low identity with engineering (Category C). [Category A includes participants for whom both identity measures scored at least medium high. For category B, either i) one of the two measures scored high and the other lower than medium high, or ii) one scored medium high and the other medium low. For category C, neither identity measure scored high, and either one of the two measures was low or absent (N), or both were medium low.] Among those with identity scores at the moderate level or above (Categories A and B), 74% (17 out of 23) have persisted. In comparison, only half (5 out of 10) of the women with the lowest identity scores have persisted.

Table VII. Coding analysis results
(* indicates non-persisters who had competing vocations)

	Transcript identity score	Survey items identity score	Persistence score	Known barriers score	"They" vs. We"	Category
High Identity	MH	**H**	**9.5**	ML	0	
	H	**H**	**9**	L	0	
	H	**H**	**9**	N	0	
	H	MH	**9**	MH	0	
	MH	**H**	**9**	ML	0	
	MH	**H**	**9**	ML	0	
	MH	MH	**9**	MH	0	
	MH	MH	**9**	N	0	
	H	MH	**8**	ML	0	A
	MH	MH	**8**	L	0	
	MH	**H**	6	L	0	
	H	**H**	**5**	N	0	
	H	**H**	2*	L	0	
	MH	**H**	1	**H**	0	
Moderate Identity	ML	**H**	**9**	ML	0	
	ML	**H**	**9**	N	0	
	ML	**H**	**9**	N	0	
	ML	MH	**9**	L	0	
	ML	MH	7.5	**H**	2	B
	L	**H**	6	ML	0	
	MH	ML	1.5*	N	0	
	ML	**H**	1	ML	0	
	ML	MH	0	N	0	
Low Identity	ML	ML	**9**	N	0	
	ML	L	**8**	ML	0	
	ML	L	7.5	MH	1	
	L	ML	7	MH	0	
	ML	ML	6	ML	0	C
	MH	L	2*	L	0	
	L	MH	2*	ML	0	
	ML	ML	2*	N	0	
	N	MH	1	**H**	0	
	L	MH	0*	N	0	

Of the women with at least moderately high engineering identity (Category A), ten of the fourteen are at least fairly strong persisters (persistence level 8 or higher), despite more than half (six of the ten) facing moderate to very strong barriers. Another is persisting, though only very tangentially in engineering (persistence level 6). She left her true engineering job because she wanted to make an impact on "millions of people in a positive way" and did not see that possibility in her engineering job opportunities. Of the three non-persisters with at least moderately high identity, one desires to return to the engineering workforce (persistence level 5) (She had moved up the management track, but now wants to get back into the technical track. However, she is finding it hard to do so). Another has a competing vocation (persistence level 2), and the last of the three non-persisters with high engineering identity (persistence level 1) faced very high workplace barriers.

Of the women with moderate degrees of engineering identity, six of the nine are persisting. The persister who faced the strongest barriers is barely persisting (persistence level 7.5), though, and another is persisting in a job only very tangential to engineering (persistence level 6). Of the three non-persisters with moderate identity scores, one chose to stay home with her children (persistence level 1.5). Another (persistence level 1) chose to take some time away to travel the world not long after graduating, and has not yet decided what she wants to do. The last never did enter the workplace (persistence level 0) due to her strong perception that it would force her to work by herself in a cubicle all day.

Of the women with the lowest identity scores (Category C), only half are persisting. Of the five that are persisting, only two are persisting strongly. Of these two, the strongest persister has not faced any workplace barriers, and she really enjoys the fact that she gets to work with the public as part of her engineering job. The next strongest persister (level 8) has a very strong desire to develop engineering technologies that protect the environment and that help rural and developing cultures. She currently believes, though, that the engineering profession is ignoring the needs of the environment and developing cultures, and thus senses a distance between herself and her fellow engineers. The persister at level 7.5 reports that the engineers she works with are seen as arrogant, thus she does not want to associate herself with them despite the fact that she enjoys engineering. The persister at level 7 frequently considers leaving the engineering workforce for two reasons: 1) she sees the workplace as more focused on money than quality, and 2) she would love to tackle an important social problem. The last of the persisters with low engineering identity scores is working half time in a job only very tangentially related to engineering (persistence level 6). She views her current role as the communicator who relates with the customer and is the go-between to the engineers. Of the five non-persisters, three have left to pursue other passions (persistence scores of 2), one left due to very high workplace barriers, and one never entered the engineering workforce due to the need to care for her high-needs children.

Considering Categories A and B together, of the women in our study with at least moderate levels of engineering identity, all but two (91%) have persisted at least tangentially in the engineering workforce or desire to persist, unless competing vocations or extremely high workplace barriers intervened. Even the women in our study with lower engineering identity scores (Category C) persisted at least tangentially unless they left for competing vocations or faced very high workplace barriers.

Discussion and Conclusion

Among our participants, the women who expressed a higher degree of engineering identity have persisted in the workplace at a higher rate (74%) than those who expressed a lower degree of engineering identity (50%). This is consistent with the findings of Buse et al.[13] who found that women who have been in engineering for 20 years on average have a very strong engineering identity. Of the 11 non-persisters, one desires to return to the engineering workforce, six opted to pursue competing vocations, and two faced very high workplace barriers. Several women reported that relationships with their workplace colleagues and/or the customers have impacted their persistence decisions or outlook. Further, several women reported that their desires to make a difference for society and/or the environment have impacted their persistence decisions or outlook.

As mentioned above, one of the unexpected factors impacting persistence that arose from the data is competing vocation, such as staying home with children or teaching in K-12. These competing vocations, along with many of the known workplace barriers[2,3,4] would conceptualize in the "cost" category used by Matusovich et al.[8]. They define "cost" as "the price of success or failure in terms of effort, time, and/or psychological impact". Thus, when the cost of fighting against the competing vocation or barrier gets too high, the women opt out of the engineering workforce.

The other unexpected factors affecting the degree of persistence were the desires that many participants expressed to relate to their colleagues in the workplace and to help others. The desire to "work with" and relate to other people is known in the psychology literature as "relatedness"[5] or "belonging"[15], a fundamental human need. The desire to help others is described as "prosocial motivation" by Grant and Berg[16]. Notably, this corroborates Buse's findings that women who have persisted in engineering for a long time highly value the fact that their job enables them to help others[14].

Thus, our data indicate that a strong engineering identity generally corresponds to a higher rate of persistence, even in the face of strong workplace barriers. Competing vocations, however, presented a large pull away from the engineering workforce for some women in our study. On a secondary level, persistence was enhanced by both a positive sense of workplace relatedness and a sense that her workplace endorses the woman's prosocial motivation to serve others. Persistence was reduced when the workplace was dominated by negative relatedness and/or opposition to prosocial motivation. We have generated the conceptual model in Figure 1 to illustrate the factors that impact engineering workplace persistence according to our data.

Our next steps are first to have at least a second researcher code a minimum of 10% of our interview transcripts to reinforce the reliability and validity of the preliminary findings reported here. Subsequently, we will test this conceptual model with more data, as well as examine the extent to which this conceptual model applies to men in the engineering workforce.

If it holds up to further data testing, then our model has at least two important implications. First, it reveals that it would be worthwhile for engineering programs to find ways to encourage the development of their students' engineering identities. This would imply that research needs

to be done to determine how best to impact engineering identity development. Second, it reveals that many former students have found a mismatch between the rhetoric they encountered in school, on the one hand, that told them that engineers can "make a difference" and the lived experience, on the other hand, in the workplace where their desire to make a difference has often been neither encouraged nor valued. Engineering educators should discuss how to address this mismatch on our end, even as engineering industry tackles it from theirs.

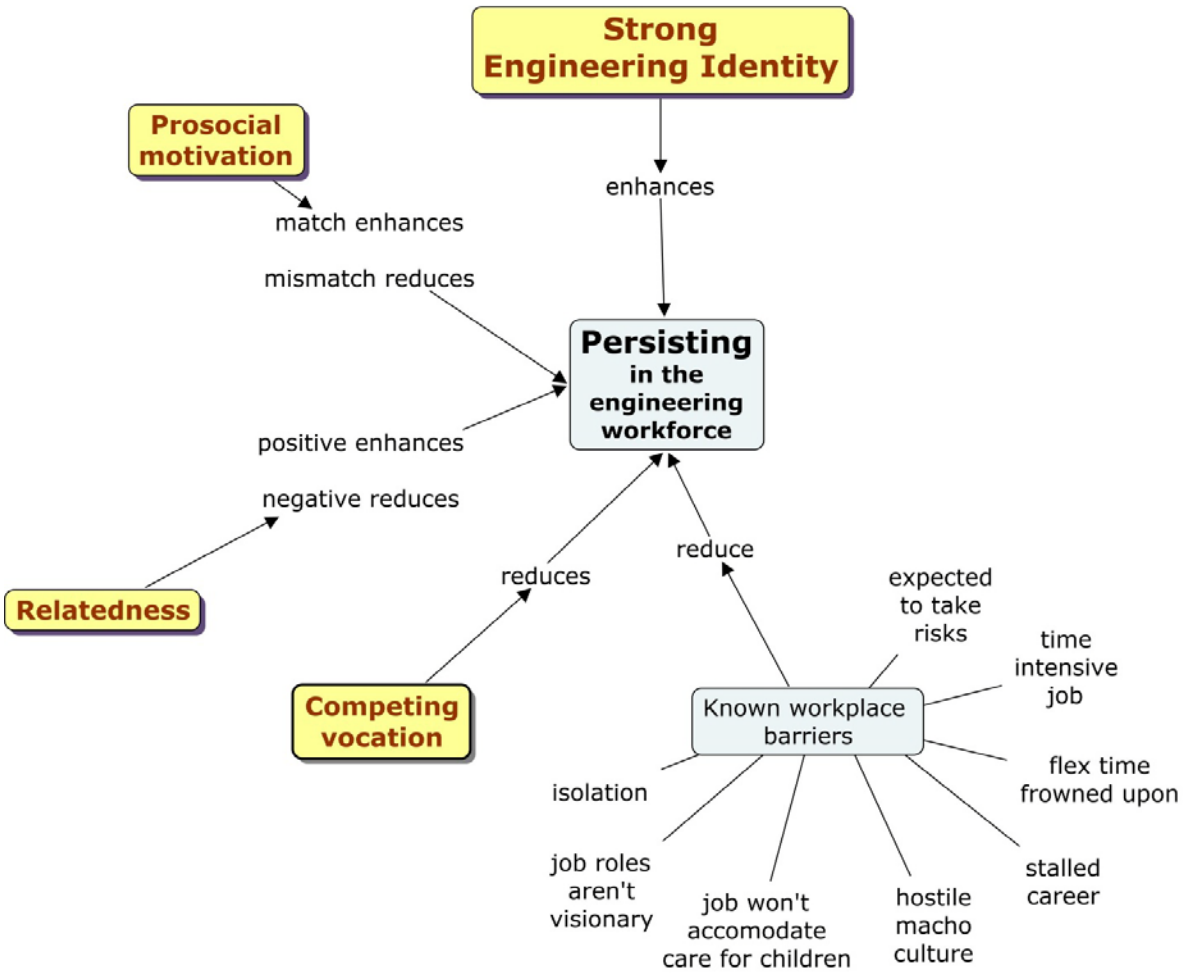

Figure 1. Conceptual model of engineering workforce persistence factors. (Known workplace barriers from Hewlett[2], Foust-Cummings[3], and The Anita Borg Institute[4])

In conclusion, our work indicates that a stronger engineering identity does correspond to increased persistence rates for the women engineers in our sample. This extends Matusovich's[8] work from the university environment into the workplace environment. While Matusovich showed the relevance of engineering identity for engineering student persistence, we now see that engineering identity is also relevant to the persistence of engineers in the workplace. Our work also corroborates Buse's[14] findings that women who have persisted a long time in the engineering workforce have strong engineering identities. Other researchers[2,3,4] are tackling the need to mitigate the known workplace barriers; our work confirms the negative impact that such barriers can have on persistence. Here we report our findings that persistence is also

significantly impacted by competing vocations, and to a lesser extent by the need for relatedness and the desire to help others both inside and outside the workplace. Our findings indicate that a strong engineering identity may mitigate these impediments to engineering workforce persistence.

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