

A Study of Gender Parity: Department Culture from the Students' Perspective

Teri Reed Rhoads, Teri J. Murphy, Deborah A. Trytten
University of Oklahoma

teri.rhoads@ou.edu, tjmurphy@ou.edu, dtrytten@ou.edu

Abstract – The School of Industrial Engineering (IE) at the University of Oklahoma (OU) has an unusual trend of gender parity at the undergraduate level. To investigate local factors contributing to the success of IE at OU, we interviewed 41 IE majors (23 female) about their background, choices, experiences, and goals, with a semi-structured protocol. Using standard qualitative research methods, we examined interview transcript excerpts related to relevant categories. Participants articulated the importance of the student-centered roles played by several of the faculty, including the director. Participants also described the cohesive community among the undergraduate majors. As a social networks model would predict, the student-student connections (horizontal ties) provide emotional support, albeit in particularly strong ways. What is most unusual, however, are the vertical ties. Faculty in IE at OU are especially proactive and diligent about offering resources to students as well as providing an additional layer of emotional support.

Index Terms – department culture, gender, industrial engineering, retention

BACKGROUND

The School of Industrial Engineering (IE) at the University of Oklahoma (OU) has a trend of success in attracting and retaining women at the undergraduate level (54 women of 119 majors (45%) in Fall 2004). The proportion of women majors climbed from 27% in 1996, peaked at 58% in 2001, and has settled at close to parity. According to one common simplistic hypothesis, gender parity at the undergraduate level can be achieved by increasing the proportion of women faculty. IE at OU does indeed have a high proportion of women faculty (4 of 13). While we agree that this factor is likely to have an impact on women undergraduates, it is unlikely that the numerical presence of women faculty alone accounts for the success of IE at OU [1]. In addition, although IE as a field has attributes that tend to be attractive to women [2]-[3], the nationwide proportion of 2001-2002 IE graduates who were female was only 34%.

Most studies and projects related to gender equity seek insight about why women are *under*-represented in engineering fields. In contrast, this paper is part of an ongoing study (NSF #0225228) to identify factors contributing to this success that IE at OU has had in achieving gender parity

among its undergraduate majors [4]-[5]. Parallel work from this project has indicated that faculty-student relationships had direct impact on the recruitment and retention of majors [3]-[7]. These relationships are part of a broader departmental social network [8]. The strength of connections in a student's social network has affects on aspects of education such as access to resources and emotional support, disproportionately so for women. In a simplistic sense, we can think of undergraduates as having connections to other students within a major (horizontal ties) as well as connections to graduate students and faculty in the department (vertical ties). This paper presents a detailed description of these relationships as relayed by students.

METHODS

Data Collection and Analysis

Guided by prior studies investigating student experiences in science and engineering fields [9]-[10] as well as work related to organization culture [11], we interviewed IE majors about their backgrounds, choices, experiences, and goals, using a semi-structured protocol. The nature of this protocol allowed the interviewer to pursue relevant directions based on participant responses. Such flexibility allows the conversation to be authentic. However, to keep the conversations to a reasonable length, the cost for this flexibility was that not all students were asked all questions on the protocol.

Using standard qualitative research methods [12]-[15] and software (NVivo, <http://www.qsrinternational.com>), we pulled interview transcript excerpts related to categories such as: role models, reasons for choosing IE, other majors considered/attempted, and department environment. These excerpts were then coded at a more fine-grained level, which led to the categories presented in the results section.

Participants

The demographic information in Table 1 came from the participants' academic transcripts. Of the 41 participants, 23 (56%) were female. Furthermore, 21 (14f) started in IE while the other 20 (9f) switched into IE from another major (e.g., Computer Engineering, Electrical Engineering, or Business). By design, we excluded freshmen, anticipating that the degree-path indecisiveness characteristic of that year would confound data collection and analysis. On the other hand,

many sophomores have settled into a major while still having fresh memories of salient experiences and their decision-making processes. The upperclassmen were important for gaining a sense of history and a quasi-longitudinal view. We included men in the sample to isolate gender-specific findings.

TABLE 1
PARTICIPANT DEMOGRAPHICS

	Male	Female	total
Sophomore	4	6	10 (24%)
Junior	3	11	14 (34%)
Senior	10	6	16 (39%)
had progressed to Masters program	1		1
total	18 (44%)	23 (56%)	41

RESULTS

Most of the participants were asked questions specifically about their interactions with other IE majors, graduate students, and faculty. Thus, this section is organized by these categories. The evidence presented here is of two kinds: at the beginning of each section are representative excerpts from the interview transcripts, edited to protect confidentiality and enhance readability; following these excerpts are summary statements, including tallies, of common themes and patterns.

Interactions with Other IE Majors

"All IEs are really good friends." (female junior)

"A couple of classes above because I've seen a lot of their group pictures and I know some of them, they're really close; they're really good friends with everyone. And I know it's the same in our class for sure." (male senior, in-switcher)

We asked the participants, "How often do you interact with other students in IE?" The responses fell into three layers of categories, ranging from superficially recognizing each other to very close friendships. At the most basic level, students indicated that they knew other IE majors, essentially as acquaintances; only 3 (1f) students responded to this effect. Another 11 (6f) participants responded to this question with comments about studying together, working on group projects assigned for classes, or seeing other students at IE functions (e.g., the annual banquet), indicating that their interactions were limited to these academic and professional contexts. In the context of this question or other topics, 18 (12f) participants used phrases such as "good friends", "tight knit", "camaraderie", or indicated that they have at least one very close friend in IE. Eight of the upperclassmen pointed out that cohorts go through the curriculum together. The participants perceived that they grew closer to other IE majors as they progressed through the courses together; one sophomore also made this comment, having heard about this tendency from the upperclassmen. One would expect students in any major to describe these three layers of interactions; what was surprising here was the small number of participants whose responses

fell into the acquaintance category versus the volume and intensity of comments that fell into the two categories ranging from some interaction to a developed sense of community.

Fourteen (9f) participants made comments that underscored the visibility of gender parity among undergraduates in IE at OU. In fact, five participants (2f) suggested that the gender parity feeds itself. One student (male senior) in particular noted that not only are there visibly many women students in IE at OU, but many of those women are strong role models for other women students. When asked if male and female students are treated differently, one female junior replied, "Between IEs there is no difference. I think we are so many, like, so many women, that they know they can't touch us". In reply to a different question about gender differences, one male senior made an analogous comment: "I'm out numbered so, it's all the same".

We also want to note that the only participants (2) who discussed the nature of competition among IE majors were specifically asked to comment on this topic. Both of them said competitiveness is not a primary, or especially visible, characteristic of IE majors at OU.

Interactions with Graduate Students

"I don't know if there's a direct relationship between when my grades started getting better and whenever I started camping out in the TAs office." (female senior)

"Graduate students are like, yeah we know how it is. We would have liked somebody to encourage us, so we're gonna encourage you." (female sophomore)

Nine (7f) participants commented about interactions they had had with graduate students who were teaching assistants for the undergraduate IE courses. These comments ranged from neutral to very positive. Some participants said that they tended to go to graduate teaching assistant (GTA) office hours more than faculty office hours with content-related questions. In fact, several participants claimed that they could not have succeeded in class without help from the GTA.

In addition, four of the senior-level IE courses at OU are also available for graduate credit. Thus, when asked about their interactions with graduate students, three (1f) participants brought up this context. However, none of these students indicated that they placed great importance on these interactions.

One striking set of comments, from three participants (2f), referred to interactions with graduate students in the context of working on research projects with faculty. One participant described the research team as "one big family" (female senior). Another striking comment came from a female sophomore who explained that one of the male graduate students had come to her high school careers class to talk about IE; she said that she later told him that she became an IE major because of him. Other less specific comments alluded to the propensity of IE majors to continue on into the graduate

program in IE at OU, indicating that the leadership of key undergraduates continued as they progressed toward graduate degrees.

Interactions with Faculty

"Just being able to talk to them and they sound like human beings when you talk to them. They actually crack jokes, smile, do different stuff, they're human. ... I seen my professor out there, it was an engineering competition but he was out there eating hot dogs and rubbing elbows with professors, everything was cool. But with different majors, it's not like that at all." (male senior, in-switcher)

"[In my previous major,] it seemed like all they cared about was their research. There, their classes came second. That's what I noticed. While the industrial engineering professors, I don't know what research they do, but they, a lot of them, it seems like their classes come first and that's very important." (male senior, in-switcher)

"You'll see them in the hall and they'll say hey to you before you say hey to them." (male senior)

"Out of class they know me as a person." (male senior, in-switcher)

"They are looking out for you, you are like their kids." (female senior)

Participants acknowledged that not all of the faculty were stellar, but for the most part the comments represented satisfied, even happy, students. Comments from 12 students depicted the department environment as generally friendly and another 10 participants emphasized that the faculty work at getting to know the students as individuals. Fifteen interviewees described the IE faculty as student-centered and accessible and 12 told stories about instances of diligent efforts on the part of the faculty to have an impact on students professionally (e.g., giving presentations in career classes about IE as a field, helping students find internships, recruiting them to work on research projects).

The participants also appreciated gestures that indicated that the faculty understood the pressures that the students were experiencing. For example, several participants described a professor who conducted the wave in one of their classes to break up the day-to-day routine. One student mentioned that another professor brought doughnuts for the class on test days.

Participants were most adamant about four of the IE faculty and a college-level administrator. Based on the length, detail, and intensity of the comments, we identified these five people as strong, positive contributors to the success of IE at OU in attracting and retaining undergraduate majors, especially women. The following paragraphs summarize the participants' comments.

Faculty Role: The Promoter

"And he always stops and asks how you're doing, how your days are going, how's the semester going with you." (male senior)

One of the four IE faculty (male) was described by five women and three men as being particularly proactive. He stood out as being "excited", "upbeat", and "happy and always there to help" in addition to being "an awesome teacher". Students seem to get caught up in his enthusiasm. Individual participants told stories of his approaching them in the hallway to ask how they were doing, offering to write letters of recommendation, proactively recruiting them for research experiences, and encouraging them to continue on to graduate school.

Faculty Role: The First Sergeant

"I heard from a lot of IE students, she'll smile, but she'll flunk you." (female junior)

"[As an academic advisor], she really tries to, to help us along, you know, and make sure we're doing what we're supposed to be doing, out there, instead of aimlessly just taking classes." (female junior, in-switcher)

"I can call her up right now and say hey, I need something, I don't know how to do this or, you know, it doesn't even have to be school related and she's always there and like a friend." (female senior)

In the marines, the first sergeant is the senior non-commissioned officer in a company (a unit that comprises about 100 people) whose responsibilities include making sure the mission gets accomplished but is also the person that junior company members turn to when they are in trouble or need a helping hand.

In IE at OU, the first sergeant is a female faculty member. Most of the 20 (12f) participants who brought her up in the interviews had come into contact with her either in her role as instructor of key undergraduate courses or as an academic advisor. Most of the 11 students who talked about her teaching explicitly said that she was excellent, even a favorite instructor. Of note, five of them also described her as "hard" or "demanding". They appreciated this aspect of her teaching and took it as a vote of confidence in their ability to live up to her expectations. Eight (4f) of the participants also gave specific examples of her diligent efforts to help them progress professionally: she initiated conversations about internship opportunities, recruited them to participate in research projects, and advised them about graduate school. They described how comfortable they felt going to her for guidance about personal issues, respecting her ability to balance her own life, as well as about academic and professional needs.

Faculty Role: The Attentive VIP

"[The Director] watches over all her students like kids." (female senior)

"I was really amazed that any director of any school would do that, you know, just pick out students just to learn about us, and seems like she was really interested in where we came from and why we picked it and everything, you know, and, she learned all of our names." (female junior, in-switcher)

In 2001, the position of Director passed from a male faculty member to a female faculty member. The seniors in our study began their degree under the male and finished under the female. As such, several students mentioned experiences with the male in his role as Director in a historical sense. However, the majority of the director-related comments focused on present context and were thus about the female. Of the 41 participants, 24 (58%) said that they had experienced positive personal contact with the female Director of IE. They described specific efforts that she made to form a relationship with them, including taking the sophomores to lunch in groups of three – brought up by 11 participants – an effort that was initiated by the previous (male) Director. Individual interviewees described instances of personal attention bestowed by the Director, such as nominating students for scholarships, helping with transfer credits, giving advice about resumes, and talking with potential in-switchers. In general, participants expressed surprise and appreciation that the Director was so interested in them.

The participants also pointed to two other women in roles of authority. At the beginning of this study, one of these women was an Assistant Dean who taught a freshman seminar course for women in science and engineering and the honors section of the introductory engineering course. She has since left OU. Although this woman was not an IE faculty member, three female participants said that she directly influenced them to persist in engineering and/or to consider IE as a major. At the beginning of this study, the other woman was a faculty member in IE who has since become an Associate Dean. She was mentioned by nine participants, eight of whom were female. As with the Director, the students were particularly impressed that these busy VIPs paid attention to them as individuals.

Women Faculty

"When you go into an office, and you see women being women but being professional still that's very appealing to a girl. ... The fact that you can be very professional and you can be good at your job at the same time and still be a female." (female sophomore)

"Having them around to talk to and to see, you know, I think just makes a big difference in just, I guess, in

the psychological belief that you can do it. You know, I think, if you are just looking at all men all day, you think man, you know, (I) I don't see many women around, maybe there is a reason for that, you know, you don't think that cognitively, I don't think, but you do, you know, subconsciously. I think it makes a big difference, just to see them every day." (female junior, in-switcher)

"You see these women who are very successful in their own right and they foster you. ... They are the PTA moms and everything else and that is neat, that is attractive because you feel like you can relate. ... You admire them because they can balance all of these different things." (female senior)

"It's not just that we have a lot of women on faculty. It is that we have a lot of strong, conscientious, dare I say, opinionated women on faculty. I think that really makes a difference." (male senior)

Of the 23 female participants, 19 (83%) mentioned at least one of the four female faculty, with 12 (52%) mentioning at least two. In keeping with the literature [1], [9], only five women students acknowledged the direct contribution of this factor to their selecting and staying with IE as a major. Exploring the impact of the women faculty at a deeper level, we note that two of the women faculty were the most-mentioned faculty: 24 participants brought up one of them while 20 participants brought up another (the next closest was 12 mentions of a male faculty member). Significant comments, from both genders, about these four women faculty were not prompted by the interviewer. Stories often came in response to the question, "What has been your best experience with a faculty member?" Eleven interviewees (5f) voiced the speculation that these women faculty contribute to the success of IE at OU in achieving gender parity. However, it is important to note that the student interview data do not merely point to numbers. Rather they point specifically to the visibility of these women faculty and their leadership roles in the department.

DISCUSSION

"Every time I hear about IE it's just like, oh yeah it's just a huge family. You know. And that's where I wanna be, one of the family." (female sophomore)

As noted above, the participants considered the department environment to be friendly, personal, and student-centered. When describing the department, 4 of the 41 participants specifically used the word "family", referred to student-student, student-faculty, and even faculty-faculty relations. This community-type language implies a strong departmental social network. In turn, this network has direct impact on student persistence [16].

In particular, the student-faculty vertical ties are unusual in two ways: first, the faculty proactively offer resources to the

students (internships, REUs, letters of recommendation) in addition to accommodating requests; second, the vertical ties also provide an unexpectedly high level of emotional support. Undergraduate-graduate student vertical ties also appear to offer access to resources (e.g., help understanding course content) as well as emotional support, but to a much lesser extent than the student-faculty ties. The student-student horizontal ties also provide a noteworthy level of emotional support and an added layer of access to resources (e.g., lowerclassmen got advice from upperclassmen). Comments from five in-switchers emphasized that these ties, both vertical and horizontal, tend to be stronger and more visible in IE than they are in some other engineering departments at OU.

We asked the participants, "What advice would you give to a new student?" Five of them said that they would recommend getting to professors and other students in the major, specifically seeking guidance and building a support group. This emphasis on building social networks matches the literature that indicates the critical nature of community in student persistence, especially for women [17]-[18].

The protocol did not include specific questions about how the IE majors meet each other. However, the comments about working on group projects for classes suggest that they may meet each other in their classes. While, in most departments, the upperclassmen tend to be in classes together, it is possible for students to recognize each other from classes but still not know each other. This is not the case in IE at OU.

The interactions with faculty described by the participants indicate that IE at OU employs an apprenticeship philosophy. Aspects of this department-level culture are portable to other areas of engineering, science, and mathematics, as well as to other IE departments. In addition to the proactive efforts described above, participants brought to our attention efforts such as taking class time to encourage undergraduates to become members of professional organization and to consider publishing papers written for courses. Also noteworthy is the number of interviewees who mentioned participating in research, including several who explicitly stated that one or more faculty had approached them with the opportunity. Participants repeatedly remarked that in general they feel taken seriously by the IE faculty and that they even feel comfortable initiating conversations about issues other than course content. Furthermore, the personal attention devoted to sophomores has a particularly strong positive impact because these students are not yet immersed in major-specific coursework and thus have fewer causes to interact with department faculty. The literature indicates that high-quality faculty-student interactions are especially important to and for female students [3]-[7], [9]-[10], [16]-[18].

The faculty in IE at OU bring a range of characteristics to the department. Participants described the importance of the student-centered roles played by several of the faculty, including the Director. While not all faculty were seen in this light, there was a noticeable absence of comments about IE faculty seen to undermine the sense of community. The data indicate that at worst a few faculty members prompted mixed sentiments from some students. Granted, our sample did not

include out-switchers, but it did include 20 in-switchers (49% of the sample). Some of these in-switchers explicitly emphasized this contrast with their experiences in other departments where they had felt unwelcome. From the direct experiences shared by our participants as well as the hearsay that they also shared, the IE faculty were almost entirely positive influences, with some having stronger impact than others.

Although the high proportion of women faculty is a critical factor contributing to the gender parity at the undergraduate level, it does not alone account for the trend [1]. Take chemical engineering as a counterexample. Nationally, women comprise only 8% of chemical engineering (XE) faculty but 33% of bachelor's recipients are women [19]-[20]. A different counterexample can be found in computer science (CS). The proportion of women faculty in CS has remained relatively stable, even comparable to that in XE (9% in 1993, 11% in 2002), but the proportion of CS bachelor's recipients who are women has decreased considerably (37% in 1985, 28% in 1994, 24% in 2001, [21]-[23]). In the context of IE at OU, it is particularly important to note that the women faculty are not just faculty – they are leaders and visible to all of the undergraduate students from sophomores through seniors. This visibility combined with respect and admiration from students and faculty alike makes these women credible role models. It is also important to note that male as well as female participants expressed appreciation for the attention given to them by these women faculty. IE at OU has achieved a climate that supports women and is also appealing to men.

ACKNOWLEDGEMENTS

The authors would like to thank the following team members for their contributions to this work: Angela Beauchamp, Kelly Brennan, Tyler Combrink, Randall Evans, M. Jayne Fleener, Cynthia E. Foor, Betty J. Harris, Rebecca Heeney, Elizabeth Kvach, Lindsey McClure, Reinhild E. Meissler, Sandra K. Moore-Furieux, Anne Reynolds, Randa L. Shehab, Donna L. Shirley, Robert Terry, Susan E. Walden, and Kim R. Warram. This material is based upon work supported by the National Science Foundation under Grant No. 0225228. Any opinions, findings and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation (NSF).

REFERENCES

- [1] Brandice, J.C. & Rosen, H.S. "Following in Her Footsteps? Faculty Gender Composition and Women's Choices of College Majors", *Industrial and Labor Relations Review*, Vol 48 No 3, 1995, pp. 486-504.
- [2] Trytten, D. A., Shehab, R. L., Rhoads, T. R., Fleener, M. J., Harris, B. J., et al. (June 2004). "Inviteful' Engineering: Student Perceptions of Industrial Engineering", *Proceedings of the 2004 American Society for Engineering Education Annual Conference and Exposition*, June 2004, Salt Lake City, UT.
- [3] Shehab, R. L., Rhoads, T. R., & Murphy, T. J. "Industrial Engineering: Why Do Students Come and What Makes Them Stay?" *Proceedings of*

October 19 – 22, 2005, Indianapolis, IN

- the 2005 American Society for Engineering Education Annual Conference and Exposition*, June 2005, Portland, OR.
- [4] Rhoads, T. R., Murphy, T. J., Shehab, R. L., Meissler, R. E., Walden, S. E., et al. "Gender Parity in Industrial Engineering", *Paper presented at the 84th meeting of the American Educational Research Association*, April 2003, Chicago.
- [5] Harris, B. J., Rhoads, T. R., Walden, S. E., Murphy, T.J., Meissler, R., et al. "Gender equity in Industrial Engineering: A pilot study", *NWSA Journal (National Women's Studies Association)*, Vol. 16 No #1, 2004, pp. 186-193.
- [6] Lancaster, S. M., Walden, S. E., Trytten, D. A., & Murphy, T. J. "The contribution of office-hours-type interactions to female student satisfaction with the educational experience in engineering", *Proceedings of the 2005 American Society for Engineering Education Annual Conference and Exposition*, June 2005, Portland, OR.
- [7] Harris, Betty, S. Walden, D.A. Trytten, R.L. Shehab, T. R. Rhoads, T.J. Murphy. "Balancing on the Tightrope: Maintaining Gender Parity in a Successful Undergraduate Engineering Program", *Proceedings of the WEPAN/NAMEPA National Conference (Women in Engineering Programs & Advocates Network/National Association of Minority Engineering Program Administrators)*, April 2005, Las Vegas, NV.
- [8] Lin, N. Building a network theory of social capital. In N. Lin, K. Cook, and R. Burt, (Eds.), *Social Capital: Theory and Research*, 2001, pp. 3-29. New York: Aldine De Gruyter.
- [9] Seymour, E. & Hewitt, N. M. *Talking About Leaving: Why Undergraduates Leave the Sciences*, 1997. Oxford: Westview Press.
- [10] Margolis, J. & Fisher, A. *Unlocking the Clubhouse: Women in Computing*, 2002. Cambridge, MA: The MIT Press.
- [11] Schein, E.H. *Organizational Culture and Leadership*, 2nd edition, 1992, Jossey-Bass, San Francisco, CA.
- [12] Leydens, J. A., Moskal, B. M., & Pavelich, M. J. "Qualitative Methods Used in the Assessment of Engineering Education", *Journal of Engineering Education*, Vol 93 No #1, 2004, pp. 65-72.
- [13] Lofland, J., & Lofland, L. H. *Analyzing Social Settings*, 3rd edition, 1995, Belmont, CA: Wadsworth Publishing Company.
- [14] Maxwell, J. A. *Qualitative Research Design: An Interactive Approach*, 1996. Thousand Oaks, CA; SAGE Publications.
- [15] Miles, M. B. & Huberman, A. M. *Qualitative Data Analysis: An Expanded Sourcebook (2nd ed.)*, 1994. Thousand Oaks, CA: SAGE Publications.
- [16] Tinto, V. *Leaving College: Rethinking the Causes and Cures of Student Attrition*, 1993, Chicago: University of Chicago Press.
- [17] Etzkowitz, H., Kemelgor, C. & Uzzi, B. *Athena Unbound: The Advancement of Women in Science and Technology*. 2000. Cambridge UK: Cambridge University Press.
- [18] Cohoon, J.M. "Towards Improving Female Retention in the Computer Science Major", *Communications of the ACM*, Vol 44, No5, 2001, pp.108-114.
- [19] National Science Foundation. *Women, Minorities, and Persons With Disabilities in Science and Engineering: 2000*. Arlington, VA: Author.
- [20] Thorsen, C. Llewellyn, D., Usselman, M., & Balsamo, A. *InGEAR (Integrating Gender Equity and Reform): Report on the Status of Women*, 1998, Atlanta, GA: Georgia Institute of Technology.
- [21] Bryant, R.E. and Vardi, M.Y. *2000-2001 Taulbee Survey: Hope for More Balance in Supply and Demand*, 2002, accessed March 15, 2005, <http://www.cra.org/statistics/survey/01/01.pdf>, Computing Research Association: Washington, DC.
- [22] Lawzowska, E. D. "CRA Testimony on the Underrepresentation of Women and Minorities in Computing", in the *Commission on the Advancement of Women and Minorities in Science, Engineering, and Technology Development (CAWMSET)*, 1999, accessed March 15, 2005, <http://www.cra.org/Policy/testimony/lazowska-5.html>.
- [23] National Center for Education Statistics, *Digest of Education Statistics*, 2000, Washington, DC: Author.