



Job Shadowing: Improving Interest and Persistence for Women in Engineering

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Abstract

With funding from the Engineering Information Foundation, the Picker Engineering Program at Smith College created a pilot job shadow program for women in engineering. Job shadowing is a workplace-based learning experience that introduces students to career areas and provides the opportunity to spend a day or two observing a professional in the field. The overarching goal of the project was to explore the effectiveness of job shadowing by undergraduate women engineering students as a means of improving interest and persistence in engineering. Shadow participants created reflective interest statements, spent a day observing engineering professionals, and reported on their experiences at a panel presentation for their engineering classmates. A mixed methods research plan was developed and implemented in order to assess the impact of the job shadow program; data collection methods included pre- and post- surveys, participant interest statements, participant reports, observations of participant presentations, and participant interviews. Several key factors emerged from the qualitative and quantitative data analysis including a number of gender specific findings. This paper describes the shadow program and research methodologies and reports the findings related to project impact and attitudes and concerns about being a woman in the engineering workplace.

Introduction

The American Association of University Women¹ reports that while girls and boys now take roughly equivalent numbers of math and science courses in middle and high school, this equivalency vanishes during the college years when the number of women involved in the study of science, technology, engineering, and mathematics (STEM) subjects drops precipitously. The enrollment disparity is particularly evident in engineering where only 19.5% of undergraduates in engineering are women². Considerable research over the last twenty years has been devoted to uncovering the factors that contribute to the underrepresentation of women in STEM disciplines. Seymour and Hewitt³ identified faculty attitudes and teaching practices, Schmader⁴ reported contextual stereotyping as leading to a lack of interest in STEM. Other researchers have identified sociocultural and environmental factors^{5, 6, 7, 8} as impacting the career choice and underrepresentation of women in STEM fields.

Recent research has examined the role of motivation⁹ and interest^{10, 11} in impacting women's decisions to enroll and persist in STEM. Interest in an occupation such as engineering is influenced by many factors including a belief in one's ability to succeed^{12, 13, 14} role models and mentors¹⁵, exposure to and knowledge of the profession^{16, 17}, and perceptions about the gender-specific role of engineers¹⁸. In addition, a recent study by Sheppard¹⁰ has shown that first-year students' intention to major in engineering is correlated with their level of intrinsic motivation, suggesting that students who are knowledgeable about and excited by engineering are more likely to persist. In fact, a number of reports and studies^{9, 11, 19, 20} have found that increased exposure to the scientific work world could be an effective method for improving interest and persistence in STEM for women. These research findings suggest that creating environments that

support women's interest and achievement in STEM will encourage more women to pursue and persist in these fields. Activities such as in-class guest speakers, field trips, co-ops/internships, and job shadowing all have been identified as mechanisms to provide information about the variety, creativity, and necessary skills within engineering professions while providing an opportunity for increased exposure to the STEM fields.

Motivation

Smith College is a private liberal arts college for women. The Picker Engineering Program was established in 1999 and is the first accredited engineering program at a women's institution in the United States. The program decided to seek funding for a job shadow program based on the research reported above suggesting that job shadowing might be one way to increase interest in engineering and on the following factors:

1. Students at Smith do not declare a major until the end of their sophomore year, thus providing a perfect opportunity for students to explore engineering and for recruiting students who might not have otherwise chosen engineering.
2. Students enrolled in Picker Engineering courses have consistently reported in surveys administered by the department that they did not know enough about engineering fields or about what engineers do.
3. Feedback from a focus group of professional engineers indicated that students would benefit from increased exposure to a range of engineering careers.

Job shadowing provides an ideal opportunity for women engineering students to obtain a quick overview of what it is like to be an engineer, particularly for women who likely never had the opportunity to see engineering first hand. Shadowing is a work-based learning experience that introduces students to career areas and provides the opportunity to spend a day or two observing a professional in the field. It has been shown to have a positive impact on student attitudes about education and work^{21, 22}. Job shadow programs have been seen primarily in K-12 settings but are increasingly being used in college and university career development centers.

The intent of developing the job shadow program at Smith College was to provide a window into authentic engineering practice, help students recognize the application of their classroom learning, and stimulate increased interest in engineering. The project was designed to meet four primary objectives, (1) to establish ongoing linkages with practicing engineers as a source of shadow placement, (2) to place 12 to 15 female undergraduate students per year in shadow placements, (3) to increase the awareness of the Picker Engineering student community about the roles, skills, and potential opportunities for women engineers, and (4) to increase student confidence in and excitement about future internship and employment opportunities.

The research was guided by the following questions:

1. How does a job shadow experience impact the knowledge or excitement of women engineering students about the engineering profession?
2. How does job shadowing impact attitudes and persistence of women engineering students?
3. Is a job shadow program an effective method for engaging first- and second-year students in engineering, especially those who may not yet have declared their major?

Project Implementation

The engineering job shadow program at Smith College was piloted during the 2011-2012 academic year with grant funding from the Engineering Information Foundation. The project involved recruiting potential workplace hosts and female engineering students, matching selected students with hosts based on location and interest, ensuring students coordinated and completed a one-day shadow with their assigned hosts, implementing written assignments and assessment instruments, and providing student shadows a small stipend to cover their time and travel expenses. Figure 1 shows the timing of these components.

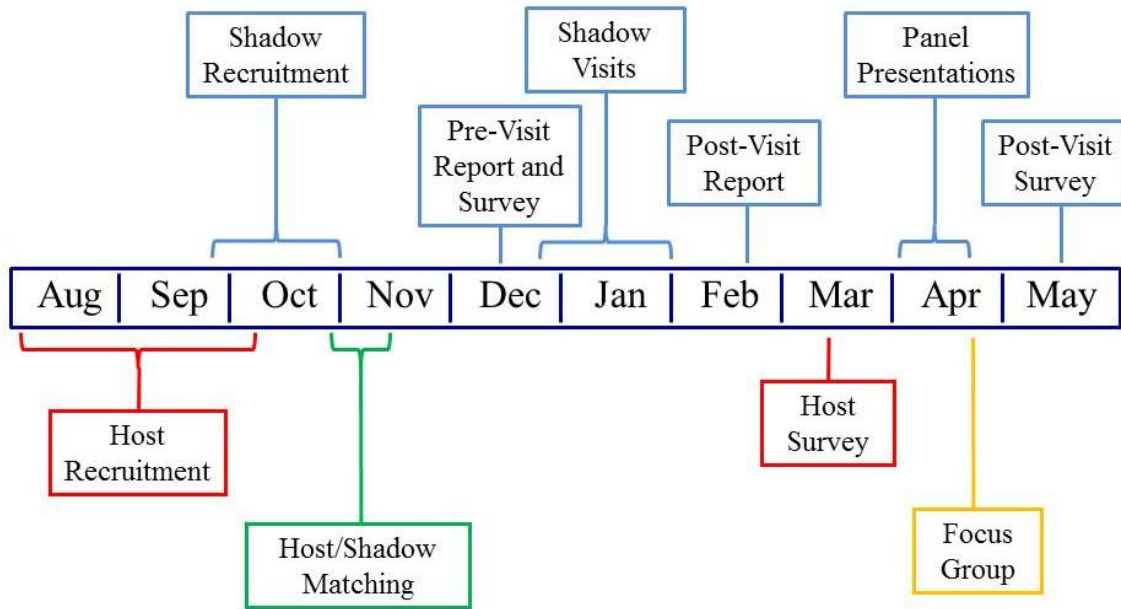


Figure 1 – Shadow Program Timeline

The initial database of potential workplace hosts was developed first with assistance from Smith’s Executive Education Program, Career Development Office, and alumnae connections. The database includes engineering professionals in industry and academia throughout the United States, many of whom are Smith alums. The database continues to grow, as more potential workplace hosts are identified for future years.

For the pilot implementation 14 students were selected as project participants. Students were selected for the project based on a review of their application material, an essay that outlined their reasons for wanting to shadow, and their stated goals if selected for the project. Five first-years, 3 sophomores, 3 juniors, and 3 seniors were selected. Placements were based on student interest and location of the host organization. Table 1 lists the organization and location of each of the selected sites.

Table 1: Shadow Host Organizations and Locations

Student Shadow Class Years	Host Organization	Host Location
Seniors, Class of 2012	General Dynamics C4 Systems	Sunrise, FL
	Analog Devices	Wilmington, MA
	Kollmorgen	Northampton, MA
Juniors, Class of 2013	Northrup Grumman	Baltimore, MD
	Alstom Power	Windsor, CT
	Greenfield DPW	Greenfield MA
Sophomores, Class of 2014	Gorton's Seafood	Gloucester, MA
	Package Machinery	West Springfield, MA
	Fuss & O'Neill	Manchester, CT
First-years, Class of 2015	University of California San Diego	La Jolla, CA
	Boston University	Boston, MA
	Mass Mutual	Springfield, MA
	Exelon	Philadelphia, PA
	IBM	Durham, NC

Student shadows were expected to complete both written reports and oral presentations as part of their involvement in the job shadow program and to aid with assessment. Prior to their shadow visits, student participants wrote a pre-visit report that involved setting goals, researching their host organizations, and preparing questions for their hosts. After the visit, the student shadows prepared a post-visit report reflecting on the goals mentioned in their pre-visit reports, listing their most important take-aways, and making suggestions to improve future shadowing visits. Student participants participated in one of three panel presentations to share their shadow experiences with an audience of their engineering classmates at Smith College. Student shadows also completed a pre- and post-surveys indicating their levels of excitement and interest in engineering, attitudes about women in engineering, and concerns about an engineering workplace.

Hosts were also asked to complete an online survey after the shadow visits to provide feedback on the program. Additional input was solicited through a focus group of audience members from the panel presentations to determine to what extent the shadow visits impacted the larger engineering community at Smith College; all three of the focus group participants had attended at least two of the shadow panels. Audience members attended the panel presentations at their own choice and focus group members were volunteers.

Analysis Methodology

The project was exploratory and, as such, utilized a mixed methods research plan in order to assess the overall impact of the pilot job shadow program. IRB approval was sought and obtained for all evaluation and research activities. As discussed above, data collection methods included pre- and post-surveys, participant interest statements, participant reports, observation of participant presentations, host surveys, and a focus group of presentation audience members. The surveys were anonymous, but each survey started with the same series of "identifying" questions,

thus providing a way for the responses to be tracked, and allowed for comparison and analysis of individuals' responses. The data available for analysis was collected over a six-month time span, from the 14 student shadow participants, from 8 of the shadow hosts and from audience members at the panel presentations. Quantitative data collected from pre-post tests and was analyzed using SPSS statistical software to determine frequencies. No statistical significance was calculated due to small sample size. Qualitative data were collected from written student responses and from transcribed focus group recordings. Using methods recommended by Anfara, Brown, and Mangione²³ the data were sorted using tabular strategies for documenting the relationship between data sources and categories in order to strengthen credibility and provide a visual representation of methodological rigor. Using strategies from the work of Conostas²⁴ and Brown²⁵, three levels of analysis were conducted. Level 1 depicts open coding. Level 2 depicts the consolidation of those units into more manageable and workable units. Level 3 is the final iteration of category development. In Level 3, central categories were identified. This process of categorization created 7 central categories, 1) tasks and responsibilities, 2) communication and collaboration, 3) work schedule and work-life balance, 4) work environment, 5) gender issues, 6) self-confidence, and 7) future plans in engineering. The quantitative and qualitative data were then triangulated in order to best address the research questions.

Results and Discussion

Pre- and post-surveys were completed by all 14 of the students who participated in the shadow program. These surveys were designed to gather information about interest and attitudes before and after the job shadow program. Results showed that student participants reported substantial interest in and excitement about the field of engineering in both pre- and post-surveys with very little variation between the two surveys. As shown in Table 2, some increase was seen regarding knowledge about engineering professions. Moreover, Table 2 also notes a marked difference was shown in student participants' knowledge about the day in the life of an engineering professional and in their confidence about their own potential for success in engineering. Beliefs about the field of engineering being open to women and about women's ability to succeed in engineering remained relatively constant with participants viewing this positively in both pre- and post-tests. Shifts were very modest with one or two student participants moving from agree to strongly agree in their responses. However, student participants did indicate an increase from 64% to 93% in their agreement that they were now familiar with a successful woman engineer.

Table 2: Pre-Post Survey Responses

Survey Question	% of Student Participants Indicating "Moderate" or "Substantial"	
	Pre-Shadow	Post-Shadow
How much do you know about different engineering professions?	64%	86%
How well can you describe a day in the life of an engineer?	7%	77%
How confident are you of your own potential for success as an engineer?	50%	93%

While the pre- and post-surveys provide some interesting data, they do not provide insights into what the student participants were really thinking about. The qualitative data is much more revealing. Prior to the shadow visits the student participants had many concerns that fell within the categories of tasks and responsibilities, work schedule and work/life balance, and gender issues. While each of these categories generated interesting data the gender related issues are most significant to this paper. More detailed information about other categories can be found in the final grant report and executive summary, available upon request from the authors. It should be noted, however, that analysis of pre-visit reports showed that gender was the most frequently raised question topic to ask hosts. In addition, 11 of 14 shadows included at least one gender-related concern in their pre-visit list of top three concerns about an engineering workplace; a selection of these concerns is reported in Table 3.

Table 3 – Gender-Related Pre-Visit Concerns about an Engineering Workplace (partial list)

<i>Being heard as an African American woman and respected for my knowledge</i>
<i>Competing with men in a male-dominated field</i>
<i>Fair treatment of women</i>
<i>How hard it is as a woman to move up in a job</i>
<i>How it is to work around a male-dominated workspace</i>
<i>Being at a disadvantage in regards to opportunity and promotion because I am a woman</i>
<i>Worried that I will not be taken seriously by my male colleagues and just be seen as a woman engineer rather than an engineer who happens to be a woman</i>
<i>If physical strength is necessary and would make a difference between hiring men or women</i>
<i>The attitude and level of respect of male engineers towards female co-workers</i>
<i>The number of expectations given to a woman engineer</i>
<i>Sexism</i>
<i>The amount of women engineers versus the amount of men engineers</i>

After the shadow visits, students were asked how the experience impacted their views about women in engineering. Several student shadows reported that it did not change their views. For the most part, those that indicated no change reported that they felt positively both before and after the shadow experience. However, other student participants noted that their views had changed in a positive way. For example, the following are sample comments made by student participants:

It really helped me to see that it is possible to succeed as a woman in engineering regardless of the path.

I already had a positive attitude towards women in the engineering field and after my shadowing experience I am even more excited about my future aspirations. I want to see how much of an impact I can make in a field where there is so much room for women to make a difference.

I realized that every woman has a unique experience. One can't place a definite answer to the question are women accepted in STEM fields? Some places are welcoming, some aren't, but most are some shade of gray.

This experience made me feel more comfortable with the idea of strong women in the engineering workplace! After interacting with a recently-hired female engineer, who was sassy, confident and extremely smart, I felt like there was a place for women in this field.

It made me really realize that there still is a gender gap in engineering, but it may show itself in different ways. At the same time, shadowing allowed me to watch an example of a successful woman engineer. It gives me a lot of hope and confidence.

Meeting so many female engineers during the shadow visit was so inspiring. It was great to see that for the most part, all of the male engineers that worked with the female engineers completely respected them and valued their opinions. All of the women that I met during the shadow visit were incredibly smart, well-spoken, and they loved what they did.

It is evident from the comments above that the job shadow experience had a positive impact on the students who participated; it helped to improve confidence and provided new insights into what it would be like for them as women in the engineering workplace. At the same time, the student shadows were realistic. While they had fewer concerns after the shadow visits, many student participants still had concerns about sexism and lack of opportunity for women in the field. The qualitative data suggest that while concerns still exist, the experience has helped the participants to see that there is still opportunity and that they are able to handle the gender difficulties that may arise in the workplace. The experience also provided them with an opportunity to think about what environments are best for them and how to deal with gender issues should they arise in future internships or work situations.

Although it is difficult to determine lasting benefits at this time, report back from student shadows suggests that there were both short-term and long-term benefits from participation in this program. Student participants noted increased confidence about their ability to succeed as a female engineer, and recognized how learning in the classroom is transferable to the work environment. Student shadows indicated that 81% percent of the goals (n=32) that they collectively set at program onset were fully achieved and an additional 13% were partially achieved. Overall, students reported that shadowing is an experience they would repeat if given the opportunity; it allowed them to get first-hand knowledge about what an industry was like, provided more information relating to future career choices, and allowed for a personal connection with engineering professionals that they would not otherwise have had.

Audience members in the panel presentations also reported learning about engineering. Focus members commented on the breadth of engineering shadow presentations and reported learning about different types of jobs and learning the details about what engineers actually do. One participant noted that the presentations helped her to think on a bigger scale, broadened her view about what engineering is, and helped her to think about her future choices. While the number of

focus group participants was small, this finding was important in that it speaks to the impact of the shadow program on the larger community of engineering students.

Conclusions and Recommendations

The pilot engineering job shadow program at Smith College matched 14 students with workplace hosts for a one-day shadow visit. As such, student shadows had the opportunity to experience a day in the life of an engineer, see how the technical skills and knowledge from class are applied by engineers, and network with practicing engineers. Student participants wrote pre-visit and post-visit reports, shared their experiences in a panel presentation to their peers, and completed pre- and post-surveys. Analysis of these assessments revealed that the job shadow program increased student shadows' knowledge about engineering professions and work, students' own confidence to succeed in engineering, and students' familiarity with at least one woman engineer. While students had gender-related concerns both before and after the shadow visits, the visits improved student confidence and enabled them to picture themselves as women in the engineering workplace. The majority of hosts reported that they thought the shadow experience was beneficial to the student participants; the hosts themselves appreciated the opportunity to share their experience and knowledge about engineering work. Based on watching the panel presentations by the student shadows, the focus group participants indicated that they, too, learned more about what it takes to be an engineer and expressed interest in participating in a shadow visit themselves.

Coordination of this pilot program went very smoothly and could easily be implemented at other institutions. Initial project activities involved the development of protocols, guides, and communication materials, which the authors are more than willing to share. For subsequent offerings, the authors recommend using a similar structure, including the pre- and post-visit report and the panel presentation for wider dissemination. For best visit value, coordinators are encouraged to emphasize to hosts that the intent is that shadows watch them work rather than go on tours. Students recommend recruiting workplace hosts in the first ten years of their career, and considering slightly longer shadow visits (2 to 3 days) to provide the opportunity to see multiple areas in complex industries and possibly shadow more than one engineer.

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