

## **Board 263: Elective Track Choice and Career Attitudes in Engineering Undergraduate Education: Antecedents, Gender Differences, and Implications**

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# **Elective Track Choice and Career Attitudes in Engineering Undergraduate Education: Antecedents, Gender Differences, and Implications**

## **Introduction**

With support from the NSF Improving Undergraduate STEM Education (IUSE) Program, this Institutional and Community Transformation project aims to serve the national interest of broadening participation by improving the representation of women in more technically-oriented roles and career paths within engineering. Research has shown that women in engineering careers are more likely than men in engineering careers to be in less technically-oriented roles and careers paths, and these gendered career patterns increase attrition risk for women engineers.

This project focuses on women engineering students' elective track choices and career attitudes as potential “upstream” predictors of gendered career patterns and investigates the driving forces behind elective track choices and career path decisions for women engineering students. We systematically explored elective track choices and career attitudes among aspiring engineers in three engineering departments—Bioengineering, Computer Science, and Electrical Engineering.

Insights gained from this research will help inform theory and practice related to improving the diversity of students participating in the more technically-oriented roles and career paths within engineering. Moreover, shedding light on factors related to women’s elective track and career path decisions will allow us to suggest institutional changes to enhance gender equality in engineering education curricula in order to better prepare women to enter technical roles in the workforce.

## **Theoretical Background**

Our project sought to shed light on early career stage (i.e., “upstream”) antecedents of gendered career patterns and their downstream career path/role choice. We use two complementary theoretical lenses to inform our investigation – intra-occupational sex segregation (IOGS) and social cognitive career theory (SCCT).

### Intra-occupational Gender Segregation in Engineering

While scholars have long noted that engineering is a gender segregated profession, researchers are also paying more attention to patterns of gender segregation *within* the engineering profession—whereby women and men pursue different career paths and roles within the profession—and to acknowledge that they may have important negative consequences for women’s professional retention in engineering [1, 2]. However, there is still a relative paucity of research examining how and why these patterns of intra-occupational gender segregation (IOGS) occur. Research on the technical/social dualism in engineering provides some insights, showing that women gravitate toward or are mentored toward managerial roles because these roles are considered to be more aligned with the “social” or “people side” of engineering [3, 4]. While there is limited research focused on the antecedents of IOGS in engineering, some work have

shown that factors such as advanced career stage and desire for promotion predict engineers' choice of managerial roles, while identification with the engineering profession predicts choice of technical roles [5].

What is not well understood, however, is when female engineers' decisions about engineering roles and career path begin to formulate and how factors present in their undergraduate educational environment may influence their later decisions to consider, or conversely gravitate away from, the most technical roles in their engineering major and sub-field. Accordingly, the purpose of this research was to examine how and why elective track choice—a factor significant to the formation, socialization, and preparation of engineers for the workforce—may become gendered during undergraduate education, and what the implications might be for downstream career decisions and attitudes. Moreover, we explored engineering undergraduate perceptions of career paths in engineering and track these perceptions over three years.

### Social Cognitive Career Theory

SCCT has been used to explain the formation of career-relevant interests, choice, and attainment of career-related goals, and emphasizes the role of self-efficacy and outcome expectations (e.g., [6, 7]). The theory posits that self-efficacy and outcome expectation beliefs are impacted by both personal and contextual factors (present in academic and career-development environments) which impact individual behavior and choice [6]. Self-efficacy (confidence) in a domain prompts positive initiation and expectations in career-related endeavors and, in turn, self-efficacy increases interest in the domain [7]. The theory also suggests that contextual factors can service as structural enablers or impediments such that personal preferences and contextual factors interact to influence career-relevant decisions.

Because of its emphasis on personal and contextual factors that influence career decision making, SCCT is a valuable lens through which to examine how women engineering students make career-critical, elective track and career path decisions during their undergraduate education, and the personal and contextual factors that may affect these decisions via positive technical outcome expectations. Accordingly, our study paid attention to the role of these factors of contributing to female engineers' elective track decisions and subsequent implications.

### **Overview of Method**

This is a three-year project (currently in a no-cost extension year) with three waves of interview data and one wave of survey data. Our interviews and survey data included engineers from three engineering majors – Bioengineering, Computer Science, and Electrical Engineering. These three majors were selected based on the gender balance in each major – high (Bioengineering; 51.4% ), medium (Computer science; 27.5% women) and low (Electrical Engineering; 14.2% women) at the focal institution. We have collected all three waves of interview data ( $N = 30, 24$  and  $21$  respectively, and  $9$  interviews of faculty and staff from each of the three majors in wave 1). We have also collected survey data with  $418$  responses. Of the survey respondents,  $237$  are men,  $142$  are women, and five are nonbinary. We collected data

from men and woman for comparison. Of the sample, 99 are bioengineering majors, 81 are electrical engineering majors and 237 are computer science majors.

## **Overview of Research Questions Addressed with Findings from Research**

We will present the main findings of this multi-year, multi-method research study. In particular, we will provide an overview of our findings with respect to the following research questions:

- (1) What personal and programmatic factors contribute to women engineering students' elective track selection? Do these factors differ by major?

Brief Overview of Findings: The analysis identified four main factors influencing intra-major specialization decisions—(1) interests shaped by curricular and extra-curricular activities, (2) program structural choice constraints, (3) perceived fit with post-graduation career plans, and (4) peer influence—and identified considerations for educators and advisors in developing engineering curricula and program structure. [8]

- (2) How do women engineering students characterize, and show interest in, the technical vs. managerial career paths in engineering industry?

Brief Overview of Findings: Analyses generated four key findings: (1) the majority of students expressed an interest in the managerial career path; (2) students associated the managerial career path with preferences for collaboration and holistic work, applying dual skills, and opportunities to have relational and organizational impact; (3) students associated the technical career path with preferences for challenge, applying specialized technical skills, and societal impact through technological innovation; and (4) students in majors with higher percentages of women were more likely to express interest in the managerial career path. Findings suggest that women have clear interests and preconceptions about engineering career paths early in their undergraduate education and may hold implications for women students' eventual career decisions and the patterns of intra-occupational gender segregation in engineering industry. [9]

- (3) How do women engineering students view the relevance of professional skills for their educational and career success? How do these views change over the course of their education?

Brief Overview of Study Focus: This study is currently in the analysis stage. The purpose of this study is to investigate engineering students' perceptions of the importance of professional skills and to explore whether and how these perceptions shift during their education. Through analysis of interviews conducted with 30 women engineering students, we compare and contrast perceptions among women engineering students in three majors—Bioengineering (BIOE), Electrical Engineering (EE), and Computer Science (CS)—and across two points in time (the second and fourth years of education). [10]

- (4) What curricular and extra-curricular factors are most related to women students' elective track selection in biomedical engineering? Do the relationships between these factors and track choice vary by gender or track? What are students' career outcome expectations associated with elective track selection? Do these outcome expectations vary by gender or track? What career sectors and career paths do biomedical engineering students report most interest in pursuing? Do these career interests vary by gender or elective track?

Brief Overview of Findings: Participants rated multiple factors as important in their intra-major specialization decisions, with Professors/Classes rated as the most important influence and Alumni as the lowest. Similarly, participants rated multiple outcome expectations of their specialization, though income was rated lower than other factors. Participants most commonly indicated interest in pursuing careers in industry and medicine. We found some differences in intra-major specialization, outcome expectations, and career interests by gender, with women students indicating a higher influence of Professors/Classes and higher expectations for their track decision to provide a career with a good income. The analysis suggests implications for curriculum design and student advising. [11]

We will discuss research findings in more detail and describe how and why contributions from the body of research stemming from this project will help inform theory and practice related to improving the diversity of students participating in the more technically-oriented roles and career paths within engineering and will provide insight into institutional changes to enhance gender equality in engineering education curricula in order to better prepare women to enter technical roles in the workforce. Taken together, results from our project reveal important insights about the track/specialization decision factors and career path plans of engineering students.

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