

## Research Brief

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# Students' Changing Images of Engineering and Engineers

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This study analyzes the images of engineers and engineering that students construct over the course of their undergraduate engineering educations. Students in their first year of study to become engineers knew very little about the work they would be doing as an engineer and their expectations were more specific, hopeful, and high status than reported in subsequent years. This may not be surprising, but it was found that even after four years studying engineering, participating in co-ops and internships, working as undergraduate researchers, and being involved in engineering organizations, some students' images of their lives as engineers and their engineering work, remained virtually unchanged.

### Implications of Findings

This paper discusses how students' constructed images of engineering change over time from images that are hopeful and romantic to images that are more mundane and more realistic. One reason for this may be that over time students receive more direct exposure to imagery and experiences in their specific fields of engineering through coursework and internships. At the same time, a few cases are discussed where romantic expectations of an engineering workplace were maintained throughout the entire four years of students' undergraduate educations or an image of the workplace was not developed until students already had a job. These instances suggest that some students are not exposed to actual engineering workplace scenarios during their undergraduate educations.

**Students' identities are affected both in common, widely circulating images of engineering and the absence of real workplace experiences.**

Attention has also been drawn to dominant images of engineering specific to certain schools in this study, suggesting that such images are developed at a larger cultural level within the colleges of engineering at these schools. These images are so dominant that in some cases they force students to perform "reconciling work" (i.e., when students augment aspects of their identity in order to fit within a dominant, institution-specific image) so that their identities can be seen to reflect these dominant images. The research suggests that these dominant images can both help, and in some cases hinder, the identity development of undergraduate engineering students.

### Method and Background

The Academic Pathways Study (APS) is a multi-year, longitudinal study of learning and development among undergraduate engineering students at four institutions. These institutions are Large Public University (LPUB), Suburban Private University (SPRI; an elite private university), Urban Private University (UPRI; a Historically Black University), and Technical Public University (TPUB; an engineering technical college).

This paper focuses on semi-structured ethnographic interviews that occurred over four years with 16 students at each of the four institutions. Students were asked the same questions over four years allowing the researchers to observe changes and alterations to the narratives they developed about their engineering education experiences. The majority of the data presented in this paper was drawn from responses to questions such as: What do you think it takes to be a good engineer? What do you expect to do on a day-to-day basis as an engineer? How would you compare yourself to other engineering students? How would you compare yourself to non-engineering students? The narratives that engineering students create provide snapshots of how they view themselves in relation to the dominant images of engineering culture developed within their respective colleges of engineering.

### **What We Found**

Two general types of student-constructed images of engineering were noted: those that refer to theories, fundamental processes, and mathematics; and those that refer to conditions of work such as group work, communication skills, and writing. Images of engineering changed over time among students within this study. For additional detail, including quotes from student interview transcripts, please see the full paper at the link below.

In the first years of engineering education, many students do not take courses in engineering, rather they take prerequisite courses in mathematics and science. Changes that emerged in this study began to surface as students enrolled in more and more courses in their respective disciplines and in some cases completed internships or co-ops.

In general, images that students had of what it takes to be a good engineer can be characterized as shifting from vague to more specific images over time. The research suggests that these changes were the result of more exposure to engineering coursework. Students initially believe that comprehending the fundamentals of engineering (physics, mathematics, etc.) will enable them to have success and be a good engineer. In many cases, what shifts in these images are features and conditions such as good communication skills and working in teams that do not have anything to do with the fundamentals of engineering. Students become aware that they need to acquire a skill set that goes beyond engineering as a science.

In addition to the images of what it takes to be a good engineer, students' visions of their future engineering workplaces also changed over time. Again, these changes are related to their exposure to more coursework in their respective majors, as well as their participation in internships. One shift observed was that students' workplace images changed from being hopeful expectations in early interviews (e.g., inventing or creating something new) to becoming more mundane and less high status (e.g., troubleshooting an existing process) in later years, more closely resembling what students will expect to find when they are working engineers. Some students' high status images of their future workplaces were never replaced with more mundane images. In these cases, the constructed images may be so powerful that regardless of what students are exposed to in a real workplace they are not transformed into something more mundane.

Some images of the field of engineering were developed at the larger cultural level at these schools. In some cases, these images were so dominant that students forced themselves to do reconciling work in order to identify the aspects of their engineering identities that did not fit

within these images. At SPRI the dominant image of engineering fostered a culture of great expectations. TPUB students found themselves working in strong teams of engineering students and developing a strong sense of ethics. Students at UPRI sought to develop a sense of engineering that fostered social good. And at LPUB, students developed an image of engineering as superior to other disciplines and were exposed to a design process that involved creativity and the goals of efficiency and cost effectiveness.

Some students in this study, in order to reconcile their identity to fit in with the dominant images of engineering at their school, augmented aspects of their identity during their interview narratives. For instance, there was a student at SPRI—an institution whose cultural image of engineering was that of engineers as entrepreneurs, risk-takers, captains of industry, and world-shaping innovators—who had designed laser light shows for well-known rock groups while still in high school and wanted to direct one of the major lighting design companies in the US after graduation. He had to reconcile his ambitions with the fact that he had not taken advance placement classes as a high school student and was working extremely hard in his introductory math and science classes at his institution (which he felt were poorly organized and taught), and was anxious about failing.

These findings reflect how students' identities are affected both in common, widely circulating images of engineering and the absence of real workplace experiences in the undergraduate engineering education.

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