

# Understanding Intersecting Social Identities in Engineering Education and Practice

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**Abstract**—Studies on the persistence and success of underrepresented groups in STEM point to a number of challenges, ranging from college-preparedness to lack of role models and financial disparity. However, few studies, if any, systematically investigate the role students’ individual identities (i.e. intersections of race, ethnicity, gender, culture, ability, sexual identity, language, etc.) play in helping or hindering their success in engineering and computer science. Relational and structural power often accrues to those who most closely approximate the defined norm, and those who do not align with these models may be compelled to withhold or even deny integral parts of their social and cultural identities as a means of successfully navigating engineering culture. We refer to this as “identity severance” and think it is negatively correlated with persistence in engineering education and practice. We have developed an exploratory study to be implemented at three distinct institutions of post-secondary education to identify the fundamental themes that would inform a more comprehensive and widespread national conversation regarding the influence of power and privilege on broader participation and practice in engineering and computer science.

**Keywords**—*identity; social inequality; underrepresented populations*

## I. INTRODUCTION

Between 1991 and 2010, the percentage of degrees awarded to underrepresented minorities improved from 10.3% to 17.8% of all degrees conferred. This was, however, at a time when the overall percentage of underrepresented minorities increased from 20.8% of the overall U.S. population to 31.3%. Thus, improvements in engineering degrees awarded, measured proportionally, actually decreased between 1991 and 2010. Underrepresentation in the field of engineering is indeed a durable problem, which impacts the engineering profession, our institutions of higher education, and our students in significant ways.

Historically, interventions instituted to overcome access and achievement disparities have been primarily deficit-driven.

For students from underrepresented groups, these deficit-driven approaches imply that their identities, or certain aspects of them, are “baggage” that they should check at the door before entering STEM programs. Whether by design or not, engineering curricula have not historically encouraged students from marginalized groups to leverage their unique cultural and social experiences and individuality as assets. Educational researcher, Robert Teranishi, asserts that practitioners must, in fact, “be aware of the social and institutional realities that yield differences in the educational experiences and outcomes” of disenfranchised groups [1]. The authors have anecdotal evidence that underrepresented students struggle with reconciling their unique identities and associated values with those imposed by the dominant culture in engineering or computer science. The process can be challenging and the authors think it has contributed to attrition.

## II. BACKGROUND AND THEORETICAL UNDERPINNINGS

Theories of systems of oppression identify institutions of higher education institutions as places that produce larger intersecting systems of sexism, racism, classism, heterosexism, ableism, and ageism that reproduce and maintain hierarchies based on such differences. The ideologies and institutional structures that sustain oppression are often invisible, particularly to those who hold social advantage based on gender, race, class, etc., and yet they produce concrete consequences that maintain power and privilege in the hands of the dominant group [2], [3], and [4]. This study seeks to examine the ways that these structures and concepts appear in and impact the lives of engineering and computer science undergraduate students.

For members of marginalized groups these multiple barriers are not accidental or incidental, but rather systemic and intersecting [5]. Engineering students and practitioners experience their professional and personal lives across intersecting identities, including ethnicity, race, class, sexual identity, and

disability profile. The issue, however, is not one of seeing the situation as made “worse” by these intersecting oppressions. Refusing to rank oppressions or create hierarchies of oppression is essential to dismantling oppressive systems [6]. Through activities outlined below, we aspire to identify and articulate faculty members’, alumni’s and students’ cognitive and affective knowledge of power and privilege. The authors believe that critical examination of how unequal distribution of social, political and economic power becomes enacted in day-to-day personal interactions will help empower faculty and administrators to shift engineering education and practice towards more inclusive, equitable and just practices. In addition, this sort of examination would provide for a more sophisticated and nuanced understanding of structural inequalities. This level of understanding is lacking in STEM fields [7] and this project seeks to raise awareness of such issues to inspire a collective call to action.

### III. PARTICIPATING INSTITUTIONS

Oregon State University (OSU), the University of Texas Rio Grande Valley (UTRGV), and the University of Hawaii - Windward Community College (WCC) possess unique settings, contexts, and student populations, which will enrich the findings:

- Oregon State University (Corvallis, Oregon) enrolls approximately 30,000 students from across Oregon, all 50 states and more than 100 countries, and is a predominately white institution (PWI). The College of Engineering enrolls about 7,000 undergraduate students.
- The University of Texas Rio Grande Valley (Rio Grande Valley, Texas) is a Hispanic Serving Institution and is the largest university in South Texas with a student population of approximately 28,300, 90% of whom are Hispanic.
- University of Hawaii-Windward Community College (Kāneʻohe, Hawaiʻi) is an Alaska Native/Native Hawaiian serving institution with an additional designation as an Asian American Native American Pacific Islander serving institution. WCC serves 2,400 students in a primarily rural region.

### IV. GOALS AND OBJECTIVES

The overall **goal** of this study is to examine the role students’ individual identities (i.e., intersections of race, ethnicity, gender, culture, ability, sexual identity, language, etc.) play in helping or hindering success in undergraduate engineering and computer science programs. The project should provide a foundation for future work focused on cultural and curricular transformation in engineering and computer science education, to achieve the end goal of creating equitable, just educational environments that intentionally recognize individual intersecting identities; recognize the importance of social, economic and political power and its differential, stratifying impact on lived experiences; and affirm the cultures of all students across their differences.

We hypothesize that engineering and computer science students who identify along social categories that are centered in US culture, including US engineering culture (e.g., white, able bodied, heterosexual, male, Christian, socioeconomic affluence), will have a higher sense of belonging and a higher sense of self-efficacy as they progress through their undergraduate programs, due in part to a greater amount of social and cultural capital they possess, relative to those who identify with subordinate groups. Both a sense of belonging and a sense of self-efficacy have been shown to be positively correlated to retention and to professional identity formation [8], [9], and [10]. Relational and structural power often accrues to those who most closely approximate the defined social and cultural norms and those who do not align with these social categories may be compelled to assimilate, withhold, or even deny integral parts of their social and cultural identities as a means to successfully navigate engineering culture. We refer to this as “identity severance” and believe it is negatively correlated to persistence in engineering education and practice. The intersecting social identities we are investigating are social constructions, with an unequal distribution of power and resources maintained across these constructions through institutional structures, systems and ideologies. If in fact we record themes of identity severance during undergraduate students’ experiences in engineering programs, interventions would necessarily involve shifts in structures and curriculum, as well as relational interactions among faculty and students.

To achieve these goals, we are investigating student, alumni, and faculty perceptions of intersecting social identities and their confluence with engineering culture. We intend to meet the following objectives:

1. Ascertain themes of identity severance among engineering and computer science students from marginalized communities that have the potential to affect the path towards becoming situated within the engineering profession.
2. Identify the role faculty’s understanding of relational and structural power across difference plays in helping or hindering students from marginalized groups successfully navigate the path towards becoming situated within the engineering profession.

### V. RESEARCH PLAN

For our investigation, we have adopted a mixed methods approach, combining both qualitative and quantitative techniques in order to provide a more holistic understanding of how students’ intersecting identities impact progression towards professional practice and identity formation. Traditional quantitative and survey-based approaches alone tend to draw a snapshot view of the attitudes, opinions, beliefs and experiences of a population, and the statistical picture that is drawn from the typical survey instrument is one of numerical “inclusion” that does not reflect on the context of that inclusion and “quality of life” factors that many underrepresented people may face in the STEM fields, for example [11], [12], and, [13]. A qualitative data collection methodology has a better chance of drawing on the personal knowledge of students and

faculty who are marginalized along multiple axes of domination. Personal interviews will help gather information from individuals who are traditionally excluded as an official part of the academy [14]. Such narrative-based techniques will also yield information to make more visible the complicated discourses at the intersections of various identities [11], [12], [15], and [16]. Combining the strengths of both methodological approaches will provide for a robust triangulated design. Institutional review boards at each institution have and will continue to be involved in the approval of survey instruments and protocols utilized for the focus groups and interviews.

#### A. Students and Alumni

The research questions we seek to answer are:

- How do students negotiate their social identities as they develop an identity as an engineer, and do they perceive these multiple concepts of self in accord with their emerging professional identity?
- As students advance through engineering education, and transition into practice, do they experience conflict between their social identities and the career options in engineering that they identify as being available to them?

The UTRGV and OSU studies will include upper and lower division students, while WCC will include lower division students. We will also identify and include alumni from these programs who are currently working as engineers in industry and those who have left engineering for another field.

At UTRGV and OSU, where common engineering and computer science programs exist, two focus groups will be implemented per discipline. Each focus group will include 5-10 students. Additional focus groups that cut across disciplines will target subpopulations of engineering students: students of color; LGBTQ students; women; students with disabilities; first generation students; and those who are from working class or socioeconomically disadvantaged backgrounds. At UTRGV and OSU, this will entail a sample of 75-100 students.

At WCC, seventy-five students have declared the Pre-Engineering concentration within the Associate of Science in Natural Sciences major. All 75 of these students will be contacted to conduct the survey and participate in focus groups yielding, at minimum, 10 students for interviews. Former WCC students who have recently transferred to the University of Hawai'i at Mānoa will also be invited to participate. Due to the smaller numbers, focus groups for various subpopulations may or may not be convened.

Initially, surveys will be used to baseline opinions, beliefs and experiences, and to better inform the design of focus groups and interviews. Stage two will involve recording information through focus groups. As detailed earlier, groups will be formed based on various characteristics, including engineering discipline, lower or upper division status, and demographics (e.g., gender, race, ethnicity, etc.).

#### B. Faculty

The research questions we seek to answer are:

- To what extent do faculty members possess a critical awareness of the social, economic and political power that blankets relationships across difference and the lived experiences of their students?
- How does the awareness mentioned above, or lack thereof, inform interactions between faculty and students in the classroom, in the lab and via co-curricular and social interactions?

The general research design for faculty will parallel that used with the students. Initially, faculty will be administered a broad survey to baseline opinions, beliefs and experiences, and to better inform the design of focus groups and interviews. Stage two will include focus groups formed around the engineering discipline only. In the third and final phase, faculty will be recruited from the focus groups to participate in individual semi-structured interviews. The UTRGV and OSU interviewing phase will include up to 40 faculty members at each institution, while the WCC study will include up to 10 faculty members. Questions will be asked to determine their understanding of systems of oppression and privilege, especially as it relates to designing educational experiences for their students. Note that none of the interviewers will be in the same units as the faculty who are being interviewed. All interviewers will receive appropriate training. Graduate students will also transcribe the conversations and be included in discussions of response coding with co-investigators.

#### C. Anticipated Outcomes

Though the institutions involved do represent a diverse set of populations, it is anticipated that further study involving more populations will be required for a comprehensive analysis of the indolence of identity in the professional formation of engineers. The uniqueness of the three participating institutions does, however, offer the opportunity to identify themes which transcend institutional type and social identities. It is hoped that those themes that are identified through this research will spark a broader discussion of the influences of power and privilege on the participation of underrepresented populations and the practice of engineering.

## VI. PRELIMINARY RESULTS

Through a series of video conferences, the authors composed surveys to explore the intersections of identity being cognizant of the various populations present at each institution. Care was taken to ensure that questions were adapted to address ethno-racial, cultural, and language differences, while maintaining sufficient consistency to enable comparisons across institutions.

Aside from basic demographic information such as major, grade level, race/ethnicity, first-generation college-going status, ability, gender, sexual identity, etc., the student survey includes questions regarding sense of belonging and self-agency, experiences within the learning environment, imposter syndrome, professional engineering identity development, attitudes towards social and cultural difference, and perceptions about the discipline. The alumni survey for the most part parallels the student survey using nearly the same set of ques-

tions. However, questions address the profession and workplace. The faculty survey is designed to evaluate the same or similar from the perspective of the instructor.

Presently, at UTRGV, survey invites were sent to 2,376 students. Surveys have been completed by 320 students, accounting for approximately 12% of the population. At the time of publication, the authors will have concluded analysis of the three survey instruments at each of the three institutions and will be designing the format and questions for the focus groups and interviews. Preliminary data will be available during the conference presentation.

## VII. CONCLUSIONS AND FUTURE WORK

At present we are still processing survey data which will inform the formation of focus groups and the recruitment of faculty participants for interviews. Moreover, the survey data will further inform questions, themes, and topics that will be explored during the focus groups and interviews.

Methods for recording data during this phase may include a combination of interviews, journals, letters, blogs, autobiographies, or oral narratives. Research assistants will also transcribe narratives and be included in discussions of response coding with co-investigators.

Two of the institutions involved are minority serving with relatively large populations of underserved students. Long term, the intent is to expand implementation of resulting instruments and investigative methods to other institutions with significantly different population demographics. In this way, we can investigate whether and how the findings of this work translate to other institutions.

To date, survey instruments have been disseminated to students, alumni, and faculty spanning the three participating institutions. Focus groups and interviews will soon be conducted. The results will be examined to identify themes, commonalities, and differences that would inform both a more comprehensive study across a more diverse group of institutions and potential interventions for students and faculty.

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