ASEE 2022 ANNUAL CONFERENCE
Excellence Through Diversity
MINNEAPOLIS, MINNESOTA, JUNE 26TH-29TH, 2022 ASEE
Paper ID #38392

CAREER: Disrupting the Status Quo Regarding Who Gets to be an Engineer -- Insights from Year 1

Jeremi S London (Assistant Professor)

Associate Professor of Engineering Education at Virginia Tech Chair of ASEE's CDEI during the Year of Impact on Racial Equity

Brianna McIntyre

Dr. Brianna Benedict McIntyre is a research associate in the Department of Engineering Education at Virginia Tech. She earned her Bachelor's and Master's of Science in Industrial and Systems Engineering from North Carolina Agricultural and Technical State University. Her research focuses on understanding how hybrid spaces influence engineering students' identity development, belonging, and agency in interdisciplinary engineering education. She leads the ASEE CDEI virtual workshop team focused on building a community of educators passionate about expanding their knowledge concerning diversity, equity, and inclusion in engineering education.

Nicole Adia Jefferson (Student)

Nicole Adia Jefferson is an Engineering Education Ph.D. student at Virginia Tech in Blacksburg, Va. She holds a B.S. in Mechanical Engineering & Technology and M.S. in Computer Science HCI, from Virginia State University, Petersburg, Va. Nicole is current member of The Research's Impact on Society and Education (RISE) Research Group where she is a GRA for CAREER: Disrupting the Status Quo Regarding Who Gets to be an Engineer.

CAREER: Disrupting the Status Quo Regarding Who Gets to be an Engineer -- Insights from Year 1

ABSTRACT

The historical exclusion of Black and Brown students from engineering can be linked to systemic racism embedded into engineering education. Rectifying this issue will require Colleges of Engineering to adopt a holistic change strategy to overcome this challenge. While existing scholarship has explored the barriers racially/ethnically minoritized students face in engineering and the change strategies that promote pedagogical innovations in engineering education, this CAREER project sits at the intersection of both topics. This CAREER Award is a multi-case study exploring five institutions that serve as exemplars for recruiting, retaining, and graduating the most Black and Brown undergraduate engineers over a recent decade. This executive summary presents insights about the first year of this study and is organized around four key topics: the project design, two key outputs of year one, preliminary insights from year one's pilot interviews, and looking ahead to year two.

MOTIVATION

Despite continual efforts to broaden participation in engineering among groups historically characterized as underrepresented, the recruitment and retention of Black and Brown students remain dismal [1]. The historical exclusion of Black and Brown students can be linked to systemic racism infused throughout engineering education. The status quo of who gets to be an engineer is often associated with white, cisgender men, resulting in an exclusionary culture based on white and masculine norms and values [2]. Thus, progress toward diversifying engineering and building an inclusive culture remains insufficient.

While existing scholarship has explored the barriers racially/ethnically minoritized students face in engineering and the change strategies that promote pedagogical innovations in engineering education, this CAREER project sits at the intersection of both topics. More specifically, research efforts focused on broadening participation in engineering have almost exclusively focused on the barriers Black and Brown students face in engineering education [3], [4]. Similarly, other research efforts have primarily focused on instructors' evidence-based teaching strategies at Predominately White Institutions (PWI). Some of the change strategies include diffusing and implementing curriculum and pedagogy; creating faculty learning communities that promote reflection among instructors; and developing an organizational culture that supports new knowledge [5]. While these change strategies are instrumental, within their context, there is a need to understand how to institutionalize change wherein equity is at the center and results in disrupting the status quo regarding who gets to be an engineer. This executive summary outlines the aims and progress of this CAREER Award to date.

RESEARCH QUESTIONS

The central goal of this research project is to identify and understand change strategies exemplary Colleges of Engineering (COEs) have used to improve Black and Brown students' access to engineering education and careers. In this study, "access to engineering" is

operationalized by recruitment to, retention in, and graduation from an undergraduate engineering program. The overarching question guiding this project is:

What combination of insights and actions form a robust, actionable change model for broadening participation in engineering and set COEs on a viable path to parity?

Accordingly, the corresponding research questions include:

(1) How and why do COEs envision, implement, and institutionalize changes that address systemic inequities and positively impact the recruitment and retention of Black and Hispanic students?

(2) What conditions and strategies contribute to the long-term success of COEs committed to recruiting, retaining, and graduating diverse cohorts of students?

THEORETICAL UNDERPINNINGS

Acker's Inequality Regimes and Kotter's Leading Change Model provide the theoretical foundations for this multi-case study. Acker's inequality regimes indicate *why* the strategic efforts performed resulted in the anticipated outcome, while Kotter's theory reveals *how* change happens in an organization. Together, these frameworks guide the investigation of the strategic changes that colleges of engineering institutionalized to mitigate systemic inequities often (re)produced in their organizational processes and practices.

Acker's Inequality Regimes

Organizations produce and maintain racial, class, and gender inequalities of varying degrees and severity [6]. These characteristics are often dependent on the category of inequality and power differentials present within the organization. Class refers to the "systematic differences in access to and control over resources" [6, p. 444]. Gender refers to the "socially constructed differences between men and women" [6, p. 444]. Race refers to the "socially constructed differences based on physical characteristics, culture, and historical domination and oppression" [6, p. 444]. Other differences based on marginalized identities exist as bases for inequality within organizations. These identities include sexual orientation, visible and invisible disabilities, neurodivergence, and religion. While the grounds for inequality may vary, most studies generally focus on race, class, and gender, often ignoring how inequalities exist at the intersection of multiple identities.

Research exists exploring how varying bases of inequalities are produced in the workplace [6], [7] and education [8]. Continual patterns of inequality can be examined through five organizational processes characterized as *inequality regimes*: recruitment and hiring, wage setting and supervisory practices, organizing general work requirements, class hierarchies, and informal interactions while "doing the work" [6]. The visibility of inequalities may be influenced by the culture and position of the individual [6]. As such, we must also remain attuned to the nuances associated with three components of inequality regimes –namely, visibility, legitimacy, and control and compliance– which often prevent change and result in maintaining the status quo. To understand how inequalities are produced and challenged in a higher education context, we adapted the five inequality regimes to examine the racial inequalities present within

admissions, financial aid, degree requirements, student engagement, and student interactions with faculty and staff. In this study, we define the inequality regimes as the processes used to:

(1) recruit students to the college of engineering, including justifications of why a student is not suitable for the engineering program.
(2) determine eligibility for receiving scholarships and other forms of financial support.
(3) determine fundamental curricular and co-curricular activities that students must meet to earn an engineering degree.
(4) understand subtle formal and informal interactions between students that when observed are informed by racialized interactions.
(5) understand how the hierarchical structures are organized and influence the interactions between students, faculty, and staff.

Figure 1 illustrates the hypothesized parallels of the inequality regimes. Exploring the validity of these hypothesized parallels is one of the expected intellectual contributions of this study.

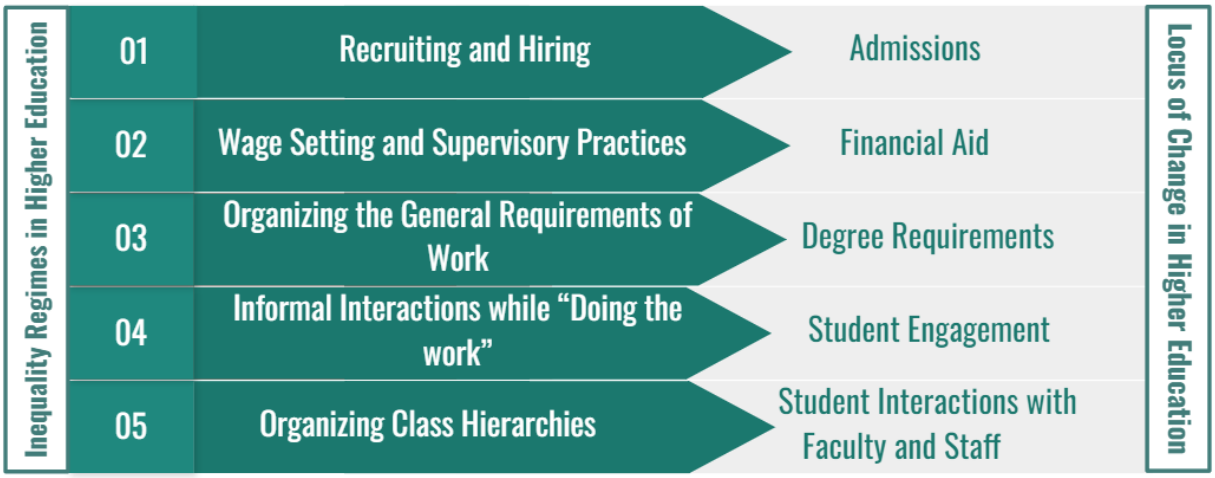

Figure 1. An Adapted Model of Acker's *Inequality Regimes* in a Higher Education Context

Kotter's Model for Leading Organizational Change

This study is also concerned with understanding how change occurs within the COEs by which Black and Brown students are permitted access to engineering education and careers. We draw upon Kotter's organizational change model [9] to examine change through three sequential phases—envision, implement, and institutionalize. The envisioning phase includes three steps: 1) create a sense of urgency; 2) build a guiding coalition; and 3) form a strategic vision. The implementation phase includes the following three steps: 4) enlist your army, 5) enable action, and 6) create short-term wins. The institutionalized phase consists of the last two steps: 7) sustain acceleration, and 8) anchor the change. Specifically, we aim to examine how COE leaders and educators actualize change at their institutions. Figure 2 illustrates the phases and steps represented in Kotter's Model for Leading Change.

Figure 2. Kotter's 8 Step Change Model [9]

RESEARCH DESIGN

This project examines the change strategies five exemplary institutions use to improve Black and Brown students' access to engineering education and careers using a holistic multi-case study [10] research design. A holistic case study is a research method that involves an in-depth exploration of a bounded system through a range of data sources and results in a detailed account of the phenomena of interest [10]. A case study approach is relevant for studying this topic because the change strategies of exemplary COEs used to improve Black and Brown students' access to engineering education and careers are vague and undocumented. Yet a critical need exists to develop a change model for broadening participation in engineering.

Site Selection

In the light of Yin [10] and Stake's [11] recommendations to explore a minimum of 4 cases and a maximum of 10 cases when conducting a multi-case study, this research design includes five exemplars. We identified the sites by referring to the American Society for Engineering Education's (ASEE) list of institutions that consistently produce Black and Brown engineers over the period of interest (2016-2018). We argue that COEs consistently named among ASEE's list of the top producers of Black and Brown engineers provide the best context for investigating the most suitable conditions for enabling racially/ethnically minoritized groups access to engineering. Table 1 lists the schools that have done so in the last three years in which

data was available at the time of the proposal submission (2020); fourteen unique school names are on the list [12]. The schools listed in the bold text appear in the list over multiple years. Schools in the top 5 list for awarding engineering bachelor's degrees to Hispanic engineers in the same year are indicated by an asterisk [12]. Lastly, we intentionally selected sites in two states (Florida and Maryland) to control for context and logistics management. Thus, the five sites were selected because of their designation as top producers of both Black and Brown engineers (as indicated by the bold and asterisks in Table 1).

Table 1. Bachelor's Degrees Awarded to Black or African Americans by School

Rank	2016	2017	2018
1	**NCATSU**	**GT**	**NCATSU**
2	**GT**	**NCATSU**	**GT**
3	**UCF***	**UCF***	**MSU**
4	**FIU***	**MSU**	**UCF***
5	**HU**	**HU**	**UMD**
6	FAMU-FSU	**UMBC**	**FIU***
7	**UMD**	**TU**	**UMBC**
8	**UMBC**	PUPR	**KSU**
9	LSU	**FIU***	**TU**
10	**KSU**	**UMD**	NJIT

Note: FAMU-FSU= Florida Agricultural and Mechanical University-Florida State University; FIU= Florida International University; GT= Georgia Institute of Technology; HU= Howard University; KSU= Kennesaw University; LSU= Louisiana State University; MSU= Morgan State University; NCATSU= North Carolina Agricultural and Technical State University; NJIT= New Jersey Institute of Technology; PUPR= Polytechnic University of Puerto Rico; TU= Tuskegee University; UCF= University of Central Florida; UMD= University of Maryland; UMBC= University of Maryland Baltimore County

In short, the institutions selected to be a part of this multi-case study include:

(1) Florida International University (FIU)
(2) Morgan State University (MSU)
(3) University of Central Florida (UCF)
(4) University of Maryland-Baltimore County (UMBC)
(5) University of Maryland-College Park (UMD)

Table 2 provides an overview of the university characteristics for the five COEs identified as exemplars in this study. The five exemplars include a mix of schools that vary in size, institutional mission, and degrees of selectivity. This sampling strategy allowed the research team to examine what is driving success in minoritized students' access to engineering.

Table 2. Overview of Data Collection Sites

University Characteristics					
Variable	FIU	MSU	UCF	UMBC	UMD
Student Population	57K	7K	68K	13K	41K
Engineering Population	6K	1K	11K	4K	4K
Admissions Selectivity	Selective	Less Selective	More Selective	Selective	More Selective
Student-to-Faculty Ratio	26:1	13:1	30:1	19:1	18:1
Undergraduate % Black/AA	12%	80%	11%	18%	12%
Undergraduate % Hispanic/Latino/a/x	67%	3%	27%	8%	10%
Undergraduate % White	8%	2%	47%	40%	49%

Data Sources & Outputs

This study includes three streams of data collection for each case: semi-structured interviews with ten participants (e.g., administrators, co-curricular support staff, faculty, student advisors, and students); publicly available artifacts that describe the exemplar (e.g., websites, publications, strategic plans); and policy documents and quantitative reports that highlight relevant change strategies and/or its impact. We also plan to visit each campus to see the points of pride mentioned during the interviews. Together, these data streams inform the development of three concrete deliverables: impact narratives stemming from the within-case analysis; a robust model for broadening participation in engineering, and a corresponding impact playbook stemming from the cross-case analysis. These outcomes will be used to design and facilitate

meaningful exchanges with the broader engineering education community. These exchanges will come in the form of sharing information with the ASEE Engineering Dean's Council, hosting a town hall discussion among Associate Professors in the ASEE community, developing a graduate course for engineering Ph.D. students, and translating the research findings into practice by partnering with at least one new institution (i.e., Virginia Tech). Figure 3 provides an overview of the project.

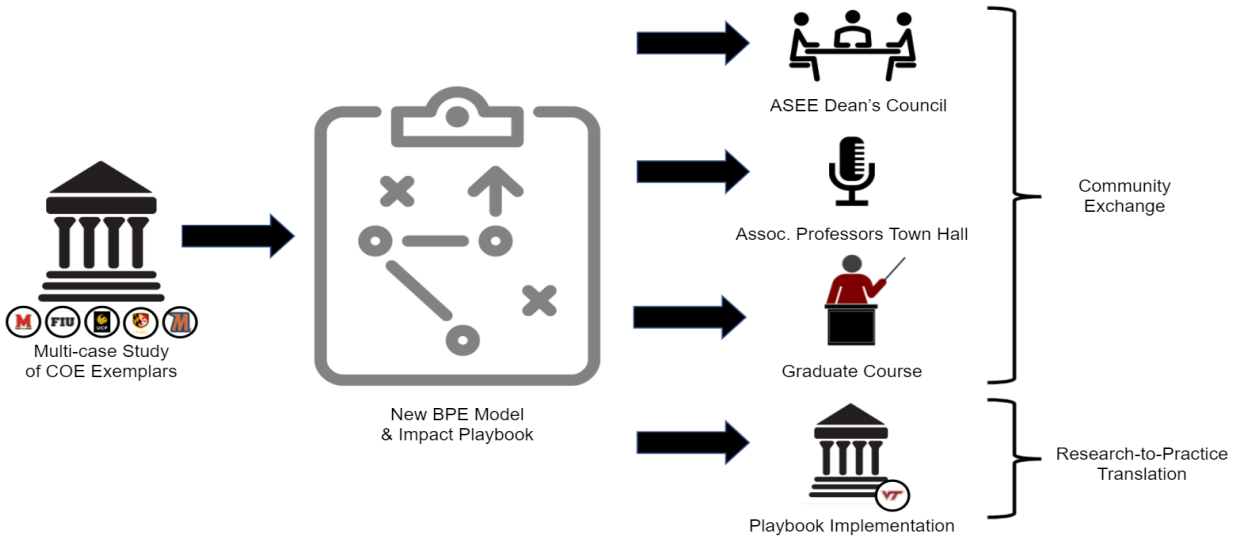

Figure 3. Project Overview

YEAR 1 – SUMMARY

Throughout the first year, we focused on leveraging the advisory board for insights before recruiting participants, conducting pilot interviews with a draft protocol, and refining the DSQ interview protocol. After the advisory board meeting, we conducted pilot interviews with a draft interview protocol with each site coordinator. Apart from serving as the basis for preliminary insights, the pilot interviews also illuminated other topics to add to the protocol and the kind of people we should attempt to talk to at each institution. The remainder of this section will summarize the two main activities of Year 1 (i.e., advisory board meeting and pilot interviews) and the next section will present the outputs of Year 1 (i.e., refined interview protocol and participant role matrix.)

Advisory Board

The advisory board meeting resulted in five key takeaways:

(1) **Advice:** Expand the scholarship used to inform our findings generated from the within and cross-case analysis. **Action:** Instituted a monthly, discussion-based book club among the research team. Topics will include case studies, organizational change, diversity, equity, inclusion, belonging, and best practices for translating research to practice.

(2) **Advice:** Expand the interview protocol to include items explicitly probing into the contextual factors (e.g., historical, local, and state legislation) influencing how the

institutions recruit, retain, and graduate Black and Brown engineers. **Action:** Revised interview protocol. (Refer to Table 3).

(3) **Advice:** Expand the recruitment strategy to include individuals from various levels within the institution (e.g., students, faculty, and staff), resulting in a role matrix that will be used to guide data collection. **Action:** Developed a role matrix (Refer to Table 4).

(4) **Advice:** Pivot from the original research design by conducting interviews virtually in response to uncertainties surrounding the COVID-19; revisit the original plan after the pandemic. **Action:** Scheduled and continuing to conduct all interviews via Zoom.

(5) **Advice:** Expand the secondary data sources to include internal data (e.g., ABET self-study, strategic plans). **Action:** Revised the interview protocol and follow-up email to explicitly ask relevant participants for this information.

Pilot Interviews

As part of the NSF proposal submission process associated with this CAREER Award, we secured a letter of support from an administrator from each institution. These administrators also agreed to serve as the site coordinator of their institution. In some cases, the site coordinator designated an additional person who could assist with recruiting interview participants and logistics associated with site visits. These participants were selected based on their extensive experience and knowledge of the institution's history and progression as a leader in recruiting, retaining, and graduating Black and Brown engineering students. All site coordinators were invited to participate in the pilot interviews; all but one had completed their interview at the time of this publication.

We invited six participants to participate in the pilot interviews through a recruitment email. Five pilot interviews were completed in Year 1 of this project. Each interview was approximately 90 minutes in duration, except for three participants where a second 60-minute interview was scheduled to complete the interview protocol. The second interview was approximately an hour. Two researchers co-facilitated each interview. These interviews were audio-recorded and transcribed verbatim. These interviews are the basis for the refined interview protocol and preliminary insights.

YEAR 1 – OUTPUTS

Refined Interview Protocol

Assessing qualitative research for quality has evolved into a reflexive practice. Researchers should consider and implement measures to ensure research quality from making to handling data [13]. It is imperative to develop dependable procedures that explicitly document how data should be collected, recorded, and analyzed to minimize random influences. As a result, we developed an interview protocol to guide the research team based on the two theoretical constructs guiding this study.

This CAREER research project employs semi-structured interviews to examine how change happens in engineering education, specifically related to the recruitment, retention, and

graduation of Black and Brown engineers. Semi-structured interviews include "both open-ended and more theoretically driven questions" explicitly connected to the research aims and questions [14, p. 45]. We constructed the DSQ interview protocol using Galletta's [14] three-segment framework. The opening segment consists of broad, open-ended question(s) that create space for participants to share their experiences. In contrast, the middle segment consists of questions that capture the nuances of the participants' experiences and transition into questions that relate to the research question. Followed by the concluding statement where the questions are generally theory-driven, carefully explore contradiction (as needed), and ask for final thoughts. These segments are clearly indicated in Table 3.

Process for Refining the DSQ Interview Protocol

Early iterations of the interview protocol included sections focused on the participants' background, university context, changes strategies that broadly address inequality, and closing remarks. However, as we conducted the initial round of pilot interviews, it became apparent how we should allocate additional time for specific participants. We also realized that we needed to reorganize the protocol and include questions that explicitly elicit responses about the inequality regimes, race and racism, and the institution's model for examining change.

Separately, the research team listened to each interview and reflected on specific areas we needed to refine after the pilot interviews. Then, we used our weekly team meetings to refine the interview protocol. The first meeting focused on creating an exhaustive list of questions for each section and creating a detailed outline tailored for each inequality regime. Throughout this process, we intentionally created items that examined the role of race and racism at the institution. The subsequent weekly team meetings consisted of reflecting on each item and collectively discussing whether the item should be removed or included in the interview protocol. This process required each team member to deeply engage with the items and critically examine whether the item(s) aligned with the research aims and questions. Refer to Table 1 to review the refined interview protocol. Each section is mapped to the theoretical and methodological framework using superscripts. These items may be further refined based on the second round of pilot interviews. In addition, we plan to develop two additional interview protocols to facilitate the focus group with students and one-on-one interviews with executive and engineering leaders and staff.

Table 3. Refined interview protocol.

Topic	Interview Questions
Personal Background[1]	1. Let's start by learning a little about you. What roles have you held at ***[Site]*** throughout your time there?
Setting the Context [1,5]	2. How has ***[Site]*** changed since you've been there? If they struggle, mention this… a. Other participants have talked about topics like leadership, students, the university's status among other institutions, etc. You're free to take this in any direction you'd like.

	b. Here's another way to think about it. When reflecting or reminiscing about ***[Site]*** with other colleagues, what topics tend to mark shifts over time? What's top of mind? 3. Describe the relationships between the COE and local entities (e.g., companies, K-12 districts, community colleges). 4. Now that we've talked about local relationships, let's go a little broader. How does the state budget and/or policies influence structural aspects of ***[Site]****?* a. If they struggle, ask them to focus on topics like degree offerings, funding, hiring Capacity/Decisions
Leaders, Faculty, and Staff [2,5]	5. Describe the representation among faculty and students at ***[Site]***. a. If they struggle: focus on the racial/ethnic and gender composition among students and faculty 6. Describe how diversity and inclusion are valued at your institution. a. This value may be present in diversity statements, selection sites, and the hiring pool reflects certain demographics. 7. This site was selected for analysis in this study because it is consistently named among the top producers of Black and brown engineers over the last 10 years. ***How*** do you think this change came about? 8. Who are the people that were most pivotal to driving this success? (Need exact names and their titles) And how did they do so? 9. We just talked about leaders, but we also know that not all change happens based on a top-down approach; some things emerge from the bottom up. So, what role did faculty/staff play in achieving this success?
Focusing on the Five Inequality Regimes [4]	Existing scholarship suggests a few critical decision points that influence racially/ethnically minoritized students' access to engineering education. They are admissions, financial aid, degree requirements, student engagement, and student interactions with faculty and staff. Now we'll spend some time talking about each of these areas.
Admissions [2,4,5]	10. How would you describe the relationship between the COE and the admissions office? 11. Black and brown students are not admitted to engineering programs at the same rate as their white peers. What strategies have ***[Site]*** implemented to address racial inequities? 12. How would you describe ***[Site's]*** outreach and recruitment strategy? a. Sample follow-up questions: Where do students tend to come from? Does ***[Site]*** have relationships with high schools or community colleges in the area that aid with recruiting Black and brown students? ***[Site]*** is located in ***[City, State].*** To what extent do you think that the geographic location of the school impacts the students ***[Site]*** recruits and retains?

	13. What kind of students do you hope are attracted to ***[Site]***? 14. Who makes admissions decisions? Who (which roles within the university) has a seat at the table when making decisions about who gets admitted? 15. Broadly speaking, how have admissions changed over time? a. Who envisioned this change? b. What concrete decisions or actions were implemented to support this change? c. How, if at all, has this change been institutionalized? d. What's on the horizon regarding ***[Site's]*** approach to admissions? What are leaders currently envisioning?
Financial Aid [2,4,5]	16. The cost of higher education is prohibitive for some – especially those from racialized backgrounds. a. What tends to disqualify Black and brown students from receiving some of the largest scholarships offered at ***[Site]***? b. What strategies have ***[Site]*** implemented to address racial inequities that arise in the financial aid process? 17. Please describe the breadth of financial aid resources available to ***[Site]*** students. a. Are there any special scholarships available for engineering students? Black and/or brown students? 18. Who makes financial aid decisions? 19. How has financial aid changed over time? a. Who envisioned this change? b. What concrete decisions or actions were implemented to support this change? c. How, if at all, has this change been institutionalized? d. What's on the horizon regarding ***[Site's]*** approach to financial aid? What are leaders currently envisioning?
Degree Requirements [2,4,5]	20. What is unique about the engineering curriculum at ***[Site]***? 21. Describe some of the main co-curricular spaces on campus that supplement the curriculum. When we come for a campus visit, what are some places we should be sure to check out? 22. What partnerships has the COE fostered with companies and other institutions in the area to benefit current engineering students? (Internship programs, etc.) 23. Outside of the explicitly stated course requirements, are there any other hidden expectations that students need to be an engineer? (Networking, etc.) 24. Can you think of any required engineering classes that have high DFW rates? a. Do you know if the rates differ for Black and brown students? b. What, if any, strategies have been implemented to help students who struggle in these courses? 25. Teaming is a big part of engineering education. a. Who tends to be in decision-making roles within engineering teams associated with class projects? Within engineering professional societies? b. Who tends to be in the most technical roles within engineering teams associated with class projects? 26. Who (which student demographic) gets access to high-impact experiences (internships, undergraduate research, study abroad, co-ops)? 27. How has the engineering curriculum changed over time?

	a. Who envisioned this change? b. What concrete decisions or actions were implemented to support this change? c. How, if at all, has this change been institutionalized? d. What's on the horizon regarding ***[Site's]*** approach to financial aid? What are leaders currently envisioning?
Student Interactions with Faculty [2,4,5]	28. How would you describe the interactions between engineering students and faculty? a. Are there any differences in interactions based on race (specifically Black and brown)? b. In what ways do engineering students interact with faculty and staff outside of the classroom? (Brown bag lunch, office hours, etc.) 29. Describe the teaching strategies used in your engineering classes. 30. Describe how your favorite engineering class was structured. 31. How have student interactions with faculty changed over time?
Race, Racism[3]	Before we wrap up, we want to talk explicitly about race and how the institution has wrestled with race-based elements of its past. 32. Tell me a little about the role of race and racism at ***[Site]*** – currently or historically. 33. What is one of the most salient race-based (racist) incidents in the last 10 years of ***[Site's]*** history? Follow-up: What has been done to overcome its negative impacts? 34. Given the shifting socio-political climate surrounding Black Lives Matter, what, if anything is ***[Site]*** doing to support Black students? 35. Given the shifting socio-political climate surrounding federal immigration policy, what, if anything is ***[Site]*** doing to support brown students?
Wrapping Up[3]	36. Is there anything else that you'd like to share with me? 37. We would also appreciate your insight in identifying participants that have the potential to shape our understanding of how [Site] has changed over time and resulted in a leading institution responsible for graduating the most Black and Brown engineers. a. What are the names of the people we should talk to next? b. Are there specific positions we should include in our case study?

Note: [1] Galletta's opening segment; [2] Galletta's middle segment; [3] Galletta's concluding segment; [4] Items examining Acker's five inequality regimes; [5] Items examining Kotter's three phases of change

Role Matrix

We developed a role matrix to cross-reference between the interview items and anticipated participant roles since we do not plan to ask every participant every question. These roles were identified based on suggestions from the advisory board and site coordinators that participated in the pilot interviews.

In addition to interviewing faculty, staff, and administrators at each site, we are also interested in recruiting students involved in the executive board of identity-based student organizations (e.g., NSBE, SHPE, AISES) to participate in focus groups. Similarly, we are interested in recruiting staff and leadership of identity-based co-curricular programs (e.g., LSAMP, CD-SSEC (FIU), McKnight Scholars Program, McNair Scholars Program). Table 4 provides a global view of the role matrix. The role matrix will vary on the institutional structure.

Table 4. Global Role Matrix

Interview Topics	University Leaders and Staff	Admissions Leaders and Staff	Financial Aid Leaders and Staff	Co-Curricular Support & Outreach Leaders	College of Engineering Leaders	College of Engineering Faculty	Engineering Students
Personal Background	✓	✓	✓	✓	✓	✓	✓
Setting the Context	✓	✓	✓	✓	✓	✓	
Leaders, Faculty, and Staff	✓	✓	✓	✓	✓	✓	
Admissions	✓	✓		✓	✓		✓
Financial Aid	✓		✓	✓	✓		✓
Degree Requirements	✓				✓	✓	✓
Student Engagement				✓			✓
Student Interactions with Faculty				✓		✓	✓
Race, Racism	✓	✓	✓	✓	✓	✓	✓
Wrapping Up	✓	✓	✓	✓	✓	✓	✓

YEAR 1 – PRELIMINARY INSIGHTS

The preliminary results shed light on each exemplar's approach to each construct within the Inequality Regimes, but less insight about how the change came about (yet). To understand how inequalities are produced and challenged in a higher education context, we adapted the inequality regimes from a workplace context to examine the racial inequalities present within admissions, financial aid, degree requirements, student engagement, and student interactions with faculty and staff.

University of Maryland (UMD) is the flagship institution in Maryland. UMD uses a holistic approach to admissions, which means that they consider both quantitative and qualitative attributes of the students to evaluate them using 26 factors. This change significantly improved

the recruitment of women into engineering but has not had as big of an impact on Black and Brown students. At UMD, the staff in the College of Engineering have a say in who gets admitted. They use a training manual as part of the process to ensure consistency in admissions decisions across reviewers. It was not uncommon for multiple members of the same family (often across multiple generations) to attend UMD. UMD is a test-optional institution, meaning they do not require standardized scores for admission into the university. As it relates to financial aid, UMD has a variety of financial needs and merit-based scholarships to offer students. Specific scholarships based on race are not allowed (because of legal reasons). Still, COE leadership used scholarships based on the students' home zip code and first-generation college status to proxy for other demographics. They made multi-year financial offers, used a common application that automatically distributes funds to those who qualify, and dropped the GPA requirement (from 3.2 to 3.0) for maintaining a scholarship. Several participants mentioned the leadership, vision, and efforts of Dr. Darryl Pines (as Engineering Dean and now UMD President). Likewise, the contributions of individual faculty members and staff were also mentioned. Details about the uniqueness of UMD's engineering degree requirements, student engagement on campus, and student-faculty interactions are still developing.

Morgan State University is a Historically Black College/University located in Baltimore, Maryland. Morgan State University employs a university-level admissions approach. Anyone who meets the minimum admissions requirements gets accepted into Morgan's engineering program. Morgan also has a legacy of generational familial attendance. Anyone who gets admitted to Morgan is required to take the math placement exam (MAP). Poor performance on the MAP was the underlying reason for the development of an online summer course focused on sharpening their pre-calc math skills, a program institutionalized within the College of Engineering and later adopted by the university. As it relates to financial aid, thus far, the participants spoke more about the difficulties with securing funding (for the university and students) rather than their approach to distributing financial aid and scholarships.

Regarding degree requirements, Morgan has competed with UMD and UMBC about which degrees they can offer. Thus, the interplay between institutions within the state of Maryland is an area we plan to continue probing. Details about the uniqueness of Morgan's financial aid strategy, engineering degree requirements, student engagement on campus, and student-faculty interactions are still developing.

The University of Maryland-Baltimore County (UMBC) is a top producer of Black scientists and engineers who matriculate to earn PhDs and MD-PhDs in natural sciences and engineering. This achievement can be primarily attributed to the Meyerhoff Scholars Program housed within the Academic Affairs office at UMBC. The Meyerhoff Scholars Program (MSP) helps students navigate academia, learn about undergraduate research experiences, form relationships with faculty, and learn how to author their STEM identity. UMBC, in general, and MSP, in particular, teach and practice the importance of social and community engagement. One uniqueness about the MSP is the establishment of a formal mechanism for Meyerhoff Scholars' parents to engage with the prospective and current UMBC students via the Selection Weekend, Summer Bridge Program, and the Winter Stress Buster event. UMBC typically admits students from high schools in Baltimore County, Prince George's County, and Howard County as it relates to admissions. Still, ironically, UMBC rarely admits students from Baltimore City Schools. UMBC has implemented infrastructure to help community college students transfer to four-year undergraduate programs resulting in UMBC recruiting and admitting more transfer students. Efforts to recruit students from Baltimore City include UMBC Honors College officials

regularly meeting with Baltimore City Schools to discuss average SAT scores and GPAs compared to students from other schools in the applicant pool. These meetings also helped UMBC officials recognize their recruitment approach was delayed and underfunded compared to UMD. UMBC implemented the Sherman Teacher's Scholar Program to improve its recruitment approach. Students majoring in STEM disciplines are encouraged to teach and mentor in math camps for schools in Baltimore City and Anne Arundel County (where 90% of students are children of immigrants). UMBC intends to provide elementary and middle school students with early exposure to its university through this new recruitment strategy. Regarding financial aid, specific scholarships and programming based on race are not allowed (because of a legal dispute at UMD). Details about the uniqueness of UMBC's engineering degree requirements, the Meyerhoff Scholars Program, financial aid strategy, student engagement on campus, and student-faculty interactions are still developing.

Florida International University is a Hispanic Serving Institution located in Miami, Florida. FIU has a large international student population based on its geographic location and connection with Latin American and Caribbean countries. President Rosenberg implemented programs to increase undergraduate advising and career coaching for job placement. He also implemented several task forces to improve diversity, equity, and inclusion across the university by implementing STEM groups for women and people of color. FIU's recruitment strategy involves community engagement and establishing partnerships with local community colleges to promote new engineering programs and recruit prospective transfer students. As it relates to the financial aid strategy, the College of Engineering has received funding from industry partners, and the Center for Diversity and Student Success (CDSSEC) has worked with the COE to establish additional funding opportunities for undergraduate engineering students. Undergraduate students also receive undergraduate research experiences through the McNair scholars program.

Regarding degree requirements, as a part of the University Core Curriculum (UCC), students are expected to engage in study abroad opportunities or enroll in global learning courses. The COE implemented a four plus one program where engineering students could earn a Bachelor's and Master's of Science concurrently. Details about the uniqueness of FIU's admissions, financial aid strategy, engineering degree requirements, student engagement on campus, and student-faculty interactions are still developing.

LOOKING AHEAD

In this executive summary, we described the process used to develop and refine the interview protocol and recruitment strategy associated with the first year of the CAREER award that aims to disrupt the status quo regarding who gets to be an engineer.

Future research and education activities include launching a monthly book club, data collection, analysis, exchanging insights with the engineering education community, and developing the project deliverables. The monthly book club will consist of the research team reading and discussing 12 books related to the research project. The data collection activities consist of conducting virtual interviews, collecting publicly available information, and preparing for the upcoming campus visits at each site. We will use the data collected to conduct a within-case analysis. These results will inform the development of impact narratives about each exemplar, a change model for broadening participation in engineering informed by the collection of cases, and an impact playbook that COEs stakeholders can use to translate research into practice. The most immediate efforts for exchanging insights with the STEM education

community include hosting meetings with leaders in the College of Engineering and College of Science at Virginia Tech (the research team members' home institution) to discuss their priorities. This conversation will inform our strategy when implementing insights from the CAREER project in a new institutional context.

The results of this work will reveal evidence-based approaches to broaden participation among students historically excluded from engineering education and careers. Understanding strategies envisioned and institutionalized by these exemplary COEs will allow the research team to document the expansion of who gets to be an engineer and lead to the translation of research to practice through partnerships with current and aspirational leaders in COEs throughout the United States who are aiming for lasting change.

ACKNOWLEDGEMENTS

This work was supported through funding by the National Science Foundation CAREER Grant No.# 2042377. Any opinions, findings, conclusions, or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation. The authors would also like to acknowledge the pilot participants and the advisory board for their feedback on earlier versions of the interview protocol and recruitment strategy.

REFERENCES

[1] B. Yoder, "Engineering by the Numbers," 2016.
[2] E. A. Cech and T. J. Waidzunas, "Navigating the heteronormativity of engineering: The experiences of lesbian, gay, and bisexual students," *Eng. Stud.*, vol. 3, no. 1, pp. 1–24, 2011, doi: 10.1080/19378629.2010.545065.
[3] A. E. Slaton, *Race, Rigor, and Selectivity in US Engineering: The history of an occupational color line*. 2010.
[4] J. B. Slaughter, Y. Tao, and W. Pearson, *Changing the face of engineering: The african american experience*. John Hopkins University Press, 2015.
[5] M. Borrego and C. Henderson, "Increasing the use of evidence-based teaching in STEM higher education," *J. Eng. Educ.*, 2014, doi: doi:10.1002/jee.20040.
[6] J. Acker, "Inequality regimes: Gender, class, and race in organizations," *Gend. Soc.*, vol. 20, no. 4, pp. 441–464, 2006, doi: 10.1177/0891243206289499.
[7] L. Alfrey and F. W. Twine, "Gender-Fluid Geek Girls: Negotiating Inequality Regimes in the Tech Industry," *Gend. Soc.*, vol. 31, no. 1, pp. 28–50, 2017, doi: 10.1177/0891243216680590.
[8] J. M. Thomas, "Diversity Regimes and Racial Inequality: A Case Study of Diversity University," *Soc. Curr.*, vol. 5, no. 2, pp. 140–156, 2018, doi: 10.1177/2329496517725335.
[9] J. P. Kotter, *Leading Change*. Harvard Business Review Press, 2012.
[10] R. K. Yin, *Case study research and applications: Design and methods*, Sixth. Thousand Oaks: Sage, 2018.
[11] R. E. Stake, *Multiple case study analysis*. Guilford, 2013.
[12] J. Roy, "Engineering by the Numbers," 2019.
[13] J. Walther *et al.*, "Qualitative Research Quality: A Collaborative Inquiry Across Multiple Methodological Perspectives," *J. Eng. Educ.*, vol. 106, no. 3, pp. 398–430, 2017, doi:

10.1002/jee.20170.
[14] A. Galletta, *Mastering the Semi-Structured Interview and Beyond: From Research Design to Analysis and Publication*, New York U. 2013.