DO WE KNOW WHO IS REALLY DOING THE PLANTING?
A CASE STUDY OF TRADITIONALLY WHITE INSTITUTIONS IDENTIFIED AS TOP DEGREE PRODUCERS OF BLACK ENGINEERING UNDERGRADUATES

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At a time when engineering schools in traditionally White institutions (TWIs) create challenging spaces for ethnically underrepresented and other students from marginalized groups, some schools have successfully graduated a high number of Black engineers at the BS level for the past five years. This qualitative study uses a case study research method to explore how two engineering schools are able to engage and support their Black undergraduates; this study also investigates how these engineering schools can build capacity for diversity and inclusion using the Smith (2009) Framework for Institutional Diversity. Through this investigation, the researcher discovered that TWIs that graduate a high number of Black engineers are not always accomplishing this goal intentionally. However, schools that demonstrate intention can change the culture and climate of their environment and create an inclusive and supportive space for students, staff, faculty and administrators. The researcher discovered four key lessons from this study: informed and engaged leadership is imperative; intentionality matters; interest

convergence may create an open door, but it does not necessary affect long-term change; and racial battle fatigue can destroy morale and negatively affect an engineering community.

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"Education is the most powerful weapon which you can use to change the world"

- Nelson Mandela

The lack of equity in education for people of color, especially economically disadvantaged people of color has always been a point of frustration for me. The disparities and obstacles can be overwhelming. I pray that my work creates opportunity by exposing structural barriers that create inequity and offering solutions to educational challenges.

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1.0 INTRODUCTION

In the past decade there have been numerous United States publications that expressed a need for the country to increase its production of science, technology, engineering and mathematics (STEM) talent to remain globally competitive (National Academies, 2007, 2010). While identifying domestic talent remains a challenge, most STEM fields do not include a significant number of individuals from ethnically underrepresented groups in proportion to the representation of those groups in the United States population. As the country is becoming increasingly diverse, Blacks, Latinos and Native Americans remain significantly underrepresented in STEM fields (Babco, 2001a, 2001b; George, Neale, Van Horne & Malcom, 2001). A 2001 report from the American Association for the Advancement of Science (AAAS) urged the country to identify the reasons why high achieving ethnically underrepresented students do not enter college as STEM majors. It also instructed the country to identify why those students who do enter as STEM majors do not always complete degrees at high rates or go on to pursue doctoral degrees in STEM areas (George et al., 2001, p. 3). To address this crisis, the AAAS report encourages the United States to expose a broader population of its citizens to STEM fields, prepare them to be academically successful, and retain both students and professionals who express an interest in these fields (George et al., 2001).

While the demand for STEM professionals continues to increase, there are obstacles that make student retention and degree completion challenging (Meyer & Marx, 2014). According to

Seymour and Hewitt (1997), 40% of STEM majors complained of insufficient preparation in high school. Additionally, students find the STEM environment within higher education to be disappointing because of negative interactions with faculty and advisors, as well as unwelcoming school climates. These experiences reduce student persistence and lead many to pursue other college majors (Haag, Hubel, Garcia & McBeath, 2007; Marra, Rodgers, Shen & Bogue, 2012; Seymour & Hewitt, 1997).

While most of the publications previously discussed address general issues related to STEM, this dissertation focuses on the production of Black engineers at the baccalaureate level within traditionally White institutions. Of all the engineering schools in the United States, only 15% have a Black student enrollment of 5% or more; additionally, only four of the traditionally White institutions have a Black engineering student enrollment that is 10% or higher (McGee, Robinson, Bentley & Houston, 2015). Therefore, the lack of representation of Black students in engineering is apparent.

When discussing the low numbers of Blacks in engineering majors and careers, it is common to hear explanations that come from a deficit perspective. For example, some respond that the low numbers of Black students represent a lack of motivation or an absence of family support (Thernstrom & Thernstrom, 1997). However, in recent publications scholars have begun to shift the conversation from discussing student problems to recommending changes that institutions can make to address historical biases and increase the number of ethnically underrepresented students (Davis, 2014; Harper, 2010a). For example, Harper (2010a) provides an anti-deficit framework that studies the factors that enable successful students of color to graduate and transition into the workforce by examining their pre-college, undergraduate, and post college persistence in these disciplines. Studies indicate that ethnically underrepresented students who develop a science identity through experiences and interaction with role models are more likely to persist in the major (Chang, Eagan, Lin & Hurtado, 2011; Espinoza, 2011). Additionally, students who have a strong foundation in math and science and receive STEM exposure as pre-college students tend to persist in STEM disciplines (Eris, Chachra, Chen, Sheppard, Ludlow, Rosca & Toye, 2010).

1.1 BACKGROUND

Engineering is a respected profession in the United States that has contributed tremendously to the development of our country. It has been the basis of industrial advancement, economic development and technological innovation for many years and George Washington, our first president, was an engineer who promoted science and math literacy (Gonzalez & Kuenzi, 2012; Grayson, 1993). However, our country has a legacy of institutional racism that created a tumultuous journey for Black students seeking engineering degrees and Black professionals working in the engineering field. This history began prior to the Civil War and it is embedded in the foundation of engineering education in the United States (Slaton, 2010). As a result, Black inventors such as Lewis Latimer, Elijah McCoy and Granville T. Woods, did not receive the recognition and acknowledgement they deserved for their contributions made to the industrial and technological developments of the late nineteenth century (Fouché, 2003; Newman, 2011; Wharton, 1992). For example, Granville T. Woods, a Black man who was born prior to the Civil War, received only a few years of formal education but devoted his life to learning about the railroad system (Williams, 2012). Through an apprenticeship and private study, Woods became an engineer in 1878 and some believe him to be the first Black mechanical and electrical engineer in America. He was responsible for patenting many inventions such as the steam boiler furnace, the telephone transmitter, the railway telegraphy and the electric railway system (Fouché, 2003, Williams, 2012). Another example is William Hunter Dammond, an honor civil engineering graduate and the first Black graduate of Western University of Pennsylvania, known today as the University of Pittsburgh. Dammond was responsible for many inventions, but he struggled to get recognition and acceptance in the engineering profession (Barksdale-Hall, 2007). In addition to these individuals, many other Black engineers served in this important profession as outsiders (Blackwell, 1987)

For almost 45 years, there have been many attempts to increase the number of Black engineers (Blackwell, 1987; Davis, 2014; Padulo, 1974; Slaughter, Tao & Pearson, 2015; Wharton, 1992). While this effort led to some improvements and structural changes such as more HBCUs with accredited engineering programs, 3-2 partnerships between engineering schools and liberal arts colleges, and an increased number of Black engineering students attending traditionally White institutions, the percent of Black students who earn BS degrees in engineering each year has declined since the late 1990s (Davis, 2014).

1.2 PURPOSE

Since engineering is a growing profession that is critical to our country's continued technological advancement and the country is becoming more diverse, the need to broaden the pool of engineers by including higher numbers of people from underrepresented groups is imperative (National Academies, 2011). However, identifying the best solution to accomplish this task has been a challenge (Davis, 2014; Pawley, 2013). Therefore, instead of focusing this study on the Black students who did not make it to engineering or those who did not persist to graduation, this research studies the approaches used by two traditionally White institutions that have been successful in awarding high numbers of baccalaureate degrees in engineering to Black students between 2011 and 2015. Committing to "learn from the small numbers", instead of focusing on quantitative measures that are typical in engineering research, allowed me to determine the approaches that support and engage students from the perspective of administrators, faculty and staff, and identify the institutional structures that support Black engineering undergraduates (Pawley, 2013, p. 2).

1.3 RESEARCH QUESTIONS

To investigate this topic, one research question and three associated sub-questions have guided the study. What are the approaches used to support and engage Black engineering undergraduates within traditionally White engineering schools that are top producers of Black engineers at the baccalaureate level?

A. How are the resources (expertise, finances, people and structures) in these engineering schools used to support Black engineering undergraduates?
B. How does the leadership of these engineering schools create or facilitate the creation of an inclusive and engaging environment for Black engineering undergraduates through academic and non-academic experiences?
C. How do these engineering schools identify and evaluate the success of Black engineering undergraduates?

1.4 SIGNIFICANCE OF THE STUDY

According to a University staff member who supports the retention efforts of underrepresented engineering students, “engineering departments are stuck in a color-blind ideology, which engenders a lack of comfort in discussing critical issues of race and ethnicity” (McGee, Robinson, Bentley & Houston, 2015, p. 14). Yet, these issues are often the very ones that, when appropriately addressed, create a welcoming and supportive community for engineering students of color. Ethnically underrepresented engineering students place a high value on their social community as “an environment where like-minded individuals engage in dynamic, multidirectional interactions that facilitate social support” (Mondisa & McComb, 2015, p. 1). Additionally, there is a strong correlation between the success of engineering students of color and their social community (Maton, Pollard, McDougall & Hrabowski, 2012; Mondisa & McComb, 2015; National Academies, 2011). This connection is even more critical for Black students who might feel isolated or unwelcomed by engineering environment (May & Chubin, 2003; Mondisa & McComb, 2015). For engineering schools at traditionally White institutions to increase the number of Black students graduating with BS degrees, it is important for them to establish a structure that addresses the culture and climate challenges of their environments (National Academies, 2011). By studying the institutional culture and climate of traditionally White engineering schools that have demonstrated success in producing Black baccalaureate degree holders in engineering, this research will provide information for engineering education administrators, faculty, and staff, as well as higher education scholars who study practices that enable schools to increase their production of Black engineers.

1.5 SITUATING THE STUDY

1.5.1 Terminology

Below is a list of terms that are common in engineering education or the minority engineering networks. I chose to explain these terms to provide clarity to the reader.

American Association for Engineering Education (ASEE)

Founded in 1893 as the Society for the Promotion of Engineering Education (SPEE), the American Society for Engineering Education is a nonprofit organization of individuals and institutions committed to furthering education in engineering and engineering technology. The membership of this organization includes faculty, staff and students affiliated with engineering or engineering technology. The website for ASEE is https://www.asee.org/.

Black

Black and African American are common race descriptors frequently used interchangeably. However, the changing ethnic identity of Blacks in America has complicated these two labels. Most Blacks living in the United States are descendants of Africans brought to the country through the transatlantic slave trade, which ended in 1865 (Jackson & Cochran, 2003). Beginning in 1965, immigration reforms enabled many Black immigrants to relocate to the United States and the highest percentage of immigrants come from Caribbean or African countries (Anderson, 2015). Immigrants contributed to nearly 25% of the Black population growth between 2001 and 2006 (Kent, 2007). Additionally, almost 12% of all Black children age 10 and younger have at least one Black immigrant parent and that percentage has nearly doubled since 1990 (Hernandez, 2012).

Since Integrated Postsecondary Education Data Systems (IPEDS) does not disaggregate Black students by ethnicity or national background, it is unclear which students are descendants of Blacks whose families have been in the United States for several generations, or which students are descendants of recent immigrants (Byrd, Dika & Ramlal, 2013). Therefore, distinguishing between the ethnicities of Black college students is difficult. Regardless of ethnicity, all Black groups experience institutional racism similarly because of the historical legacy of discrimination in the United States (Waters, 1999). This study will use the term Black to describe these groups, unless the referenced literature uses the term African American.

Center for the Integration of Research, Teaching and Learning (CIRTL)

CIRTL is a NSF funded center for STEM teaching and learning in higher education. The goal of the center is to advance learning by equipping future faculty members with effective teaching methods to improve the educational experience of STEM students at multiple education institutions, increase the diversity of people pursuing STEM fields, and improve the STEM literacy of the country. The website for CIRTL is www.cirtl.net/

Historically Black College or University (HBCU)

A college or university that is a part of the group of institutions originally created to educate Black students pursuing postsecondary education.

Louis Stokes Alliances for Minority Participation (LSAMP)

The LSAMP program is a National Science Foundation funded program created in 1991 to increase the number of underrepresented minorities earning degrees in STEM fields. The program functions through alliances of multiple two and four-year institutions and provides students with academic and social support in their transition to a baccalaureate degree program, persistence to graduation, and transition to graduate studies. There is more information on this program at www.lsampsymposium.org

Minority Engineering Program (MEP)

An academic support program typically within traditionally White engineering schools that provides academic enrichment, retention and community building activities for Black, Latino, Native American and other ethnically underrepresented engineering students.

National Action Council for Minorities in Engineering (NACME)

NACME is a non-profit organization that supports ethnically underrepresented students through excellence in engineering education, career development and scholarship support. The organization funds high-achieving students pursuing degrees in STEM fields and supports their career development efforts during their undergraduate years. The NACME website is www.nacme.org.

National Association of Multicultural Engineering Program Administrators (NAMEPA)

NAMEPA, formerly known as the National Association of Minority Engineering Program Administrators, provides professional development to minority engineering program professionals and industry representatives regarding best practices to recruit, retain and graduate ethnically underrepresented engineering students. The organization was created to serve "as an advocate for the academic, vocational, emotional and social needs of engineering students" and to provide "a forum for discussion of issues vital to the success of the (minority engineering) Effort." (National Association of Multicultural Engineering Program Advocates, 1987, p. 9)

The National GEM Consortium (GEM)

The GEM Consortium is an organization that started in 1974 to increase the number of ethnically underrepresented students earning graduate degrees in engineering. This organization was a part of the University of Notre Dame campus with funding from the Sloan Foundation.

Today GEM is a stand-alone organization that provides graduate school preparation workshops and fellowships to ethnically underrepresented students seeking a graduate degree in engineering or technology. The GEM website is www.gemfellowship.org.

Society of Hispanic Professional Engineers (SHPE)

The Society of Hispanic Professional Engineers is a professional organization whose mission is to empower the Hispanic community through STEM awareness, access, support and development. The organization began in 1974 with a group of professional engineers who were to serve as role models in the Hispanic community. Today the organization includes pre-college, collegiate (both undergraduate and graduate), and professional members. SHPE provides support, professional development and community connection for its members in seven regions across the United States and Puerto Rico. The SHPE website is www.shpe.org.

STEM

Science, technology, engineering and mathematics. Since the STEM acronym includes engineering, the document frequently uses the term interchangeably when discussing activities or best practices related to engineering majors or careers.

Traditionally White Institution (TWI)

A college or university, also known as a predominately White institution (PWI) or a historically White institution, whose student population has traditionally contained a White majority. The term traditionally White is used because some of the institutions formerly known as PWIs, such as some of the Hispanic Serving Institutions, may have a population of students that is primarily ethnically underrepresented.

1.5.2 Positionality

The achievement of Black students, particularly high achieving Black students with limited resources, has been an interest of mine since the early 1990s, when I completed my undergraduate degree in physics education at Lincoln University of Pennsylvania. This interest developed because of my personal journey as well as my observations of the educational experience of my peers from various backgrounds. As a Black female who is a first-generation college graduate from a low socioeconomic background, I embraced education as the key to my future and my way out of lack. My mentors and role models believed in me and cultivated my potential by encouraging me to take rigorous courses, connect with motivated peers, enroll in college, and pursue a degree in engineering. While I completed most of the action items they suggested, instead of earning an engineering degree I followed their example and became an educator.

Over more than 20 years, I have worked with underrepresented students on both the pre-college and undergraduate levels. I have shared in my students' daily experiences and witnessed many highs and lows on their journey. From watching a first-year engineering student give a research talk and own the room, to counseling a student who is having difficulty connecting with her peers because they told her that they cannot relate with her culturally, these experiences have shaped and taught me the importance of community connection. These experiences have also given me a heart for students who experience difficult situations without having a connection to informed peers or caring adults in an academic environment.

As a minority engineering program professional, I am a member of the American Society for Engineering Education (ASEE), a professional organization that keeps me informed about broader issues within the area of engineering education. Within that organization, I am a member of the pre-college engineering education and the minorities in engineering divisions. I am also an active member of the National Association of Multicultural Engineering Program Advocates (NAMEPA), where I just completed a two-year term as the national secretary and formerly served as a regional officer and member of the national conference planning committee. I am a member of the National Society of Black Engineers (NSBE), and I served as the advisor of the University of Pittsburgh chapter from 2008 – 2016. As a staff member at the University of Pittsburgh, I received the Blue Stars Red Carpet Award as the NSBE advisor in 2009 and the Chancellor's Affirmative Action Award in 2011. Additionally, I received the 2012 NSBE Golden Torch "Minority Engineering Program Director of the Year" Award in recognition of my contributions to supporting underrepresented students in engineering and the 2016 Lottie P. Edwards EdD Community Service Award for my work STEM education from the Mt. Ararat Community Activity Center. These organizations, their associated experiences, and the honors mentioned above provide examples of who I am as an educational practitioner. They also represent the value that I place on supporting marginalized students.

1.5.3 Analytical lens – Critical Race Theory

Due to the racialized experiences in my personal and professional life, I embrace critical race theory (CRT) as an analytical lens. Critical race theory started in the field of law with a historical understanding of the experiences related to the civil rights movement as well as other ethnic, social and gender studies movements. Critical race scholars believe that racism is a common part of American social institutions (Delgado & Stefancic, 2012; Gillborn, 2008). It is "ordinary, not aberrational – normal science, the usual way society does business, the common everyday experience of most people of color in this country" (Delgado & Stefancic, 2012, p. 7).

One of the constructs included in critical race theory is “interest convergence”, which explains that the historical advances of Blacks (*or other marginalized groups*) in the United States have only taken place because of the benefits to Whites (*or those in the elite group*) (Bell, 1980; Delgado & Stefancic, 2001). This perspective provides a way of understanding the world that helps when navigating through life, particularly in engineering spaces.

While it took years for me to embrace this lens, I understand the significance of using it to observe the dynamics between race, racism and power and to share the stories of marginalized people to add a historical and cultural narrative. In this document, CRT illuminates the racialized experiences that emerged in the historical review of engineering education, it influenced the development of the interview protocol, and it helped when analyzing the findings of this study.

1.6 ORGANIZATION OF THE DOCUMENT

This dissertation explores the history of Blacks in engineering education through a qualitative study that seeks to understand the practices of traditionally White engineering schools that are successful in graduating high numbers of Black engineering undergraduates. Chapter 2 of this document provides a historical review of literature pertaining to Blacks in engineering, beginning with the development of engineering education and ending in current years. Chapter 3 explains the conceptual framework of the study. Chapter 4 provides systematic instructions of the case study method used to investigate the problem. Chapter 5 reports on the two schools investigated in this study. Chapter 6 describes the general findings and reviews the concepts that emerged from the study and Chapter 7 provides conclusions and recommendations for future research, policy and practice.

2.0 HISTORICAL REVIEW OF BLACKS IN ENGINEERING EDUCATION

In the United States, Black people have historically encountered many barriers that have not only frustrated their general educational experience, but also their higher education journey. For more than 200 years prior to the conclusion of the Civil War, enslavement was legal in the United States and it was a prevalent part of the culture and financial structure of the country (Franklin & Moss, 1988). This practice kidnapped African people from their families, disconnected them from their country of origin and history, relocated them to the Americas, and sold them, their talents and skills as property. It was illegal for enslaved people to read or write and those who gained literacy skills did so in secret. In fact, it was common for those enslaved individuals seeking an education to be hurt or even killed (Humphries, 1994). These prohibitions against literacy continued 100 years after the Civil War with laws that promoted racial inequality and institutionalized segregation. Despite these challenges, Blacks pursued literacy and broader opportunities for education (Anderson, 1993; Blackwell, 1987; Fouché, 2003).

This review of literature highlights the historical trends regarding the educational experiences, particularly in the field of engineering, of Black students in the United States. It also examines the development of engineering education and the history of Blacks in the field of engineering. Finally, the review concludes by noting the current state of Blacks enrolled in and completing undergraduate degrees in engineering, while reviewing contemporary developments in the field.

2.1 EARLY HIGHER EDUCATION OPPORTUNITIES FOR BLACKS

The nineteenth century marked a time of firsts for Blacks in higher education. In 1823, Alexander Lucius Twilight became the first Black man to graduate from an American college; he received a bachelor's degree from Middlebury College in Vermont (Bennett, 1988). Three years later, two additional Black men graduated from college; Edward Jones received a degree from Amherst College in Massachusetts and John Russwurm received a degree from Bowdoin College in Maine (Cowan & Maguire, 1995). In 1833, Oberlin College in Ohio became the first institution in the United States to openly welcome Blacks and admit them without respect to race. Prior to the opening of Oberlin, Black students occasionally received admission to American colleges and universities, but without the open access that was available to White students. Oberlin was also the first school to grant a degree to a Black female, Mary Jane Patterson, in 1862 (Cowan & Maguire, 1995).

Additionally, the first colleges created for Blacks opened during the nineteenth century. Missionary aid societies opposed to slavery founded many of the early institutions known as Historically Black Colleges and Universities (HBCUs). Black students who were previously uneducated were the beneficiaries of these schools, so elementary and secondary instruction was a part of the educational curriculum (Humphries, 1994). Cheyney University, formerly the Institute for Colored Youth, was one of the first HBCUs established in 1837. This Pennsylvania institution started as an elementary and high school for the education of children freed from slavery and later evolved into a degree granting college (Franklin & Moss, 1988). In 1854, the American Missionary Association established Ashmun Institute, later known as Lincoln University of Pennsylvania. Lincoln was the first HBCU to award baccalaureate degrees (Roebuck & Murty, 1993). While the creation of these schools expanded opportunities for Black students, too often the members of the missionary organizations that created them were paternalistic and condescending towards Blacks and motivated by a need to "civilize" them (Allen & Jewel, 2002; Brazzell, 1992).

By the conclusion of the Civil War, there were only 28 Black people with baccalaureate degrees in the United States (Roebuck & Murty, 1993). Additionally, very few Black people freed by the Emancipation Proclamation could read, write or do mathematics (Humphries, 1994). Therefore, the U.S. government formed the Bureau of Refugees, Freedmen and Abandoned Lands, commonly known as the Freedmen's Bureau, to support previously enslaved Blacks with their transition to independence and freedom, which included providing medical, contract and other services. The Freedmen's Bureau, and some church affiliated missionary groups, began to establish primary and secondary schools to educate formerly enslaved Black people and their children. They also assisted with the creation of additional historically Black colleges and universities.

2.2 THE BEGINNING OF ENGINEERING EDUCATION

Since the founding of the United States in 1776, there was a need for engineers to provide military, construction and mechanical expertise to the country (Gonzalez & Kuenzi, 2012; Grayson, 1993). The U.S. had no formal means to train new engineers and the limited number of engineers available received their training in Europe (Grayson, 1993). In the nineteenth century, as the United States began to transition from an agricultural to an industrial society, the demand for engineers grew even more. However, the existing higher education institutions in the country focused on religion and classical instruction and did not include the practical educational courses necessary to train engineers (Rudolph, 1990). In 1802, Congress established the United States Military Academy as the first engineering school in the country. While the U.S. Military Academy at West Point did not award engineering degrees until 1933, the cadets who went through training were able to perform military and civilian tasks related to the field of engineering (Grayson, 1993). Later, civilian schools of engineering began to emerge. Norwich University, founded in 1819, was the first civilian school of engineering and Rensselaer Polytechnic Institute (RPI), founded in 1824, awarded the first undergraduate degree in engineering in 1835 (Grayson, 1993).

By 1862, at a time when the United States was a divided country due to the Civil War, the Union that was composed of the Northern states established new policies designed to prepare the country for an industrial transformation. According to Grayson (1993), three important policies led to the emergence of engineering education in the United States: 1) The Homestead Act, which encouraged people to move westward by providing 160 acres of land to any head of household who worked five years to improve the land, led to the construction of new roadways and homes. 2) The United States transcontinental railroad charter, which created a project that called for skilled laborers and engineers and 3) The Morrill Federal Land Grant of 1862, which provided federal funds to states to create at least one college in that state to teach agriculture or mechanics and provide a practical education (Gonzalez & Kuenzi, 2012; Rudolph, 1990). These policies increased the demand for engineers and shifted the focus of higher education (Grayson, 1993). Additionally, the Morrill Act caused the number of engineering schools in the United States to increase from less than 24 schools in 1862 to 70 schools by 1872 (Grayson, 1993, p 43).

2.3 THE EXCLUSION OF BLACKS

In 1863, President Abraham Lincoln signed the Emancipation Proclamation that legally freed slaves in the states that were in rebellion to the Union, but the racial divide between Blacks and Whites limited the social mobility of Blacks. Southerners believed that Blacks were intellectually inferior and not worthy of the same educational opportunities as others (Pounds, 1987). Therefore, as engineering education blossomed in the United States, these opportunities did not readily extend to Blacks (Slaton, 2010; Wharton, 1992).

2.3.1 The 1890 Morrill Land Grant Act

The 1862 Morrill Federal Land Grant Act, which gave funds to states to provide educational opportunities to the industrial and working classes, resulted in the creation of several land grant colleges in the United States (Rudolph, 1990). In 1890, the United States passed a second Morrill Land Grant Act to include the Southern states that were in rebellion to the Union during the original act (Gonzalez & Kuenzi, 2012). As a result, the number of engineering schools in the United States increased to approximately 100 and all these engineering schools combined produced over 1200 graduates per year, but they functioned with different admissions standards, course curricula, and years of study (Grayson, 1993, p. 54). The Second Morrill Act also prohibited the appropriation of land grant funds to states that denied students college admission because of race unless the state also provided separate but equal facilities (Rudolph, 1990). To receive these funds, many states created separate colleges for Black students that led to the creation of 17 additional HBCUs, primarily agricultural or vocational in nature (Rudolph, 1990).

While the new Morrill Act seemed to expand opportunities for Blacks, it further segregated the educational experiences of the races by providing funds for separate and unequal educational institutions. According to Slaton (2010), “all seventeen segregated land-grant systems of the early twentieth century provided deeply discrepant services to their states’ black populations” (p. 24). The newly created schools failed to incorporate rigorous course offerings, such as mathematics, science or engineering classes, into the curriculum. Therefore, these new institutions, which could have expanded the reach of engineering education, failed to do so and did not increase the number of Black engineers (Slaton, 2010).

After the Morrill Land Grant Act of 1890, access to the engineering field became more competitive. In 1892, the United States Bureau of Education published a list of “engineering schools” and a list of schools approaching the academic rigor necessary for an engineering school (Grayson, 1993, p. 77). In 1893, a group of engineering faculty started the Society for the Promotion of Engineering Education (SPEE) to address the varied requirements for engineering at different institutions and create standards for the profession (Grayson, 1993, p. 68). In 1896, the United States Bureau of Education followed up with a classification system for engineering colleges, noting a list of schools that offered the courses necessary for the technical specialization of the field and the schools that were at various levels of development regarding the necessary coursework (Grayson, 1993). While the development of these accountability systems within engineering education ensured the expertise of individuals becoming engineering professionals, it further limited the possibility that Black students and institutions educating Black students would have access to this emerging profession because of the resource and academic discrepancies between traditionally White schools and historically Black colleges and universities.

In 1910, Howard University became the first HBCU to add engineering as a major; this addition provided an opportunity for more Black students to major in the discipline (Wharton, 1992). However, the number of Black students with access to engineering education was still very limited for many decades afterwards. In 1930, the United States census indicated that 500 of the 200,000 engineers in America were Black, and 100 of the 66,000 engineering and architectural students were Black (Wharton, 1992). In addition, only three HBCUs -- North Carolina Agricultural and Technical (NCA&T) College, Howard University and Hampton Institute -- offered engineering degrees and NCA&T was the only school out of the 17 Black land-grant colleges created by the Second Morrill Land Grant Act to offer an engineering program (Slaton, 2010).

2.3.2 The impact of segregation on traditionally White institutions

While higher education options were available to Black students interested in attending HBCUs, Black students did not have the same access to attend traditionally White institutions. The University of Maryland is one example of Black students' limited access to engineering education at traditionally White institutions. After the Second Morrill Act, the state of Maryland created a land grant institution for its Black students, Princess Anne Academy more recently known as the University of Maryland, Eastern Shore. As the nation's demand for engineers increased, the state of Maryland invested financial resources into its engineering program at the main campus of the University of Maryland, but neglected to invest resources in the University of Maryland, Eastern Shore campus or offer any engineering courses at that school (Slaton, 2010). However, when legal pressure began to move towards the desegregation of the College Park campus, the University of Maryland president responded by upgrading the facilities on the

Eastern Shore campus and adding an engineering discipline. He made these changes to avoid a legal requirement to admit Black students at the College Park campus (Slaton, 2010). However, his attempt was unsuccessful and in 1951, Hiram Whittle became the first Black student to attend the University of Maryland, College Park campus (Slaton, 2010). His admittance took place three years prior to the *Brown vs. the Board of Education* ruling, which cracked the door open for Black students to attend traditionally White colleges and engineering programs across the country.

2.3.3 The beginning of desegregation: Progress or interest convergence?

Brown vs. Board of Education (1954) represented a change in the educational and civil rights of Blacks. This case reversed the legal segregation of public facilities, including schools, that were endorsed by the *Plessy v. Ferguson* ruling in 1896 and acknowledged that "separate educational facilities are inherently unequal..., deprived of the equal protection of the laws guaranteed by the Fourteenth Amendment" (Franklin & Moss, 1988, p. 238). While the Brown case addressed K-12 schools, it provided the groundwork for educational institutions to begin to break down the barriers of discrimination at every level. Because of the ruling, students received the legal backing to integrate Southern colleges such as the University of Florida, University of Mississippi, University of Alabama and other schools that were unwelcoming to Black students (Cowan & Maguire, 1995). However, this ruling experienced backlash from former Confederate states when 101 Southern legislators issued *The Southern Manifesto* that resisted the desegregation ruling and stated that it abused federal power, neglected states' rights and applied the Fourteenth Amendment incorrectly to address education issues (Day, 2014).

According to Bell (1980), the Brown ruling did not reflect a moral shift in the U.S. policy pertaining to the education of Black citizens, instead the motivation for the ruling appeared to be interest convergence - the need to address pressing challenges that affect the larger society and coincidentally aligned with the interest of Blacks. Some of the pressing issues of the day included defeating the growth of communism, maintaining the allegiance of Black WWII veterans, and breaking the barrier of segregation in the South to advance industrialism (Bell, 1980, pp. 523-525). Instead of ending segregation to eliminate the inequity that persisted in the education of Black children, the case served as a public relations statement for the United States government to earn the good graces of the world in the face of communism.

2.4 A U.S. CALL FOR RIGOR IN MATH, SCIENCE AND ENGINEERING

In 1957, the Soviet Union launched the satellite Sputnik; this Russian accomplishment represented a lapse in national security for the United States as well as a failure in math and science education. This event further stirred the fear of communism in the country. In response, the United States passed the National Defense Education Act (1958) to provide funds to increase math, science and foreign language proficiency of the country (Jolly, 2009). The National Defense Education Act (NDEA) allocated federal funds to finance student aid and gave money to states to improve mathematics, science and foreign language instruction, to develop programs for gifted and talented students, to train guidance counselors, and to implement standardized testing (Gonzalez & Kuenzi, 2012; Jolly, 2009). Two Alabama legislators, who signed the *Southern Manifesto*, sponsored the NDEA and did not include a requirement to adhere to the *Brown vs. Board of Education* desegregation ruling. Therefore, Southern states that were in rebellion to the desegregation ruling were still eligible to receive NDEA funds (Urban, 2010), demonstrating that the defeat of communism and not the advancement of educational equity was the true priority of the legislators.

2.5 EDUCATIONAL PROGRESS THROUGH CIVIL RIGHTS

The 1960s was a time of struggle and progress for Blacks in the United States. In 1961, President John F. Kennedy signed Executive Order 10925 to “take affirmative action to ensure that applicants are employed, and employees are treated…without regard to race, creed, color or national origin.” (Kennedy, 1961, p. 1). In 1964, Lyndon B. Johnson assumed the presidency after President Kennedy’s assassination, and signed the Civil Rights Act (1964), which put an end to the segregation of all public institutions and made it illegal for government agencies who applied discriminatory practices in their daily operations to receive federal funds. Through the Civil Rights Act of 1964, President Johnson tried to dismantle state enforced discrimination and create equal opportunity for Black Americans. Johnson clearly stated his intentions in his 1965 commencement address at Howard University.

> But freedom is not enough. You do not wipe away the scars of centuries by saying: Now you are free to go where you want, and do as you desire, and choose the leaders you please. You do not take a person who, for years, has been hobbled by chains and liberate him, bring him up to the starting line of a race and then say, ‘You are free to compete with all the others,’ and still justly believe that you have been completely fair. Thus, it is not enough just to open the gates

> of opportunity. All our citizens must have the ability to walk through those gates.
> (Johnson, 1965, p. 2)

In this speech, Johnson reviewed the painful history of Blacks in America, highlighted recent victories, and discussed some of the changes necessary for Blacks to gain equal opportunity in the United States. Johnson acknowledged the long battle for equality. He talked about the violence of slavery and the oppression and racial injustice that continued, even after legal slavery had ended. President Johnson's statement acknowledged the structural racial inequities embedded in American history and the challenges that the experience of enslavement created for Black Americans. He also expressed a desire to right the historical wrongs that had been committed.

In November of 1965, President Johnson followed up his statements by signing the Higher Education Act. The purpose of this law was to strengthen the educational resources of colleges and universities and provide financial assistance for students in post-secondary and higher education. This act was very comprehensive in nature and it improved higher education options for all citizens or permanent residents, regardless of race, gender or socioeconomic status. The legislation represented a significant change in the educational options afforded to students and addressed several higher education concerns. Some of the provisions of this law included funds for continuing education programs, support to college libraries, resources for developing colleges, the expansion of student assistance programs, student funds for colleges in the form of grants, loans and work-study, teacher education enhancements, undergraduate education improvements, and funds to support facilities of higher education institutions (Higher Education, 1965). Traditionally White institutions began to form programs to increase the number of minority students enrolled in their undergraduate programs (Humphries, 1994).

The victories of the Civil Rights era and the Higher Education Act of 1965 increased the number of Black college students. In 1950, 50,000 Black students enrolled in United States higher education institutions (Humphries, 1994). During the Civil Rights era, this number increased from 200,000 in 1960 with 90% of those students attending HBCUs, to 470,000 in 1970 with most of those students attending traditionally White institutions that were previously inaccessible to them (Humphries, 1994).

2.6 THE MINORITY ENGINEERING EDUCATION EFFORT

With the increase in educational access for Blacks and other citizens of color, the corporate community called for an increase in the participation of minorities in the field of engineering. However, this corporate response provides another example of interest convergence. The basis for this call was a need to increase the supply of engineers to make it easier to respond to the affirmative action requirements for federal contracts (Malcom, 1996). It was also in response to concerns that unrest could develop if minorities were not included in engineering and future engineering management positions (General Electric, 1972; Landis, 2005; p. 1; Sims, 1992). In July 1972, J. Stanford Smith, a senior vice president with General Electric, spoke at the Engineering Education Conference. He challenged those in attendance to "take bold, innovative, all-out action to increase the supply of minority engineering graduates not by a few percentage points by 10- or 15-fold, and to get it done within the decade" (General Electric, 1972). Smith noted that in 1971, 43,000 engineers graduated from college and only 470 of them were Black. He also pointed out that 70% of the Black engineering graduates were from HBCUs (Sims, 1992, p. 1). Smith's urgency was clearly articulated and industry representatives, government officials, educators and others chose to rally around his call. His statement marked the beginning of an organized and concerted effort to increase the number of Black and other minority engineers.

In May 1973, the Commission on Education and the National Academy of Engineering convened a group of corporate representatives, engineering educators, government officials, students and other leaders for the Symposium on Increasing Minority Participation in Engineering (Padulo, 1974). The purpose of this meeting was to develop a plan to respond to the challenge issued by Smith and the outcome of the meeting was a report entitled *Minorities in Engineering: A Blueprint for Action* (1974). This publication expressed an understanding of the educational challenges experienced by students of color and provided a comprehensive list of 20 recommendations to reform engineering education at the pre-college and undergraduate levels to increase the representation of minorities in engineering. Establishing one organization to raise and distribute funds to support minority engineering students and working with HBCUs responsible for producing a high percentage of minority engineers to gain their accreditation and increase enrollment. Identifying schools with high populations of Chicano, Puerto Rican and American Indian students, developing programs at those schools to support engineering degree completion, and increasing the production of minority PhDs in engineering to serve as faculty and administrative leaders to mentor students enrolled in engineering schools are examples of some of the suggestions made. The report addressed the lack of adequate preparation of minority pre-college students and recommended summer classes for high school students interested in engineering and tutoring programs for students already enrolled in college as engineering majors (Padulo, 1974). As a result, there were four new organizations created to support prospective and current minority engineering students. The National Advisory Council for Minorities in Engineering (NACME) and the Committee on Minorities in Engineering (COME) were two advisory groups that provided guidance on the engineering effort. The National Fund for

Minority Engineering Students (NFMES) was a scholarship fund for minority students pursuing engineering degrees. The Minority Engineering Education Effort (ME^3) was a college matching service that paired students interested in engineering with engineering schools (Blackwell, 1987). These organizations eventually merged into the National Action Council for Minorities in Engineering (NACME) (Landis, 2005).

2.6.1 Minority engineering programs

In response to the national initiative to increase the number of Black engineers as well as engineers from other ethnically underrepresented groups, traditionally White institutions developed minority engineering programs (MEPs). These programs, generally run by staff or faculty members at traditionally White higher education institutions, exist to support, retain and graduate Black, Latino, and Native American engineering students. MEP professionals help students navigate through their engineering journey, while coaching them through academic hurdles, social interactions and institutional barriers. As Nathaniel Thomas, former MEP director at Illinois Institute of Technology stated, MEP directors "are "the sweat hogs" of the minority engineering effort... the 'et ceteras' and the "And do forths" that do the work" (National Association of Multicultural Engineering Program Advocates, 1987, p. 3). Effective minority engineering programs reduce the racial isolation experienced by students and create a sense of community (Landis, 2005; May & Chubin, 2003; Tsui, 2007).

In 1982, a group of minority engineering program directors formed the National Association of Minority Engineering Program Administrators (NAMEPA) to provide professional development to MEP administrators regarding the recruitment, admission, retention and graduation of minority engineering students by addressing pre-college and college needs

(NAMEPA, 1987). As the organization grew, the group outlined an administrative structure and developed procedures related to the minority engineering effort. In 1985, the National Action Council for Minorities in Engineering (NACME) and the National Association of Minority Engineering Program Administrators (NAMEPA) collaborated to create a handbook of best practices entitled *Improving the Retention and Graduation of Minorities in Engineering.* This document provided guidance to early MEP professionals on how to develop a comprehensive program and the document chapters, authored by representatives of NACME and NAMEPA, described the various components of a "model" program such as recruitment, orientation, minority engineering student organizations, academic advising, academic support and faculty involvement (Landis, 1985). Minority engineering programs and the strategies associated with these programs have been identified as effective in increasing diversity (Davis, 2014; May & Chubin, 2003; National Academies, 2011; Tsui, 2007) and a best practice when supporting Black students pursuing engineering degrees (Tsui, 2007).

As a professional organization of minority engineering program advocates, NAMEPA kept its fingers on the pulse of issues related to advancing minorities in engineering and recognized shifts in support over the years. In 1986, the leadership of NAMEPA identified a list of 43 "Vital Issues" pertaining to the minority engineering effort at the pre-college, college, graduate, institutional and organizational levels. The primary concern expressed in this list was that many of the barriers outlined at the beginning of the minority engineering effort in 1972 continued to exist. Some of the continued challenges included a lack of support at the government and institutional levels, educational challenges within K-12 system, and the limited progress towards meeting the initial goals of the effort (National Association of Multicultural Engineering Program Advocates, 1987).

2.6.2 National Society of Black Engineers

Just as educators, corporate representatives and government officials were involved in the effort to increase the number of Black engineers; students were an active part of the movement as well. In the early 1970s, two Purdue students formed the Black Society of Engineers (BSE) to create a support network that would help to address the low first year retention rate of 20% for Black engineering students (National Society of Black Engineers, n.d.). In 1974, Dr. Arthur Bond, the former faculty advisor to BSE, helped students establish the Society of Black Engineers (SBE). Shortly thereafter, the group-contacted deans of all accredited engineering programs along with the University presidents to inform them of the organization and to invite Black student leaders, organizations and faculty members to support their efforts and approximately 80 schools responded. In April 1975, 48 students representing 32 schools met at Purdue University for the first national meeting of the National Society of Black Engineers (NSBE) (National Society of Black Engineers, n.d.). The mission of NSBE is "to increase the number of culturally responsible Black engineers who excel academically, succeed professionally and positively impact the community" (National Society of Black Engineers, 2010, p. 3). Today NSBE is one of the largest student-run organizations with more than 31,000 collegiate, professional and pre-college members. Each year, the organization sponsors several conferences including a national convention with approximately 9,000 participants, regional conferences, and professional development meetings (National Society of Black Engineers, 2010). The organization has been a key part of the community of Black engineering students since its inception and it consistently provides mentoring and career preparation to Black engineering students (Slaughter, Tao & Pearson, 2015).

2.7 OPPOSITION TO ADVANCEMENTS IN CIVIL RIGHTS

Because of the educational opportunities that became available to Blacks in the late 60s and early 70s and the concerted effort of the minority engineering movement, the percent of Black engineering undergraduates increased from 3.3% of the total undergraduate engineering population in 1973 to 9.4% of the total engineering undergraduates by 1993. Additionally, the percent of Black baccalaureate degree recipients in engineering increased from 1.5% in 1973 to 5.0% in 1998 (Landis, 2005). This increase in access for Black and other underrepresented students led to complaints that Whites were now at a disadvantage and receiving unfair treatment due to new racial preferences that resulted in claims of reverse discrimination. One of the first U.S. Supreme Court cases opposing affirmative action policies was *Regents of the University of California vs. Bakke* (1978). In this case, Bakke, an engineering graduate seeking admission to medical school, claimed that the medical school denied him admission because of the affirmative action program and related admissions standards at the University of California. Because of the case, the Supreme Court outlawed the use of quotas for minority admission but recognized the educational value of diversity and found race as a permissible consideration in admission decisions (Malcom, et al., 2004; Spratlen, 1979).

Following Bakke, multiple court-cases, voter initiatives and legislative actions emerged to oppose the use of race in the admissions decisions of ethnically underrepresented students and a number of these cases advanced to the United States Supreme Court (Malcom, Chubin & Jesse, 2004). The *Hopwood* (TX) case and the California Civil Rights Initiative - Proposition 209 (CA), which both took place in 1996, prohibited race as a consideration in the admissions process and banned affirmative action in the state's public institutions, respectively. Because of the California legislation, many colleges and universities in the state eliminated minority engineering programs and the school experienced a decrease in their ethnically underrepresented enrollment numbers (Lesesne, 2013). Nationwide, there was a 16.2% drop in the enrollment of Black engineering undergraduates (Campbell, 1998). Additionally, the number of minority engineering programs decreased significantly (Landis, 2005). According to Malcom (1996), to eliminate the challenges that made affirmative action necessary, higher education institutions will have to make structural changes by improving introductory courses, connecting students with professional and research mentors, and finding innovative ways to promote student success.

2.8 FROM AFFIRMATIVE ACTION TO INCLUSIVE EXCELLENCE

Three additional cases, *Grutter v. Bollinger* (2003), *Gratz v. Bollinger* (2003) and *Fisher vs. University of Texas, Austin* (2013) put further limitations and restrictions on affirmative action policies regarding admission, scholarships and support programs. In addition, *Schuette vs. Coalition to Defend Affirmative Action* (2014) made the consideration of race in admissions a state decision. In response to the *Grutter v. Bollinger* (2003) and *Gratz v. Bollinger* (2003) cases, the American Association of Colleges and Universities introduced its *Making Excellence Inclusive* initiative to provide research in support of diversity and inclusion.

Inclusive excellence places diversity at the core of university operations and restructures the institution to create a community that is supportive of everyone, regardless of race, ethnicity, gender, ability, religion or sexual orientation (Williams, Berger & McClendon, 2005). The literature developed through this initiative strengthens institutional diversity efforts by connecting them to the mission of the school and demonstrating the positive benefits of a diverse learning environment on faculty and student success (Hurtado, Milem, Clayton-Pedersen &

Allen, 1999). Other research demonstrates that a comprehensive approach to diversity creates a more inclusive campus environment that supports the recruitment, retention and graduation of students from all backgrounds, including historically underrepresented groups (Hurtado, Milem, Clayton-Pedersen & Allen, 1999; Williams, et al., 2005). Additionally, the connection that an institution makes to a student and as well as the connection that a student makes to an institution through relationships with peers, faculty or staff members increases the likelihood that the student will persist to graduation (Tinto, 1993).

In addition to addressing diversity and inclusion from an institution-wide perspective, educational scholars have studied the aspects of minority support programs that are most effective and a resounding number of studies point to the value of mentoring (Girves, Zepeda & Gwathmey, 2005; Mondisa & McComb, 2015; Wilson, Holmes, Sylvain, Batiste, Johnson, McGuire, Pang & Warner, 2012). The mentoring process connects students with advocates and champions that come in many forms - one-on-one, group, peer and professional mentors, but all provide a connection that increases retention (Wilson et al., 2012). In fact, the services offered by minority STEM (or engineering) programs serve as tools in the hands of mentors (Mondisa & McComb, 2015). Mentoring creates relationships that resemble the connection to a family and has significant value for minority students (Girves et al., 2005). Mentors also contribute to the community of individuals such as family, peers, university representatives and community connections, who help to socialize engineering undergraduates through their educational process and contribute to the formation of their identity as engineering professionals (Weidman, DeAngelo & Bethea, 2014).

The Meyerhoff program at the University of Maryland, Baltimore County (UMBC), serves as an example of inclusive excellence and the power of mentoring because its success emerges from students' connection to an academic community (Mondisa & McComb, 2015). In the 1980s, UMBC experienced racial tension and general challenges around the academic performance and retention of minority students (Maton, Pollard, McDougall, Weise & Hrabowski, 2012). In response, the University leadership organized campus-wide focus groups composed of students, faculty and staff to explore the problems in the community. The leadership followed up by sharing pertinent data with the various groups and gathering feedback to determine how to remedy the problems (Maton et al., 2012). Through this process, the University's administrators, faculty and staff developed a plan for student success that valued the input of faculty members and engaged the entire campus community in the solution (Maton, et al., 2012). This plan resulted in the creation of the Meyerhoff Scholars Program, a national model that serves a broad audience of students with a goal of developing a diverse group of scholars in STEM fields. The program focuses on academic excellence, campus culture and community connection. Because of the effectiveness of this program, the University of Maryland, Baltimore County is a leading traditionally White institution in the production Black BS degree recipients who complete PhD degrees in science and engineering (Girves, Zepeda & Gwathney, 2005; Hrabowski, 2014; Mondisa & McComb, 2015).

2.9 THE CURRENT STATE OF BLACKS IN ENGINEERING

In 1970, at a time when Black students had "been virtually excluded from all levels of formal education for the greater part of our nation's history" (Padulo, 1974, p 25), less than 1% of the new BS degrees in engineering went to Black graduates (Blackwell, 1987). After interventions through the minority engineering effort, the number of Black engineering students earning baccalaureate degrees showed some improvement as indicated in Figure 1 below. However, the percent of Black engineering undergraduates receiving BS degrees compared to the total number of undergraduates receiving BS degrees in engineering hit a maximum percent that was just below 6% before 2000 (Davis, 2014, p. 4). In 2015, only 4% of the new BS degrees in engineering went to Black graduates (Yoder, 2015). This percent was on the same level as the percentage in the early 1990s and it falls dreadfully short of the recommendations proposed by J. Stanford Smith.

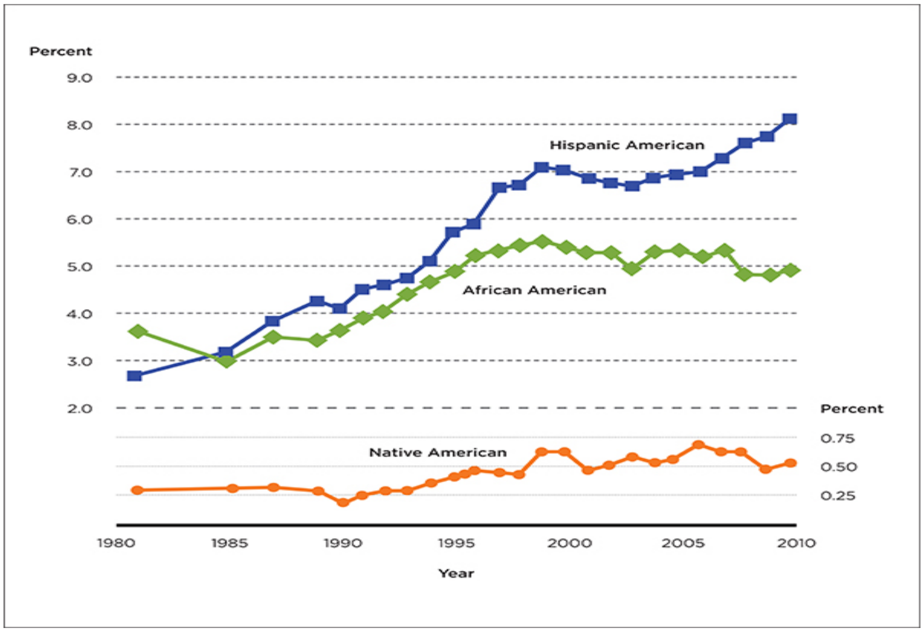

Figure 1. Minorities as a percentage of US baccalaureate engineering graduates (Davis, 2014)

To complicate matters more, there was a change in the ethnic identity of Black students in the United States. In 2013, the Black immigrant population was 8.7% of the total U.S. Black population and the U.S. Census Bureau projects that by 2060, 16.5% of Blacks in the United States will be immigrants (Anderson, 2015). More than 12% of all Black undergraduates enrolled in United States colleges are Black immigrants and these students make up 27% of the Black students at selective higher education institutions that typically contain highly ranked engineering schools (Kent, 2007; Massey et al., 2007). The addition of Black immigrant students to the Black student population and the limited growth in enrollment and degrees to

Black engineering students, indicate that many students are not making it to engineering school. Recognizing these challenges and the need to increase technical talent in the United States, many schools are trying new approaches that use some aspects of the MEP model with an inclusive excellence approach to increase the number of ethnically underrepresented students in engineering

In 2013, the American Society of Engineering Education (ASEE) and the National Academy of Engineering (NAE) hosted a diversity forum entitled "Surmounting the Barriers" for engineering educators and organizational representatives to discuss increasing ethnic diversity in engineering. During this session, participants identified barriers that have consistently been problematic since the 1970s, reviewed and analyzed historical recommendations, and developed updated solutions to these barriers. Some of the items highlighted included building the academic and professional knowledge of students, providing pedagogy training for teachers and faculty, improving institutional climate regarding ethnic diversity, and providing financial support to students and student organizations (Davis, 2014, p. 7). Additionally, the group generated a list of possible solutions to remedy these historical challenges such as link diversity to the mission of educational institutions, "know your students", make engineering relatable, make institutional commitments to diversity via funding, deal with problem faculty and reward allies, and leverage the professional societies, to name a few (Davis, 2014, p. 18).

Following the diversity forum, ASEE declared the 2014-2015 academic year as the "Year of Action in Diversity". With this focus, the organization hosted special diversity training sessions, highlighted diversity practices in the ASEE publication, and provided resources for engineering schools to incorporate diversity and inclusion practices into their operations (American Society of Engineering Education, 2016). The year concluded with a White House visit by the ASEE Engineering Dean Council where the group shared a letter stating its commitment to diversity and planned actions at the institutional level (American Society of Engineering Education, 2017). A copy of this letter is included in Appendix A.

In addition to the efforts from the ASEE, the National Science Foundation (NSF) initiated a new broadening participation program, Inclusion across the Nation of Communities of Learners of Underrepresented Discoverers in Engineering and Science (INCLUDES). The NSF INCLUDES grant provides funding over multiple years to programs that work collaboratively to address the lack of inclusion of underrepresented students in science and engineering. The 50K Coalition, a new collaboration between the engineering diversity professional organizations - American Indian Science and Engineering Society (AISES), the National Society of Black Engineers (NSBE), the Society of Hispanic Professional Engineers (SHPE) and the Society of Women Engineers (SWE) - received one of the 37 launch pilot grants for $294,000 in 2016 (National Society of Black Engineers, 2016). This coalition of organizations is working together to identify and package retention strategies for colleges and universities to adopt to increase underrepresented students in engineering.

As a part of the 50K Coalition effort, the National Society of Black Engineers developed a white paper to highlight institutional interventions that promote success for students of color. This document reviews approaches that make systematic changes to engineering schools to create a supportive environment for its students. Many of these approaches are beneficial for all students because they create a connection to the academic community and socialize students into the engineering discipline. The list includes having engaged institutional leaders, sponsoring summer bridge programs, providing collaborative and living learning communities, offering facilitated study groups, engaging in early alert systems, giving scholarships, enhancing positive self-efficacy, enhancing positive identity development and sponsoring faculty development programs (Reid, Ross, & Yates, 2016). These interventions in concert with other approaches engage ethnically underrepresented students and socialize them into the discipline of engineers

Many of the recent efforts address the lack of diversity in engineering in a more comprehensive manner by encouraging schools to articulate their commitment to diversity and inclusion, address climate and educational challenges at the institutional level, and create environments that are supportive of students. This approach serves as the basis of the conceptual framework for this study.

3.0 CONCEPTUAL FRAMEWORK

According to Baber (2015), interest convergence motivated many of the historical efforts to diversify engineering. He views this motivation as problematic because it focuses on enrollment and not institutional transformation, provides inconsistent and limited financial resources to diversity efforts, and does not include a structure to reward faculty for their investment in diversity efforts (Baber, 2015). With the history of challenges for Blacks in engineering education, designing an institutional solution that considers the past and proactively creates a more inclusive environment is essential. Smith's (2009) Framework for Institutional Diversity merges these concerns to create a model that integrates diversity into the mission and core operations of a school. It also requires campus stakeholders to assess diversity practices from an institutional versus a program perspective (Smith & Parker, 2005). The dimensions of this model address multiple areas such as institutional capacity, pedagogy, intergroup relations and student success.

The Smith (2009) framework merges well with a critical race theory (CRT) lens because it promotes institutional transformation by revealing systemic barriers and inequities. Critical race theory exposes disparities and systems of oppression in higher education institutions while building capacity for diversity (Hiraldo, 2010). The Smith framework provides a tool for higher education institutions to "describe and evaluate" diversity efforts to build capacity in an "inclusive and differentiated" manner that embraces all groups but distinguishes between the approaches that are most effective to engage each group individually (Smith, 2009, p. 71).

3.1 SMITH'S FRAMEWORK FOR INSTITUTIONAL DIVERSITY

Smith's (2009) Framework for Institutional Diversity, Figure 2, connects the mission of the school to four dimensions – institutional viability and vitality, education and scholarship, climate and intergroup relations, and access and success of historically underrepresented students. The James Irvine Foundation used this framework to complete a campus diversity study of 28 California institutions (Smith, Parker, Clayton-Pedersen, Moreno & Teraguchi, 2006). The goal of the study was to address the lack of diversity in California colleges and universities despite the state's population growth in underrepresented groups. The process included a campus self-study, comprehensive diversity plan, an evaluation, a report and participation in an annual seminar with all campuses (Smith, 2004). The illustration below is a visual depiction of this framework and following the figure is a description of each dimension.

Figure 2. Smith's Framework for Institutional Diversity (Smith, 2009)

3.1.1 Institutional viability and vitality

Institutional viability and vitality is the first dimension of this framework because it serves as the foundation that supports the other three dimensions and it illustrates the capacity that a school has for building diversity (Smith, 2009). This dimension requires the institution to incorporate diversity into the mission of the school as a core value (Moses, 2014). It considers the structures, expertise, leadership and resources available on a college campus or in an individual school within a campus to support diversity and inclusion in a systematic fashion. When examining the diversity commitment of a school, it is important to observe if the primary business and daily operations of the institution integrates that commitment or if it is only on the fringes and in limited segments of the institution. One can observe if diversity is a part of the core mission of the university through daily interactions and key processes such as strategic planning, capital campaign solicitations and accreditation.

Campus culture is another important part of this dimension because it is key in leadership and change efforts (Crutcher, 2006; Kezar & Eckel, 2002a). This dimension acknowledges the history of an institution and examines how the institution has addressed past injustices or points of alienation. Schools that are excelling in this dimension include a diverse group of leaders who can represent the needs of the campus with intentionality. Intentionality, "reflectively and deliberately" using strategies to bring about a specific goal, enables leaders to influence diversity, regardless of their professional status (Harper, 2010b, p. 288). Strength in this dimension recognizes individuals who are champions and empowers everyone on the campus to create a supportive, positive and inclusive environment. One can measure the effectiveness of this dimension by observing the extent to which diverse populations thrive and succeed in the institution (Smith, 2009). This dimension considers if the culture of the school celebrates diversity and values all members of the community, regardless of status or rank.

3.1.2 Education and scholarship

The dimension of education and scholarship examines the educational experiences of students and the academic focus of the institution. The dimension emphasizes the importance of research, pedagogy and multiple perspectives to create a campus climate that is inclusive and inviting for individuals from a variety of backgrounds and perspectives. This facet of the diversity framework considers the faculty members in place, the type of research that University faculty members engage in, as well as the incorporation of diversity into how the school fulfills its mission. It also considers the instructional practices used to engage students, which is of concern in the academic discipline of engineering that has a reputation of using poor teaching approaches (Besterfield-Sacre, Cox, Borrego, Beddoes & Zhu, 2014; National Academies, 2011; Seymour & Hewitt, 1997). Schools that are strong in this dimension encourage their students and faculty to be culturally relevant or globally minded, regardless of their discipline of focus.

Schools can assess the strength of this dimension by observing if faculty members use multiple learning styles and pedagogical approaches and if the classroom setting is supportive and open to individuals from a diversity of backgrounds. This dimension is strong in schools that provide its faculty, staff and graduate students with training on how to engage all students and incorporate diversity into their course content. Some of the strategies used by schools to strengthen this dimension include problem-based learning, service learning, study abroad experiences, civic and community engagement activities, and faculty and staff training on how to engage in courageous conversations or difficult dialogues (Clayton-Pedersen, Parker, Smith, Moreno & Teraguchi, 2007).

3.1.3 Climate and intergroup relations

Climate and intergroup relations refer to the perceptions of the school culture and its impact on the well-being and satisfaction of individuals from various groups. This dimension measures the climate and morale of the campus as experienced by students, faculty and staff as well as the interaction within and between these different groups. According to Smith (2009), intergroup relations encourage connection and dialogue between individuals from different cultures, ethnicities, genders, religions and social economic backgrounds. This approach celebrates and/or respects differences while encouraging cross cultural connection and relationships. A positive campus climate can provide students, faculty and staff with the environment necessary to thrive while a negative climate can jeopardize their academic or professional success and emotional health.

Some educators believe that ignoring difference will eliminate racism, discrimination and bias. These individuals consider comments such as “I don’t see color” or “I treat all of my students the same” as statements of equality (Lopez, 2003). However, this perspective overlooks the structural issues embedded in racism that shape the life opportunities of individuals from different races (Bonilla-Silva, 2003, p. 26). According to Lopez (2003), racially neutral approaches such as colorblind ideology, prevent individuals from addressing the systematic nature of racism. Bonilla-Silva (2003) believes that this colorblind ideology reinforces structural inequalities and maintains White privilege without naming the beneficiaries or victims of that privilege (p. 4). It is a way to justify inequality in a “subtle, institutional and apparently non-racial” way (Bonilla-Silva, 2003, pp. 2-3). Structural inequities can lead to isolation and racial tension for Black engineering undergraduates and can contribute to an unhealthy campus environment (May & Chubin, 2003; McGee & Martin, 2011).

Some of the emotional challenges commonly experienced by students, faculty and staff include impostor syndrome, microaggressions, racial battle fatigue and stereotype threat. Impostor syndrome, originally presented as a phenomenon that affects women, leads a person to believe that his/her success is undeserved and the result of luck and not intelligence, skill or competency (Clance & Imes, 1978). According to Sherman (2013), “impostor syndrome can create performance anxiety and lead to perfectionism, burnout and depression” (p. 31). A microaggression is a subtle comment that intentionally or unintentionally degrades a person (Yosso, Smith, Ceja & Solórzano, 2009). According to Pierce (1969), the psychiatrist who first introduced the concept of microaggressions when studying the experiences of Blacks, these statements have negative long-term effects that can adversely affect an individual’s sense of confidence. They can also lead to mental, emotional and physical stress that can result in racial battle fatigue. Racial battle fatigue is the stress and tension that can adversely affect people of color when they encounter repeated incidences of discrimination. Racial battle fatigue can also lead to anxiety as well as poor physical and mental health (Smith, Yosso & Solórzano, 2011). This condition can also affect administrators, faculty and staff who encounter similar challenges. Finally, stereotype threat is a phenomenon in which an individual may fear living up to a negative assumption and in turn that fear creates a self-fulfilling prophecy and negatively affects his/her performance (Steele, 1997). These challenges, which affect the emotional health of students, staff and faculty, can hinder an individual or a group's ability to succeed and thrive on a college campus.

3.1.4 Access and success of historically underrepresented students

When considering the diversity of a college campus, one typically observes the racial, ethnic and gender breakdown of students, staff and faculty with an assumption that the presence of a certain percentage of individuals from underrepresented groups indicates success for the school. This limited perspective does not consider the extent to which these groups are thriving academically and socially on the campus. Therefore, the access and success of historically underrepresented students dimension calls schools to consider the overall academic and social well-being of students from underrepresented groups as a litmus test to measure diversity on campus. It also challenges institutions to broaden their definition of student success by finding additional ways to identify excellence such as academic performance, persistence, co-curricular accomplishments, and graduation of underrepresented undergraduate, graduate and professional students. An effective way to measure this dimension is to use a tool such as the Equity

Scorecard, a document that enables school leaders to determine key indicators about their institutional success, such as student persistence, performance and time to graduation by breaking down the information for various racial groups and observing the information in a disaggregated format (Harris & Bensimon, 2007).

4.0 METHODS

The review of literature in Chapter 2 discusses the challenges surrounding the production of Black engineers, the history of interventions to mitigate these obstacles and the continued efforts to remove barriers. As noted, the early interventions to increase the number of Black engineering graduates were collaborative efforts between colleges, corporations, professional organizations and government agencies that resulted in an initial increase in the number of Black engineers (Landis, 2005; Padulo, 1974). This joint approach led to the development of a comprehensive list of recommendations to address access, recruitment and retention issues in engineering. However, legal opposition slowed progress and caused a decrease in the number of degrees awarded to Black engineers (Landis, 2005; Lesesne, 2013). Consequently, for almost 45 years it has been difficult to increase the number of Black engineering graduates on a consistent basis. As the diversity of the country increases, it becomes more apparent that our failure to engage all students in opportunities to encourage or support their interest in science and engineering is a national crisis (National Academies, 2007, 2011). It is also a historical failure to ignore the systematic and institutional exclusion of Blacks in engineering.

Chapter 3 considers all the historical literature provided in Chapter 2 and offers a conceptual framework developed to build capacity for diversity and create a mechanism to develop inclusion from an engineering school perspective. Finally, this methods chapter outlines a research approach that takes a deep dive into understanding the production of Black engineering undergraduates from the perspective of engineering schools recognized as top contributors of Black engineering graduates.

4.1 DESCRIPTION OF THE RESEARCH

This study investigates how engineering schools identified as top degree producers of Black undergraduates engage and support their Black students and serves as a problem of practice to investigate how engineering schools can build the capacity for diversity. A problem of practice is the study of a professional challenge to develop a deeper understanding of the issue and possibly identify a solution (Carnegie Project on the Education Doctorate, 2016). Through this study, the researcher collected data by reviewing institutional documentation and interviewing engineering deans, faculty, staff and minority engineering program professionals, where possible. Instead of studying this topic by focusing on retention strategies, this study focused on broader issues related to institutional commitment and campus climate that undergird the interaction with students.

4.1.1 Problem statement

While traditionally White engineering schools can be identified as unwelcoming spaces for marginalized groups (McGee & Martin, 2011; Slaton, 2010) and race-conscious policies are contested regularly (Bowen & Bok, 1998; Campbell, 1998, Fisher v. University of Texas, 2013), some traditionally White institutions are regarded as top degree producers of Black undergraduate engineers (*Diverse Issues in Higher Education*, 2016; Yoder, 2015). This inquiry uses case study research to investigate how these schools are consistently able to graduate high numbers of Black engineers and conveys the story from the perspective of the two institutions chosen for this study.

4.1.2 Research questions

In recent diversity and inclusion literature, the emphasis has shifted from a focus on the individual student to a focus on the institution (Baber, 2015; Hurtado et al., 1999; Smith, 2009; Williams et al., 2005). Therefore, this study examines the capacity for diversity that exists in traditionally White engineering schools identified as top degree producers of Black engineering undergraduates. The study focuses on one research question with three sub-questions. What are the approaches used to support and engage Black engineering undergraduates within traditionally White engineering schools that are top producers of Black engineers at the baccalaureate level?

A. How are the resources (expertise, finances, people and structures) in these engineering schools used to support Black engineering undergraduates?

B. How does the leadership of these engineering schools create or facilitate the creation of an inclusive and engaging environment for Black engineering undergraduates through academic and non-academic experiences?

C. How do these engineering schools identify and evaluate the success of Black engineering undergraduates?

4.2 CASE STUDY RESEARCH

To understand the school-wide approach that top degree producing traditionally White institutions use to graduate a high number of Black engineering undergraduates, the researcher used case study for this investigation. Case study provides the researcher with an opportunity to shine a light on the topic of inquiry because it gives a thorough and detailed description of the situation (Merriam, 2009). Using this method, the researcher comes "to know extensively and intensely about the single case" (Stake, 1995, p. 36). This method allows the researcher to investigate more thoroughly to gain an empathetic understanding through a "thick description" (Stake, 1995, p. 39) and observe the complex interrelationships that exist. Case study easily incorporates critical race theory because it uses stories to express the findings of a study much like critical race theory uses counter-storytelling to give voice to marginalized individuals or groups (Delgado & Stefancic, 2012).

In this study, the specific case is traditionally White institutions ranked as top degree producers of Black undergraduate engineers. Case study research seeks to answer "how" or "why" questions (Yin, 2009, p. 13), so this inquiry sought to understand how top degree producing engineering schools educate their Black engineering undergraduates and why the methods used by these schools have resulted in higher numbers of Black engineering graduates. In addition, I used instrumental case study to understand an area or issue related to the case (Stake, 1995). While graduating higher numbers of Black engineering undergraduates is important, understanding how the practices of these engineering schools fit into a broader diversity context is most important in this study. Finally, case study research easily illustrates some of the racialized systems at play since issues related to institutional structures and campus climate are a part of the investigation (Feagin, Orum & Sjoberg, 1990).

4.3 PARTICIPANTS

Each year *Diverse Issues in Higher Education* publishes a list of institutions that award the most degrees to students of color. This list provides information for various groups across disciplines and within specific disciplines (*Diverse Issues in Higher Education*, 2016). Table 1 is a list of the institutions ranked as top producers of Black BS degrees recipients in engineering for the past five years. This list provides information on the ranking of these institutions, the number of Black students receiving BS degrees in engineering, and the percent of Black students receiving BS degrees in engineering. This list order is according to the ranking in 2015.

The highlighted institutions are historically Black colleges and universities (HBCUs), that produce a significant number of Black graduates and create supportive and engaging spaces for Black students (Redd, 1998). However, the traditionally White institutions (TWIs) without the highlighted words are the focus of this study. While TWIs are typically known as contentious spaces for Black students (McGee & Martin, 2011; Slaton, 2010), these institutions are known for producing a high number of Black BS degree recipients for the past five years.

Table 1. Top Producing TWIs of Black Engineering BS Degree Recipients, 2011-2015

Schools	2011			2012			2013			2014			2015		
	Rank	# grd	% grd	Rank	# grd	% grd	Rank	# grd	% grd	Rank	# grd	% grd	Rank	# grd	% grd
North Carolina A&T State University	1	138	80%	1	137	75%	1	135	75%	1	125	77%	1	143	74%
Prairie View A&M University	4	63	69%	4	68	65%	4	78	66%	4	92	75%	2	107	62%
Georgia Institute of Technology - Main	2	105	6%	2	97	6%	2	109	6%	2	96	5%	3	100	5%
Morgan State University	9	51	57%	5	62	69%	3	86	84%	4	71	75%	4	91	84%
Tuskegee University	7	54	89%	14	38	88%	10	49	94%	8	49	94%	5	74	94%
North Carolina State University	3	84	7%	6	59	5%	6	62	5%	5	59	5%	6	68	5%
University of Maryland - College Park	6	57	8%	12	42	6%	12	43	5%	7	53	6%	7	65	7%
Howard University	19	34	76%	10	43	77%	9	50	75%	8	49	92%	8	61	86%
Alabama A&M University	10	48	91%	3	70	96%	5	67	94%	10	46	90%	9	56	92%
University of Florida	7	54	5%	9	46	4%	8	58	6%	6	54	5%	11	49	4%
Southern University and A&M College	5	62	86%	8	47	96%	6	62	94%	13	40	89%	12	46	90%
Auburn University	14	39	6%	7	48	7%	21	31	5%	18	37	5%	17	38	5%
CUNY City College	13	41	17%	15	36	17%	21	31	12%	14	39	14%	19	34	12%

Source: Diverse Issues in Higher Education, 2016

4.4 DATA COLLECTION AND ANALYSIS PLAN

Table 2. Data Collection and Analysis Plan

Research Questions	Conceptual Framework Dimension	Data Sources	Data Collection	Analysis
Q1: How are the resources (expertise, finances, people and structures) in these engineering schools used to support Black engineering undergraduates?	Institutional Viability and Vitality	Strategic Plan; Organizational Chart; Annual Report: Marketing Materials; Interviews of dean, associate dean, MEP staff member, faculty, student services staff member	Document review, conduct recorded interviews in person or on the telephone focusing on questions 1, 2 & 3; audio recordings; analytic memos	**Documents**: Review and deductively code for information in alignment with designated dimension(s); document findings while viewing for consistency related to appropriate dimension. **Interviews:** Deductively code interviews using descriptive methods by assigning labels to data based on the appropriate dimension in the conceptual framework with the flexibility to recognize information that does not fall within the dimensions.
Q2: How does the leadership of these engineering schools create or facilitate the creation of an inclusive and engaging environment for Black engineering undergraduates through academic and non-academic experiences?	Campus Climate and Intergroup Relations; Education and scholarship	Marketing materials; Faculty Demographics; Annual Report; Interviews of dean, assoc. dean, faculty, MEP staff member. student services staff member	Document review, conduct recorded interviews in person or on the telephone focusing on questions 3, 4 & 5; audio recordings; analytic memos	
Q3: How do these engineering schools define and evaluate the success of Black engineering undergraduates?	Access and Success of Underrepresented Students	Marketing Materials; Student-Related Statistics and Demographics; Interview of dean, assoc. dean, faculty, MEP staff member, student services staff member	Document review, conduct recorded interviews in person or on the telephone focusing on question 6; audio recordings; analytic memos	

Table 2 outlines my data collection and analysis plan for this study by listing each research question, indicating the question's connection to the conceptual framework of the study, listing the data sources, discussing the data collection procedure, and discussing the plan for analysis. As with most qualitative studies, I added other data sources that included information on the schools chosen for this case study to triangulate the findings.

The strength of a case study design comes from the use of multiple sources of data to investigate a guiding question, also known as triangulation (Patton, 2002). Therefore, when conducting case study research, it is important to use multiple data sources, create a case study database, and maintain a chain of evidence (Yin, 2009). It is also common for a case study researcher to use one form of data to confirm and/or develop a more extensive investigation of the topic of study. For this study, I collected data for this study by interviewing engineering personnel including deans, associate deans, faculty members, staff and minority engineering program administrators, when appropriate. I also reviewed documentation about the institutions. Some of the documentation came directly from the school and some of the documentation came from reports, publications, ASEE conference proceedings, press releases, media reports and other forms of information publicly accessible regarding the institutions.

4.4.1 Data sources

The primary data sources for this study are institutional documentation and the interviews of multiple engineering school personnel. Institutional documentation includes school history, strategic plans, annual reports, marketing materials, faculty diversity information, student related statistics, campus incidences of hate crimes and other relevant data. Most of this information is public record that is available online or through the office of research at each school. Multiple sources of information provided the researcher with an opportunity to employ triangulation by crosschecking data and confirming information from different perspectives (Merriam, 2009, p. 21). A researcher can properly document the story of the participants through case study audit trails or databases to convey the most accurate picture. The researcher can track this information in a journal or memo records (Merriam, 2009, p. 223). An audit trail provides detail about data collection, category development, and the decisions made throughout the study to achieve triangulation. As I moved through the process of collecting data, particularly non-interview data, I maintained a folder on each school. I used this folder to store documentation such as organizational charts, newspaper articles, strategic planning documents, annual reports and other information that contributes to the story of my two schools. Collectively, these documents contain all the information included in the vignettes about each school.

This study used purposeful sampling by intentionally selecting individuals who are knowledgeable about the topic of study (Patton, 2002). These individuals understand the history, policies and practices of the engineering schools related to the experience of Black undergraduates. That mastery comes from directly working with the students or understanding the organizational structures of the institution. When choosing specific cases for a study, Stake (1995) suggests that researchers select participants that are "easy to get to and hospitable to inquiry" (p. 4). Because of my role as the national secretary of the National Association of Multicultural Engineering Program Advocates (NAMEPA), I have contact with many of the minority engineering program directors and some of the deans for the schools in Table 1. In addition, the engineering dean at the University of Pittsburgh, the institution where I work, served as the chair of the Engineering Dean Council for the American Society for Engineering Educators (ASEE). With the ASEE goal of increasing diversity in engineering, the ASEE engineering dean council is very interested in the results of this study. This interest allowed me to enlist the dean's assistance to participate in a pilot interview, provide feedback regarding the interview protocol, and facilitate my connection with the institutions of interest for the study.

4.4.2 Data collection

Stake (1995) suggests clearly outlining the data collection plan for case study research, but there is also a need for flexibility and adjustment. I began the study by collecting online documentation on each institution as shown in Table 1 such as strategic plan information, annual reports, and historical information described in the previous section and reviewing this information to check for alignment with the four dimensions outlined in the conceptual framework. This initial screening provided additional information to identify the two schools of focus. After I identified the schools, the University of Pittsburgh dean sent an email of introduction to the deans at each school introducing them to the research and inviting their participation in the study. A copy of the email sent by the dean as well as the participation letter is included in Appendix B. After sending this correspondence, I made several follow up phone calls to the deans and MEP directors. I also sent multiple emails to seek the commitment of the schools of interest and to see if they could accommodate a visit to their campus. I advised them that each visit would include six 45-60-minute interviews with engineering school representatives including the dean, an associate dean, a faculty member, an engineering student services staff member and a minority engineering program administrator, if the school included a MEP program. Both schools provided a liaison to the dean who helped to schedule the visit and contact appropriate faculty and staff on campus for the interviews. One school provided me with a list of faculty members who would fit my needs and the other school scheduled each of my interviews for me, with some input from me based on my knowledge of the school.

Interviewing is a common qualitative research technique because it allows the researcher to gain an understanding of the behavior, feelings or worldview of the participant(s) without direct observation. It is the best approach when the researcher must interview a few individuals or a larger number of people for a broad range of ideas (Merriam, 2009, p. 88). In this case, I utilized semi-structured interviews because they facilitated the conversation in a flexible manner, probed for specific data, and addressed specific questions or issues (p. 89). These interviews were more phenomenological because I used them to "uncover the essence" of the participants' experiences (p. 93). Additionally, I used purposeful snowball sampling (Patton, 2002) within the study by using professional networks to connect to participants relevant to the study and by allowing the engineering deans to provide the people to interview.

The questions posed were more open-ended, as referenced by Merriam (2009), designed to get the professionals to tell the story of their schools. These conversations served as the foundation for this research study. I used this interaction to understand and make meaning of the significance of the school's accomplishments related to the production of Black engineers. Appendix C contains the interview protocol and Appendix D includes the informational script shared with each study participant. To preserve the information for analysis, I recorded each interview and had it transcribed by a transcription service. Appendix E provides a copy of my IRB document documentation and the data management plan for this study. In addition to the transcribed interviews, I used analytical memos to record thoughts and other significant observations that emerged. This information contributed to the audit trail. Additionally, personal notes and impressions are a key part of the data when analyzing and determining general themes for each case.

The interview process was very different for each of my schools, East Coast University and Uptown University. My two-day visit to East Coast University began with an interview with the dean. During my time in the waiting area, I could observe a great deal of activity and interactions between students and staff in the office. Following that initial interview, I met with two additional school representatives and could observe a few the routine activities of the engineering administrators, faculty and staff. Coincidentally, I was fortunate to be on campus during a major spring recruitment event for admitted students. Therefore, not only did I interview administrators, faculty and staff, I was also able to observe a recruitment presentation that included the dean, take part in an engineering tour, attend a departmental presentation, sit in on a presentation by the women in engineering staff, and peek in on a program for current students sponsored by the minority engineering program. Additionally, I was able to have lunch with two of the administrators and observe the random interactions that took place between them and their students and colleagues. These experiences contributed to the illustration of the school in Chapter 5.

My trip to Uptown University was very different from my first school visit. The school wanted to see my interview questions prior to scheduling. After providing a list of questions, I negotiated with the dean's office for many weeks before we could identify the best day for the visit. The dean was not available when I was on campus, so another school representative greeted me, coordinated all my interviews, and helped me to navigate the campus. My time on campus was very limited, so all the interviews took place in one day. Since the dean was unavailable, her representative told me that I would receive the dean's written responses to my questions later. Unfortunately, my tight interview schedule did not allow me to make the same general observations that I made at East Coast University. Therefore, I was not able to hear the perspective of students through informal interactions, observe a recruitment presentation, go on a tour, or have lunch with any of the faculty and staff. However, the interviews were very informative and the faculty and staff were candid about their experiences. The multicultural images in the engineering student services suite and the office of one of the administrators also inspired me. After completing each data collection process in the form of documentation review or interview, I recorded notes, tracked thoughts and impressions, and sorted the information obtained according to the dimensions in the conceptual framework of the study. Moreover, I connected with the dean at a conference that took place after my visit to clarify some of the data pertaining to the engineering school and confirm my findings.

4.4.3 Data analysis

Many researchers identify data analysis as the most challenging task in case study research, particularly for novices (Merriam, 2009; Stake, 1995; Yin 2009). To manage and analyze all the data for this study, collection and analysis took place simultaneously. I collected the data for this study through qualitative approaches and used deductive coding to categorize the data according to the four dimensions in Smith's framework for institutional diversity (2009): institutional viability and vitality, education and scholarship, climate and intergroup relations and access and success. Coding is a process by which a researcher assigns some sort of designation to various aspects of the data (Merriam, 2009). In this study, I deductively coded the data using descriptive methods to summarize general topics from the documentation and the interview transcriptions to align with the conceptual framework for this study (Saldaña, 2016).

The analysis process within this study was ongoing; allowing me numerous times to interact with the information obtained and make meaning of the data. I maintained an audit trail, as referenced previously, by maintaining a journal that highlighted impressions and other patterns that emerged as well as adjustments to original plans and a folder to track the information and documents collected about the case, along with associated categories and observations. These two systems simultaneously helped me to manage the large amount of data collected for this study.

After coding the data, I used inductive coding to categorize the themes or patterns observed to understand the phenomenon that was taking place. This process was an iterative one where categories seemed to emerge as I gathered more information on each school. According to Guba and Lincoln (1981), these categories can divide according to frequency, importance, uniqueness and unrecognized grouping. In applying a critical race theory lens, I intentionally observed for incidences of interest convergence and used the interview comments to provide narratives of the participants. This analysis process left space for information that did not fit into any category and allowed other concepts to emerge, such as colorblindness, inclusive excellence and leadership, as I analyzed the data.

4.5 LIMITATIONS

When conducting case study research, it is important to address topics such as bias, limitations and generalizability of the study through the research design as well as the plan for analysis and reporting. These factors are concerns in all areas of research, but they are of particular interest when it comes to case study research, a method where the researcher serves as the "primary instrument of data collection and analysis" (Merriam, 2009, p. 52). Some of the common questions asked of case study researchers are the following:

> If the researcher is the primary instrument for data collection and analysis, how can we be sure the researcher is a valid and reliable instrument? Is the researcher biased and just finding out what he or she expects to find? Doesn't the

researcher's presence result in a change in participant's normal behavior, thus contaminating the data? (Merriam, 2009, p. 212)

To address these concerns, I disclose my personal bias and related connections. I also highlight my personal expertise and value in this area, which contributes to my ability to collect data and analyze it with an insider's perspective of the case (Merriam, 2009).

As a minority engineering program director, I have a great deal of connection to the study and its participants. I have worked in minority support programming, for high school and college students, for over 24 years and believe the profession is vital to increasing the number of ethnically underrepresented students in engineering and other STEM fields. I also believe that universities can benefit from understanding the history of the minority engineering effort as well as the institutional knowledge of the professionals who lead these efforts. As the minority engineering effort approaches 45 years, many of its original leaders have retired or are retiring so this study is timely regarding the collection of institutional history and data. Because I find great value in the role of MEP professionals, it was important to apply numerous strategies to promote validity and reliability in this study. Therefore, I confirmed the information collected by validating it against other data sources, sharing my findings with the participants, for clarification purposes when appropriate, and reviewing throughout the data collection process. I utilized the comments of colleagues and dissertation committee members to examine the research plan and interpretation and to maintain an audit trail. I also added to the data sources by exploring areas that did not confirm initial thoughts or impressions (Merriam, 2009, p. 229).

"Qualitative researchers treat the uniqueness of individual cases and contexts as important to understanding. Particularization is an important aim, coming to know the specifics of a case" (Stake, 1995, p. 39). Therefore, the goal of case study research is not to produce generalizations, but to bring both the researcher and the reader to a place where they develop a better understanding of the phenomenon examined in the study. A skilled researcher presents the findings in a way that provides the context of the study so that the information is open to the interpretation of both the researcher and the reader. In this case, the participants are limited to individuals affiliated with traditionally White engineering schools who graduate a high number of Black undergraduates. Therefore, reviewing the case findings provides an extensive amount of detail that will allow the readers to develop a deeper understanding to observe the characteristics that are transferable to their setting.

5.0 A STUDY OF TWO ENGINEERING SCHOOLS

This chapter will provide a description of the two engineering schools investigated in this study. Each summary provides a snapshot of the university, details about the engineering school, information about the leadership of the school, and engineering school demographics. Following the description is an analysis of the institution's capacity for diversity based on the Smith (2009) Framework for Institutional Diversity. The Smith framework is a tool that measures a school's ability to create a diverse and inclusive community that is supportive of marginalized groups. It provides four dimensions for analysis: institutional viability and vitality, education and scholarship, climate and intergroup relations, and access and success.

5.1 EAST COAST UNIVERSITY

East Coast University is a four-year, large, public, and highly selective research university located in a suburban setting that is within five miles of a major metropolitan city. The university has a diverse population of students with more than 27,000 undergraduates. Fifty-one percent of its undergraduate population is White, 16% is Asian, 13% is Black and 10% is Hispanic. East Coast University is a commuter campus, but it has a thriving on-campus community that includes residence halls, collegiate sports and multiple student organizations.

In 2017, *U.S. News and World Report* ranked the engineering school at East Coast University in the top 25 of best undergraduate engineering schools. The school has more than 4000 undergraduate engineering students and approximately 8% of that population is Black. In the past five years, East Coast University experienced consistent growth in its undergraduate engineering enrollment and its Black undergraduate engineering enrollment. The percent of Black undergraduates in engineering has increased from 6% to 8% in that timeframe. The engineering school also has seven Black tenured or tenure-stream faculty members, placing it in a small pool of engineering schools with more than two Black engineering faculty members (McGee et al., 2015). For the past five years, this institution has been on the list of top 25 producers of Black engineers at the baccalaureate level.

East Coast University has unique approaches to engineering education and professional development that help to shape the experiences of its engineering undergraduates. The dean of the school teaches an optional dean's seminar each term, which provides undergraduates with direct access to the school's leadership and an opportunity to learn about the demands and possibilities embedded in engineering. The dean also regularly interacts with incoming and current students through recruitment events and student organizations activities. The engineering school is a part of the Center for the Integration of Research, Teaching and Learning (CIRTL) network. The school also sponsors an educational program that assigns faculty members deemed as most effective based on teaching evaluations or faculty members with distinguished faculty status to teach first and second year classes. This program imposes a cap of 50 students on each class and provides a learning community and teaching fellows to support the courses. Additionally, the engineering professors who teach these classes serve as mentors to first year engineering students. Finally, students receive mid-semester grades and individuals who receive low grades hear from an advising professional about possible interventions.

Once the students move beyond the first two years of engineering study, their departments provide tutoring and learning communities that are major-specific. Some of the departments provide opportunities for undergraduate students to connect with departmental faculty members through mentoring and research activities. For example, the material science and engineering department requires each of its students to attend a one-on-one meeting with three different faculty members over the course of three terms to discuss career options within the field. This expectation is outside of advising requirements. Finally, the engineering school has articulation agreements with local community colleges and prides itself on having structures that enable students to smoothly transition into the school. Multiple faculty members reported that after one term of adjustment, the academic performance of transfer students is on par with students who begin their academic experience at East Coast University engineering school. One faculty member explained that East Coast University faculty members worked with the faculty of the community college to standardize the classes offered at the community colleges and create a better transition for students shifting environments.

> *I had an NSF engineering education program several years ago where I worked with six community colleges…and one of the things we did was make sure they understood what the gateway requirements to get into East Coast were so that they were advising their students. So basically, after we had that program, the admission rates for the kids that applied from those community colleges to East Coast was 90 – 100%. We are proud of that.*

Since the early 1980s, the school has been the home of a minority engineering program that provides academic programming and community connection to ethnically underrepresented students in the school. The MEP director has been a part of the program in some capacity since its inception and multiple faculty members described the director as a respected member of the school's leadership team, particularly when it comes to work with ethnically underrepresented students. Several faculty members look to the MEP director and staff to take care of the students of color, though not all ethnically underrepresented students plug into the services provided by the office. The MEP office is responsible for the Louis Stokes Alliance for Minority Participation (LSAMP) and provides several programs that seem to be highly respected by the campus community. This comprehensive programming includes a summer bridge program for incoming first year students, advising, undergraduate research experiences, support of engineering diversity student organizations, an annual leadership retreat that invites not only East Coast University students but also other engineering students at local colleges, an annual MEP recognition dinner and numerous outreach events throughout the year. One of the faculty members shared the comment below about the MEP at East Coast University.

> *That is one of the best things we have gotten because it is always a safe place…and [MEP] is [a place] where you have people looking out for the good of the students.*

In addition to the MEP program, East Coast University offers a woman in engineering (WIE) program. These two programs are within the same area, but the culture of the two offices seem to be slightly different. The WIE office coordinates programming for engineering females and coordinates the female and male living learning communities for first and second year engineering students. The female living learning community participates in programming activities to empower engineering women and provide a space to discuss equity issues. The male living learning community focuses on similar topics, but they address them from a leadership and ethics perspective. The WIE director seems to be very knowledgeable about issues related to diversity and inclusion such as intersectionality, tokenism and intentionality, and is skilled at navigating the engineering terrain at East Coast University. When addressing the concept of intersectionality, the WIE director spoke of recent efforts to collaborate between the MEP and WIE offices.

> *I think that there is a very strong support system in place…One of the things that we have been trying to do is work better so that particularly women don't have to choose an identity that's served. I think it's a growth area for us and we need to do a lot better job at it, but I know that we are starting to have those conversations over the past several years at helping students be supported from a complete perspective.*

Outreach and increasing the number of underrepresented students in the engineering pipeline is a priority for East Coast University. Therefore, multiple departments within the engineering school offer pre-college programming. The school's director of outreach and recruiting coordinates multiple efforts to connect with both pre-college and prospective undergraduate students. The MEP office also offers programming to pre-college students. The engineering school at East Coast University sponsors SAT preparation for students in the community. The engineering school also works with a local district to provide professional development and curriculum support for a local technical high school. Finally, the school hosts several summer enrichment programs for high school students. One program is for students from Puerto Rico to come to the school during the summer to participate in research with all costs, except for travel cost, covered by the school.

Historically, East Coast University had its share of challenges in the areas of diversity and inclusion. The University was an exclusive institution that did not admit Black students until the 1950s, after legal pressure required its leadership to adjust the admissions policy. The school's first Black undergraduate was a transfer student who majored in engineering. In the span of approximately 70 years, the university moved from having a racially insensitive leadership team who did not believe that Black students belonged in the school to a culturally sensitive leadership team who seeks to increase the diversity of the undergraduate population and to educate its campus community about all aspects of diversity and inclusion. Even in recent months, the campus leadership has responded to both internal and external racial incidents with an understanding of the importance of inclusion and the establishment of new policies to address the underlying tensions that lead to these incidences. Some of these events included racially themed parties sponsored by student organizations and violent crimes toward students from marginalized groups.

5.1.1 Institutional viability and vitality at East Coast University

The engineering dean at East Coast University is a relational and a racially responsive leader who intentionally connects with students, staff and faculty. A racially responsive leader is an individual who "continuously works to acknowledge and understand and then redress historical, personal, cultural and structural racism in collaborative ways and with high levels of intentionality" (Harper, 2017, p. 118). The dean is aware of the history of institutional racism at the school and the current racial tensions that periodically emerge within the school, yet motivated by a desire to create a culture of inclusive excellence. The executive leadership of the campus supports this commitment and the newly crafted engineering strategic plan includes strong language regarding diversity, fearlessness, service learning, entrepreneurship and other goals that stir creativity and innovation. The dean's sentiment about the importance of diversity and inclusion is apparent in the comments below about how to diversify the graduate student population.

When I was department chair…I wanted to encourage the faculty to admit more diverse students as well as more US citizens…I had the database of all the graduate students and who their supervisors were...the South Korean faculty member had…5 South Korean PhD students…the guy from India…10 Indian students. ...the Scottish guy had three people from the UK. Think about the next time you hire another graduate student…Actually consciously think about it…Hire somebody that will make your groups diverse. Bring another person up to this level of excellence.

At East Coast University, diversity is intentional. The dean believes that the school should be number one in diversity. As a result, the leadership of the school recently developed goals that are in line with the ASEE Dean Council goals in Appendix A such as investing in K-14 initiatives to build a pipeline of engineers, attracting a diverse pool of students, and retaining and graduating a diverse pool of students. This planning process began with a "Day of Diversity and Inclusion" that involved experts, engineering administrators, faculty, staff and students; the goals developed through this process impact funding, recruitment, outreach and research. The comments below reflect the understanding that faculty and staff have regarding the school's commitment to diversity:

In any given week, I probably get 10 emails about diversity, and diversity actions on the campus. Programs for people to participate in or articles that were written.

The current dean has been pushing us to raise our minority and our female cohorts…

Yesterday the development officer says…the work that the (MEP) does is very important, that is it is important to our dean.

While the administrators and staff in leadership are aware of the school's diversity priorities, some faculty members do not have the same knowledge.

5.1.2 Education and scholarship at East Coast University

The engineering school at East Coast University sponsors diversity training for its students, staff and faculty. New faculty also receive a brief orientation on diversity resources available to them. The school is committed to providing effective educational experiences to its students. Students have the unique opportunity of connecting with administrators and faculty through the dean's seminar and departmental mentors. The female and the male living learning communities educate first-year and second-year students on issues related to diversity, ethics and leadership. The engineering school includes a center for teaching excellence and assigns expert teachers to instruct first and second year students within the engineering learning community. The school's participation in the CIRTL network also indicates a commitment to quality instruction through diverse learning opportunities.

While the East Coast University engineering school has many strengths in this dimension, the school presents innovative educational programs to all students with no intentional plan to engage Black students. One faculty member shared his color-blind ideology when stating, "when I look at a school, quite frankly, I don't see Black or White or male or female or Asian or Hispanic. I see a student."

Additionally, administrators track the general educational enrichment experiences of students involved in research, study abroad or cooperative education, but they do not disaggregate that information to determine the enrichment involvement of Black students or any other marginalized group. The school only disaggregates the retention and graduation rates of

Black versus White students. Yet, some staff members expressed that they did not believe that Black students were as engaged in these opportunities as possible.

5.1.3 Climate and intergroup relations at East Coast University

East Coast University addresses this dimension through annual programs such as the "Day of Diversity and Inclusion," when various constituents share their views of the school climate. Responses to the activities as well as the leadership team working groups contributed to the development of the school strategic plan. Programming offered through the male and female living learning communities educate first year students on various issues related to diversity and inclusion and help to form a connected engineering community. Student organizations such as the National Society of Black Engineers (NSBE) provides an academic and professional community for Black students to develop and the MEP also provides a place of support and accountability for Black students and connects the students with caring adults and role models.

When discussing the value of student organizations and diversity-focused programs and the role they play in socializing Black engineering undergraduates into the academic culture of the engineering school, some staff members believe that students tend to pick an identity and choose a group that goes with that preferred identity, but they often do not branch out beyond that one choice. The staff comment below expresses this concern:

> *I'll ask them: so what organizations are you joining and quite often the response I get is oh, I'm joining NSBE and I say so what else are you joining and oftentimes it's all minority groups. Which means that they're not engaging in the groups that have nothing to do with race on the surface. So, for instance, if you're an electrical engineering major, you're African American, and you're not*

joining IEEE. Well, that's a problem in my view. And I don't' think the two have to be, I don't' think this is a zero-sum game where you join one and you don't join the other. I think you can do both.

Engineering staff express similar concerns when discussing the choices that Black female engineering undergraduates make regarding student organizations or program affiliations.

We do have some diversity (in the WIE program). It tends to parallel what we have in the college, but I think it's unfortunate because it is a smaller group of students and it really just depends on the year. So, it's something that we are very conscious of. But I wish it were more diverse.

The women are not joining the Society of Women Engineers or the engineering sorority…The membership does not look like Black women. So, when I see that I say two things. Yes, we're joining organizations we meaning Black students. But they're not represented in all organizations…I don't see them engaging in the mainstream.

Finally, there was a concern that if traditionally White institutions only rely on MEP programs to engage students of color, schools will overlook some Black and other marginalized students.

We have different groups of Black students that are engaging or may not be engaged…and I oftentimes have noticed that the, as you and I said, the MEP model and programs across the country that were built in the era of '60s and '70s at the start of Affirmative Action were built … defining Blacks as a monolithic term, or as a very singular term. There are students that are African born; there are students who are biracial. There are students who are from the West Indies, who do not feel that the programs that were created 30 years ago necessarily apply to them. So, I often ask the question, as the country becomes more diverse, *not just in terms of race but in terms of ethnicity, in terms of nationality, does the model that was created 30 or 40 years ago still apply today?*

5.1.4 Access and success at East Coast University

The East Coast University engineering school provides outreach to local school districts through various departments in the school such as the engineering outreach office, the MEP office and through various faculty members. These activities include SAT preparation courses, robotics clubs, research opportunities and other STEM camps and activities. The East Coast engineering school also provides similar outreach activities to high school students outside of the metropolitan area, with the hope of recruiting those students to the university. The engineering program funds these activities and charges families either no or a low cost for participation. In most cases, camp programs – residential or commuter – require the students to obtain transportation to the campus.

The engineering school maintains active articulation agreements with community colleges in the area. Some of the academic departments have other arrangements with the community college where they provide online instruction to students or professional development for the instructors. Additionally, the LSAMP at East Coast includes a community college as one of its alliance schools.

Once students enroll in the engineering school, the faculty and staff of East Coast University track the academic progress of first and second year students. They also track students' participation in enrichment opportunities such as co-op, research and study abroad experiences throughout their time in the school. However, they do not to specifically track this information for Black students or students from other marginalized groups. They also do not consistently share information about struggling students with the MEP office.

Annually, East Coast University recognizes ethnically underrepresented students who participate in the MEP program. Students coordinate this event and faculty, staff, corporate representatives and others in the MEP community attend this activity to recognize the accomplishments of ethnically underrepresented students enrolled in the engineering school.

5.2 UPTOWN UNIVERSITY

Uptown University is a four-year, medium-sized, public research university in an urban community. This commuter campus provides an inexpensive higher education option in line with its original purpose to provide access and education to the working class and to immigrants. Today Uptown University has a diverse undergraduate population of approximately 13,000 students that are 25% Asian, 16% Black, 36% Hispanic and 14% White.

In 2017, *U.S. News and World Report* ranked the undergraduate engineering program at Uptown University around 100. The engineering school has approximately 3000 engineering undergraduates and the school has consistently been a top producer of Black engineers with a baccalaureate degree. Additionally, in the past five years, Uptown University has experienced consistent but small increases in its undergraduate engineering population. However, the number of Black engineering students has not increased at the same rate, resulting in a shrinking percentage of Black engineering undergraduates. The engineering faculty of Uptown University does not reflect the diversity of the student population. Uptown University has five Black tenured and tenure-stream faculty members in its engineering school, which is 4.3% of the total population of tenured and tenure-stream faculty and above the national average of 2.5% for Black tenured or tenure-stream faculty (McGee et al., 2015).

Prior to the 1970s, Uptown University was a free institution that admitted students based on merit. In 1970, at the end of the Civil Rights era, Uptown University became an open enrollment institution and charged a small amount of money for tuition, an adjustment that appears to be an example of interest convergence. This shift enabled the school to take advantage of the new educational opportunities available through the federal government and increase its enrollment of ethnically underrepresented students. This focus labeled Uptown University as a school that has a high likelihood of improving the socioeconomic status of its students. To support the efforts to increase access, the state in which Uptown University is located provided additional financial resources for University-based support programs targeted towards academically at-risk students. Some of the individuals who currently work as administrators in the engineering school as well as some faculty members are alumni of Uptown University and beneficiaries of the increased access provided by the institution.

By the late 1980s, Uptown University instituted a minority engineering program that included summer bridge programs for incoming freshmen and transfer students, advising, academic monitoring of students, math and science support, professional development, and student internship experiences. The success of the program allowed the engineering school to move its first-year retention rate for ethnically underrepresented students from 50% to 90% within ten years. This program, along with the director and the dean who created the program, gained recognition from the American Association for the Advancement of Science (AAAS) and the National Science Foundation, and became known as a model MEP. However, after the dean transitioned into a faculty role and the director left the institution for a position at another school ten years after the dean's transition, the school eliminated the MEP program and adjusted its engagement structure for underrepresented students.

While Uptown University has an impressive mission, its open enrollment policy that was in place for almost 30 years gave it a tainted reputation According to the faculty, prior to the 1970s the school was a competitive institution that produced outstanding graduates. However, open access led to a dip in the quality of students and a drop in the school's retention and graduation rates. When Uptown University reversed its open enrollment policy, after a budget crisis that demanded a change, the school eliminated remedial classes and redirected students who did not meet a certain standard to community colleges. The need to improve the performance of Uptown University students also resulted in changes to the admissions policy in engineering, requiring new students to place into pre-calculus or higher to gain admittance to the school. These changes affirmed faculty and staff beliefs that there is a correlation between the racial/ethnic identity of students and their academic preparation as engineering majors. For example, the comments below express the mindset of some faculty and administrators regarding the demographics of the student population:

> *We know the demographics are constantly changing… In let's say the early 90s we had a lot of students from the Caribbean…And I think also because their academics were very strong we had a much more vibrant academic type of setting, even though it was predominately on the foreign student end…they brought a different dynamic to the school. The tuition of the school increased, and foreign students may opt to go other places… so it has changed; the dynamics have changed.*
>
> *Open enrollment I think really opened the doors to a lot of students from underrepresented schools, especially African Americans…the problem is this*

open enrollment caused a disaster in a sense in that the range of students you had in the classroom was so wide that the professors had to adjust their teaching to the lower end of the spectrum and I think that impacted the entire school. So, this open enrollment was not a great period…And the campus has been trying to get back to the greatness that we supposedly had before the early 80s…but we have to be very cautious not to cut off that group.

Today, Uptown University and its engineering school are in another time of transition. Both the president and the provost of the University are serving in interim roles. There is a lack of financial resources within the University due to state cuts and financial mismanagement. The current engineering dean, a trailblazer and a champion of inclusive excellence, has been in position for less than four years and has engaged the faculty in diversity training on the topics of implicit bias and inclusive excellence. The dean has been a visible national leader addressing issues of diversity and inclusion for ethnically underrepresented populations in STEM areas. At Uptown University, some believe that there is a need for more diverse faculty so students can interact with individuals that they view as examples and role models. The University leadership requires the chair of each search committee to receive implicit bias training. Additionally, the leadership has charged the dean with creating a diversity committee in the school of engineering that is in line with the University-wide inclusive excellence committee. Ironically, many of the administrators and faculty talk about the concept of inclusive excellence but their definition seems to be very general and void of race or ethnicity.

Within the school of engineering, there is a sense that faculty and staff feel frustrated, stretched and even overwhelmed. One administrator reported that the staff of the former minority engineering program was larger than the current staff who serve the entire engineering population. Engineering advisors have caseloads of up to 600 students and many engineering classes are at capacity. In fact, some students are unable to progress in their academic program because the lack of course availability hinders them from moving forward in their major courses. In addition, students in academic trouble during their prior term cannot register for classes until they successfully complete the classes in their current term, which can prevent them from getting the courses they need to move forward and may possibly extend their stay in college.

While the mission and goals of the engineering school in Uptown University refer to the value of a diverse student body, some administrators and faculty members diminish the importance of diversity in their effort to focus on excellence. In fact, the conversations about inclusion have become contentious among the faculty and some view diversity and inclusion as the reason that excellence has not prevailed at the school. This sentiment is apparent in the statement below from one of the faculty members:

> *So, there's always been that conflict of "open admissions destroyed the college" … That's a lot of nonsense, I think. It made opportunities available to students. What I see is that the standard deviation has increased, but that is the price you pay to allow more access and more opportunities for individuals…you have students that really should not be here, but then you have students that are incredibly strong and go on to great things, even go to graduate schools everywhere and get an excellent job…I guess they equate the minority population with open admissions, and that's completely wrong.*

When questioned about initiatives in the school for Black students, administrator responses included comments about the value of the total population and the reduced need for special programs for Black students. For example, some respondents discredited the value of diversity student organizations such as the National Society of Black Engineers (NSBE), which was a surprise considering the visibility of one of their alumni who was a national leader in the organization while an undergraduate at the institution. They also talked about the lack of professionalism and lack of academic excellence within the NSBE group on campus. Yet, multiple administrators celebrated the efforts of the Society of Hispanic Professional Engineers (SHPE) and bragged about the value of the academic support and professional development offered through that organization. The statements below reflect the school's new approach to the socialization of engineering students.

> *They become more major-specific rather than identify only as their particular ethnic or cultural or gender group. So even though they celebrate that diversity within their own majors they are more or less infused into their majors…They are very much assimilated into their majors. So, they celebrate diversity with a sense of assimilation, so it's more or less a multicultural model…*

Realizing that the more rigorous admissions standards reduced the diversity of the undergraduate engineering population, Uptown University strengthened its articulation agreements with six local community colleges. The dean and associate dean traveled to all the community colleges to meet with their deans and academic advisors to communicate the expectations of Uptown University and to make the transfer process seamless for potential students. They also created joint degree programs with two of the schools, which included one predominately Latino school. The joint degree programs involve more connections between the community college and Uptown University, which includes campus visits, updates to the schools about curriculum changes at Uptown University, and pre-advising meetings. When reflecting on the value of the community college partnerships, one faculty member shared the following statement:

> *We have a really nice group of community colleges that I think are seen as feeder schools into our programs and a number of minority students come through that*

route. Often students also come in…just immigrated to the U.S. or fled from a country and managed to get to the U.S. They go to a community college and then they come after two years after entering the program…they have been very successful…that has also kind of helped us.

The engineering school at Uptown University has been involved in pre-college programming and educational outreach for many years. In the past, the engineering school provided engineering demonstrations to elementary, middle, and high school students. The school also sponsored Saturday programs that allowed high school students from ethnically underrepresented groups to build solar vehicles as a part of an annual competition. Currently, the school continues to engage in similar activities with many of the events coordinated by student organizations. Uptown is a Hispanic Serving Institution with a very active chapter of the Society of Hispanic Professional Engineers (SHPE); this group has retained the same advisor since the early 1980s and is a key part of the academic socialization, community connection and professional development of its members. Each year the Society of Hispanic Professional Engineers (SHPE) hosts an annual college preparation conference for local high school students that includes touring the campus, meeting professors, attending a financial aid information session and connecting with undergraduate students. The conference also includes a keynote address from a company representative. Diversity student engineering organizations at Uptown University also volunteer each year with the Lego League competition and serve as role models and volunteers with various STEM outreach events in the community. In addition, the school sponsors a free five-week summer academic program for "Hispanics, female and other minority" high school students in grades 9 – 11. Students qualify for participation by having excellent grades, competitive standardized test schools, reputable school attendance, and a willingness to stay connected to the Uptown University engineering school until high school graduation. While such initiatives exist at the school, some feel like these programs further stretch staff and faculty.

> *Because we had five hundred and something entering freshmen last year. Our school normally holds like three hundred students, meaning as the entering class. So, we are not looking at pre-college as a major thing. We are looking at what happens with undergraduate students in general to be able to increase their retention and their graduation rates, because they are not graduating in the time that we would want them to. We want them to graduate faster and we want more of them to graduate.*

While the engineering school at Uptown University does not currently have a special program to support its Black and other ethnically underrepresented students, the school participates in supplemental programs that provide academic and/or financial support for students. For example, this upcoming year the engineering school will have a bridge program for incoming first year engineering students that will run simultaneously with the summer academic program for high school students. This program will strengthen the math and science skills of incoming students and prepare them for a rigorous engineering curriculum.

Uptown University is also a partner institution with the National Action Council of Minorities in Engineering (NACME) – a scholarship organization for underrepresented undergraduates majoring in engineering or computer science. Uptown is a part of the Louis Stokes Alliance of Minority Participation (LSAMP) - a National Science Foundation (NSF) program that exists to increase the number of ethnically underrepresented students in science, technology, engineering and mathematics (STEM). It is also a member of the National GEM Consortium – a fellowship organization for ethnically underrepresented graduate students in STEM areas that sponsors workshops to assist students with the graduate school application process and provides funding to masters and doctoral students. Uptown University has an innovation center that is a combination of an incubator and a maker space; it provides workshops on practical engineering skills such as soldering and using Arduinos. It also supports students and community members interested in pursuing start-up ventures. While the center has an interdisciplinary focus, many engineering students choose to participate in the programming to receive practical experience in their field of interest. The center also seems to be a place that celebrates diversity and diverse groups of students participate in the program. However, it is not clear how many of these participants are Black students.

5.2.1 Institutional viability and vitality at Uptown University

The engineering school in Uptown University has a mission of access and excellence. It has a staff that includes administrators and faculty members that are well versed in what it means to be a diverse and inclusive school and includes some high-level administrators and faculty members who are representatives of ethnically underrepresented groups. However, half of the representatives from the engineering school that participated in the interview process diminished the significance of access and focused on excellence. These individuals referred to the concept of inclusive excellence, but used a definition that slightly deviated from the definition in the literature. In the literature, inclusive excellence places diversity at the core of university operations and restructures the institution to create a community that is supportive of everyone, regardless of race, ethnicity, gender, ability, religion or sexual orientation (Williams, Berger & McClendon, 2005). However, this group of school representatives seemed to prescribe to a color-blind ideology and stress that race and ethnicity do not matter. Instead of focusing on supporting everyone, the engineering school focuses on giving everyone the same support. This belief is the opposite of Smith's view that diversity is "differentiated and inclusive" by embracing all groups but distinguishing between the approaches that are most effective to engage each group individually (Smith, 2009, p. 71).

Another observation related to this dimension is the unrest in upper-level administration at the University. With the president and provost in transition, it is difficult for the engineering school to function most effectively, particularly since some of the challenges seem to be political and financial. Unfortunately, I was not able to meet with the dean of the engineering school until months after the faculty and staff interviews; so much of my initial information about the dean's views came from articles and online videos of interviews and presentations. However, the dean confirmed many of the observations and provided additional background regarding the financial and political circumstances surrounding the school. This interaction with the Uptown University dean varied significantly from East Coast University where the dean took the lead and set the tone for the school visit. There is also an indication that administrators, faculty and staff are juggling a lot of responsibility in their roles at Uptown University, which makes many of them frustrated with the school. The student population seems to be growing, but the resources, funds, space and staff, are not increasing at the same rate. This lack of resources limits the ability of the university to thrive in this dimension.

5.2.2 Education and scholarship at Uptown University

Uptown University houses a Center for Teaching and Learning that provides engineering and science faculty with teaching strategies to engage a diverse population of students. However, based on comments from administrators, engineering faculty do not use this center on a regular basis. The engineering school and the University also provide diversity training for its faculty and staff. Some of the faculty have published on the topic of engineering education, specifically research pertaining to outreach, engineering student support, and engaging underrepresented populations in engineering.   The engineering school and the University also provide diversity training to faculty and staff and require all search committee chairs to complete implicit bias training prior to serving in that role. One faculty member noted that the same people attend the diversity and inclusion seminars and meetings. There was no mention of incentives offered to faculty to participate in educational training or scholarship related to diversity. In fact, one administrator, who formerly participated in engineering education and outreach efforts, pointed out that outreach does not get a faculty member tenure; research does that.

5.2.3 Climate and intergroup relations at Uptown University

The Uptown University engineering school monitors its climate through student surveys and engineering town hall meetings. These tools provide engineering administrators with feedback about the student experience and a forum to connect with students to hear their questions and concerns about the school. As the engineering school increases in size and the administrators, faculty and staff feel more stretched, there is less attention paid to the individual student and more focus placed on academic process and policies. For example, one administrator explained the value of using an academic contract to monitor a student's performance over their academic career and reported that the school retention and graduation rates have doubled over the last six or seven years.   The school also shifted to departmental advisors for each major and those individuals are responsible for guiding students through their engineering coursework. However, the same individual reports that some departments that have a larger number of students in a major, which leads to a larger student to advisor ratio.

I did not interview students as a part of the study, but it was apparent through the conversations with faculty and administrators that the Black students do not have a support network or school officials as champions at Uptown University unless they are members of the Society of Hispanic Professional Engineers (SHPE). SHPE provides its participants with a supportive community, professional development and career preparation. SHPE students appear to be engaged in outreach, research and study abroad experiences. No one could share that type of information about the National Society of Black Engineers. The school staff frequently talked about the Black students from a deficit perspective, particularly the Black students from the city around Uptown University. This negative view of Black students could adversely affect the students' experiences and morale, and lead to racial battle fatigue, impostor syndrome or stereotype threat. Overall, Uptown University did not appear to have a welcoming environment for Black students or school representatives who strongly advocate for Black students.

The lack of support on campus has also had an impact on the administrators and faculty. Many people expressed that they felt stretched with the number of students and the lack of staff, faculty and administrators to care for the students. The office of one faculty member who worked at the institution for many years looked like a temporary space that contained half-packed boxes. When questioned about the history of Black students in engineering at Uptown University, he seemed to be very knowledgeable. He provided a list of supports that he believes should be included in a successful minority support program such as counseling, mentoring, tutoring, networking and advocacy. After talking to him and other individuals at this institution, it is apparent that this type of support does not exist for the Black engineering undergraduates at Uptown. Additionally, this individual seemed negatively affected by the current experience of Black engineering students at Uptown University.

Two statements that stood out during the interviews that provide examples of the staff members feeling stretched are the following:

> *We don't have enough people to make those types of (pre-college) activities be as positive as it should be. I mean those are things that you do but you do at the side; it's not like something that could be done on a school level because right now faculty, staff, administration, everyone is focused on undergrads, and the ratio of undergrads to current staff is very high.*
>
> *We don't get that kind of support, so you have to be very efficient and very targeted on what you use even with your human capital.*

5.2.4 Access and success at Uptown University

The engineering school at Uptown University has a pre-college program for high school students and strategic partnerships with community colleges. Currently, both initiatives primarily seem to target Hispanic students and not Black students. While the Uptown chapter of NSBE seems challenging based on the comments from some of the individuals interviewed, the national NSBE organization provides a venue for the school to increase its visibility and recruit additional Black engineering undergraduates. The NSBE students at Uptown University could also benefit from the mentorship and advocacy that SHPE receives through their faculty advisor.

Several times throughout the interview process, I requested student data such as the current percent of Black engineering undergraduates enrolled in Uptown University, the one-year retention rate of Black engineering undergraduates, and the graduation rate of Black engineering undergraduates at four, five and six years, but the school did not share this information. A 2011 news broadcast posted online information that the school had a 35% graduation rate in engineering. The number was an overall number and not disaggregated by race or ethnicity in the report.

Because of the pressure to increase the retention and graduation rate of Uptown engineering students, the school recognizes only traditional measures of success such as retention, grades and graduation rates. There was not much discussion about how the school disaggregates these numbers for various groups. There was some discussion of other engineering enrichment activities within the school such as internships, cooperative education positions, study abroad experiences and research, but the school does not track this information. The school has historically included some Black engineering students who participated in a supplemental academic support program in another part of the university, but the number of engineering participants from ethnically underrepresented groups who participate in that program has decreased tremendously.

6.0 ANALYSIS OF FINDINGS

The purpose of this study was to identify the approaches used by engineering schools in traditionally White institutions to support and engage Black engineering undergraduates using the Smith (2009) framework for institutional diversity. The two schools selected for this case study have been on the list of top 25 producers of Black baccalaureate degree recipients in engineering for the past five years as reported by *Diverse Issues in Higher Education*.

In selecting these schools, I expected to find information about innovative and intentional approaches to engage students. However, the inquiry uncovered two very different engineering schools with varied support systems and different school cultures and levels of success. The findings from this study also highlighted that placement on this list of top producers does not speak to the retention rate, graduation rate, or academic performance of Black students at these schools. It also does not speak to the school's ranking, academic reputation or even percent of underrepresented students in its graduating class. Each section below responds to one of the three sub-questions for this study based on the case descriptions shared in Chapter 5.

6.1 USE OF RESOURCES

1. How are the resources (expertise, finances, people and structures) in these engineering schools used to support Black engineering undergraduates?

Institutional viability and vitality at the school level is essential to create an environment that supports the retention and graduation of Black engineering undergraduates. Therefore, the leaders of engineering schools with a goal of supporting Black students indicate that commitment in their strategic plan and operations. They also provide adequate financial resources and expertise to executive the activities related to the goal (Smith, 2009). However, this study illustrates that the resources expended to demonstrate a school's commitment to this goal vary from institution to institution.

At East Coast University, the engineering dean demonstrates intention and courage regarding diversity and inclusion and appears to have the support of executive leadership at the school. The dean is familiar with the history of the school regarding the experiences of Black students and can talk a great deal about the historical challenges of the engineering school and the entire University. In recent years, the school responded to the racial incidents and student protests in Missouri by taking an inventory of the engineering community. This initiative started with a day of diversity and inclusion that included a faculty panel, a student panel, a keynote presentation and a community discussion among administrators, faculty, staff and students to talk about inclusivity. After the event, the school leadership formed diversity and inclusion committees and eventually those committees helped to form a new diversity strategic plan. This approach to identifying disparities that exist in the community and revising the mission to address the disparities while including the entire community in the process provides an example of the dean's intentionality as a leader (Barber, 2015; Harper, 2010b, 2017)

The engineering dean at East Coast University is intentional about recruiting a diverse group of faculty members, graduate students and undergraduates and is motivated to obtain a first-place ranking in diversity. The dean regularly engages faculty in conversations about how to expand the diversity of the engineering faculty and graduate student population and is willing to provide the necessary incentives to support these efforts. The dean also participates in recruitment events for prospective undergraduates. This focus on transforming the school to increase the number of individuals from underrepresented groups is admirable and a key part of true institutional change (Baber, 2015; Kezar & Eckel, 2002a).

East Coast is also very generous with funding to support diversity outreach efforts. The dean's office provides funds for academic and college preparation programming for local and out of area pre-college students. The dean supports diversity engineering student organizations and provides funds to make the East Coast University chapters of organizations such as the National Society of Black Engineers and the Society of Hispanic Professional Engineers visible participants on the regional and national levels.

The engineering school of East Coast University uses its faculty and staff expertise to support all students, including Black and other marginalized students. For all students, the school provides expert faculty to teach first- and second- year engineering classes. The structure of the engineering curriculum incorporates this expertise because the professors who teach within the program are distinguished faculty who receive additional administrative support. The MEP director serves as an expert to the school and some faculty consult the director on issues regarding the academic well-being of ethnically underrepresented students.

Uptown University has an inspiring historical mission to create access and opportunity, but not everyone celebrates the mission. In fact, recent changes in administration and the school's relatively new commitment to "inclusive excellence", as defined by the institution, seems to have moved the school away from its core values of diversity and inclusion. Many of the faculty members talked about the struggles of open enrollment and pointed out the flaws they viewed in this open access model. Based on my interview of former administrators, it seems that discussions about the open enrollment policy are common on campus. Furthermore, the resources available to support students, Black engineering undergraduates and others, at Uptown University are very limited, resulting in overcrowded classrooms and overextended staff members.

The Uptown engineering school has a diverse group of administrators and faculty members that include Black engineers in leadership roles who serve as examples of success to the students. The engineering administrators and faculty members seem to speak the same language regarding the concept of inclusive excellence, but their approach seems to be a one-size-fits-all model that is ineffective in caring for the needs of all students, particularly individuals who deviate from the norm (Harper, 2010b). However, the shared message that "we see all students as the same" appears to be a part of the mission or vision of the engineering school and the University. This colorblind approach negatively affects student success because it hinders the ability to monitor their academic or social needs in a disaggregated manner and hides structural inequities (Lopez, 2003). This approach also prevents the school from intentionally supporting the needs of diversity student organizations, such as the National Society of Black Engineers.

Engineering faculty members from Uptown University mentioned the existence of a strategic planning diversity committee for the University and for the engineering school. However, data collected on Uptown University does not demonstrate an engineering school commitment to Black students because the school does not provide any additional socialization or academic support to Black engineering undergraduates.

The Uptown University engineering faculty and administrators include experts in diversity and inclusion. For example, the Uptown University engineering dean is a well-known advocate of issues of college access and academic success in STEM, but I was unable to meet with the dean until after the formal study interviews. Instead, two former deans who currently serve on the faculty made themselves available for interviews. Based on the comments from the faculty and administrators, the dean has been actively working to establish more of a community within the engineering school. However, it appears that the unrest in the executive leadership of the University is having an adverse impact on the engineering school.

6.2 STUDENT ENGAGEMENT

2. How does the leadership of these engineering schools create or facilitate the creation of an inclusive and engaging environment for Black engineering undergraduates through academic and non-academic experiences?

As stated by Museus, Palmer, Davis and Maramba (2011), students of color in STEM majors benefit from a healthy racial climate, innovative educational approaches that promote collaboration and present socially relevant challenges, and on-going quality interaction with faculty and advisors. A supportive community is the key to academic persistence for Black students (May & Chubin, 2003; Tsui, 2007). Additionally, a student with an authentic connection to an academic mentor has an increased chance of being successful in higher education (Haring, 1999). Therefore, it is important that students, particularly ethnically underrepresented students, connect with a social community and receive socialization into the academic and profession environment of engineering (Mondisa & McComb, 2015; Weidman et al., 2014).

As with the response to the first research question, the engineering schools at East Coast University and Uptown University provide two different experiences to their Black students. The engineering school at Uptown University focuses primarily on academics and making sure all students take the appropriate courses. The school is also concerned with improving its retention rates and shortening the length of time it takes for a student to graduate. The primary point of contact for each student is a departmental advisor who establishes an academic contract to guide students through their undergraduate experience. All engineering undergraduates receive socialization through engineering town hall meetings and departmental mixers. The engineering student services office conducts periodic surveys of students' experiences in the school of engineering at Uptown University.

It appears that intentional academic mentoring relationships are not common for Black students outside of special programs such as LSAMP and NACME. Student organizations such as the National Society of Black Engineers and the Society of Hispanic Professional Engineers are available to students with interest in diversity student organizations. The Innovation Center also provides a diverse and engaging community where students can participate in interdisciplinary learning, hands-on activities and entrepreneurial activities.

The engineering school at East Coast University provides comprehensive support to its Black engineering undergraduates. A great deal of this support is available to all students, but some is specialized for ethnically underrepresented students. For all undergraduate engineering students at East Coast University, the female and male living learning communities are available for the first two years of college. These communities provide professional development, career preparation, leadership development and mentoring activities. These living and learning communities are a best practice for first- and second-year engineering students of color (Reid, et al., 2016). East Coast engineering students also take engineering-specific classes during the first and second years of college taught by expert teachers involved with the center for teaching excellence. These professors also serve as mentors to first year engineering students. After the second year of school, engineering students receive academic support in their chosen academic departments. Smaller departments provide more engagement such as a lounge for its undergraduates and mentors in each major. In addition, students can register for the dean's seminar and participate in undergraduate research.

Black students can participate in the MEP program by attending the pre-freshman bridge program or connecting with the numerous programs and activities available to individuals who plug into this community. Summer bridge participants are more likely to plug into the broader resources of a University, so participation in this initiative increases an engineering student's ability to persist (Tsui, 2007). Black females have the option to participate in the MEP and Women in Engineering (WIE). Students can also receive peer mentoring and professional support through involvement in the National Society of Black Engineers.

While the mechanisms to support ethnically underrepresented students at East Coast University are very impressive, some administrators and faculty members seem to detach themselves from concern about the academic socialization process of Black engineering undergraduates because they view concern about this group as the responsibility of the MEP staff. This mindset is problematic, because it does not acknowledge the extensive amount of time that students spend in their academic departments, it releases the general faculty and staff from the responsibility of supporting Black engineering undergraduates, and it puts extra pressure on the MEP staff to assume all this responsibility. This mindset also neglects ethnically underrepresented students who do not connect with the MEP office, since departmental support varies based on the number of students in each academic discipline.

6.3 IDENTIFICATION AND EVALUATION OF SUCCESS

3. How do these engineering schools identify and evaluate the success of Black engineering undergraduates?

Access and success, one of the dimensions in the Smith (2009) framework for institutional diversity illustrated in Figure 2, encourages higher education institutions to go beyond tracking the enrollment of ethnically underrepresented students and begin assessing other areas of success such as academic performance, persistence, time to graduation, engagement in the campus community and involvement in leadership activities. Harper (2010b) believes that with intentionality comes a commitment to a strategic and data-driven approach that measures progress to determine success. It is difficult to improve the engagement and performance of Black engineering undergraduates if schools do not assess the areas where they would like to see improvement. For example, students who engage in immersive learning experiences such as research, study abroad, service learning and internships gain socialization skills and personal development skills that go well beyond the typical classroom interaction. However, there are disparities in participation for various groups (Harper, 2010b). Tracking student engagement in these areas expands the definition of success for Black students.

The engineering schools in both Uptown University and East Coast University use grades to identify and evaluate the success of their Black engineering undergraduates. At Uptown University, the engineering leadership is under pressure to improve the retention and graduation rates of its students, so they track this data frequently. They also measure the retention of their engineering transfer students. Additionally, each year the Uptown school of engineering sponsors an honors and leadership recognition ceremony. This event recognizes dean's list students and other award recipients based on grades or contributions to the community.

One of the administrators spoke about journal papers and research presentations that shared the progress of engineering transfer students at Uptown University and provided associated data for the school. The school did not share specific data regarding student enrollment, retention, graduation and performance during this study, so the researcher is unaware of general or disaggregated data in these areas. While the school did not speak of tracking academic enrichment involvement, the advisor of SHPE reported that he tracks this information for the members of this organization.

The engineering school at East Coast University identifies and evaluates student success based on academic performance, retention and special recognitions such as national scholarships or special competitions. They track this information for students who enter the engineering school as freshmen and the students who transfer into the school. One of the associate deans could share disaggregated data related to graduation rates of engineering students in East Coast University. He also discussed the mid-semester grade monitoring system for first and second year engineering students. Departmental advisors as well as the MEP and WIE office staff provide academic intervention when students do not do well mid-semester or at the end of the term. However, the MEP office does not always receive this information. East Coast University does not appear to disaggregate various ethnic and gender groupings when measuring the involvement of students in academic enrichment activities such as research, study abroad, internships and cooperative education. Finally, the MEP office tracks the percent of ethnically underrepresented engineering students with a 3.0 or higher term and cumulative GPA.

Each year, East Coast University sponsors a school-wide honors convocation. In addition, the school of engineering selects students to receive special school-based and department-based awards. Only a limited number of students and even a smaller number of Black students receive these school and departmental recognitions. However, the MEP office sponsors an annual awards banquet to share the accomplishments of its students with alumni, corporate partners and other stakeholders. Students, administrators, faculty and staff attend this event and the MEP staff uses the banquet to celebrate the academic and leadership achievements of its students. This event is popular among the engineering staff, administrators, and faculty and it provides the students with affirmation and academic motivation.

7.0 CONCLUSIONS

The purpose of this study was to investigate how engineering schools at traditionally White institutions (TWIs) that are top producers of Black engineering graduates at the baccalaureate level engage and support their Black undergraduates. An additional goal of this study was to draw implications for how engineering schools can build capacity for diversity and inclusion. I used Smith's (2009) framework for institutional diversity that includes four dimensions - institutional viability and vitality, education and scholarship, climate and intergroup relations, and access and success of historically underrepresented students - to identify the approaches and draw the implications.

Through this investigation, I discovered that TWIs that graduate the highest number of Black engineers are not always accomplishing this goal intentionally. I learned the importance of institutional viability and vitality, one the dimension in the Smith (2009) diversity framework, when examining the capacity for diversity in an engineering school. If diversity and inclusion are not specifically included in the mission of both the university and the engineering school, there is an increased probability that Black students and other individuals from marginalized groups will experience exclusion and possibly isolation. However, schools that are explicit about their commitment to diversity and inclusion can create a supportive community that contributes to increased retention and graduation rates for Black engineering undergraduates. Additionally, I learned that schools that demonstrate intentionality, in order to be more inclusive, can change the culture and climate of their environment and create an inclusive and supportive space for students, staff, faculty and administrators.

East Coast University and Uptown University provide valuable lessons for the engineering education community. The engineering school at East Coast University demonstrates that second chances are possible when intentionality is applied. This school began as an exclusive institution that was unwelcoming towards Black students, but today it is a highly selective, yet inclusive and supportive space for Black engineering undergraduates. In contrast, Uptown University began with a goal of expanding access, but the school is shifting its priorities to become a more selective and impersonal institution. This university reminds the engineering education community that regardless of how committed a school appears to be regarding diversity and inclusion, specific resources and support must be in place to maintain that momentum. It also teaches us that a lack of institutional structure, leadership and finances can lead to burnout among faculty, staff, students and even administration.

7.1 LESSONS LEARNED FROM STUDY

The concepts listed below emerged when studying and observing the policies and practices of the engineering schools in East Coast University and Uptown University. These lessons provide important themes to consider when changing the culture of an engineering school.

Informed and engaged leadership is imperative. At the beginning of this study, I believed that the MEP staff members or a few committed individuals on a campus created the environment to support underrepresented engineering students. However, after interacting with the schools in this study, it became apparent that the structures, systems and leadership team are the foundation of a supportive environment. The dimension of institutional viability and vitality in the Smith (2009) framework for diversity supports this conclusion. After interacting with the schools in this study, it became apparent that the engineering the dean as well as other executive leaders on campus make successful interventions possible because they can establish the priorities for the school, adjust structures where necessary, allocate certain funding streams, advance key initiatives, and increase the visibility of programs. It is also important that executive leadership and the mission of the institution support the dean's commitment. This finding does not diminish the responsibility of faculty, staff and other individuals who work directly with students of color; it just makes it clear that multiple systems are at play to support marginalized students.

At East Coast University, the dean's interest in diversifying the school motivated one of the institutional advancement officers to introduce the MEP director to a corporate representative who wanted to fund the program. In addition, the engineering dean at East Coast University invited the engineering community to engage in courageous conversations about the racial tension and lack of inclusiveness within the school and develop a plan to shift the culture. The leadership skills of the dean made it possible to pull all the necessary players together to tackle this issue in a collaborative fashion. This dean possesses what Harper (2017) defines as racially responsive leadership. This type of leadership proactively and directly addresses challenges that seek to impose structural inequities and hinder diversity and inclusion.

Uptown University provides an example of a leadership challenge because while the dean is knowledgeable about diversity and inclusion in STEM fields, this dean does not have the same level of influence in the school as the East Coast University dean and lacks the support of the executive administration and institutional mission. To affect change, the dean must transform the culture using change strategies such as collaborative leadership, clear communication, incentives, and appropriate support structures for faculty and staff (Kezar & Eckel, 2002b). However, a lack of response from this dean can lead to further crisis within the engineering school.

Intentionality matters. Harper (2010b) defines intentionality as "reflectively and deliberately employing a set of strategies to produce desired education outcomes" (p. 2). When observing the leadership of the engineering dean at East Coast University or the leadership of the SHPE advisor and former dean at Uptown University, intentionality appears to motivate their decisions. The East Coast University dean demonstrates tenacity when supporting underrepresented groups and understands that this commitment comes with a personal cost. Because of intentionality, this dean designated a staff member to form relationships with local school districts to expand the pipeline of underrepresented students moving from local high schools to East Coast University as engineering majors. Additionally, intentionality motivates the dean to educate the faculty and staff about issues of diversity and inclusion and to provide incentives for the engineering faculty to diversify the population of graduate students in their specific research laboratories.

At Uptown University, the former dean's commitment to the Latino community fuels intentionality. This dedication empowered the former engineering dean to become an advisor to the Society of Hispanic Professional Engineers (SHPE), develop mentoring relationships with the students, and empower the students to impact the next generation of Latinos who may eventually transition into the school as engineering students. Because of this leader's efforts, the SHPE chapter at Uptown University is one of the largest and the school is one of the leading producers of Latino engineers.

Interest convergence may create an open door, but it does not necessarily lead to long-term change. Interest convergence is a tenet of critical race theory that explains that marginalized groups in America only advance when the advancement is beneficial to the elite group in power (Bell, 1980; Delgado & Stefancic, 2001). In many instances throughout this study, interest convergence led to a short-termed change. One example of this phenomenon is in the history of the minority engineering effort. According to Malcom (1996), one of the pressures for the corporate world to diversify the field of engineering was to expand the option for federal contracts related to affirmative action. As affirmative action came under fire, corporations placed less of a priority on the minority engineering effort and the comprehensive investment in the issue began to slow down. Today, there is a renewed call to promote engineering and other STEM fields to underrepresented groups, but the motivation is because of a desire for global competitiveness and not equity in opportunity for underrepresented groups. Therefore, efforts to diversify engineering and science, such as the National Science Foundation INCLUDES grant, capitalize on interest convergence to gain insight into possible solutions for the lack of Black, Latino, Native Americans and women in engineering. However, these efforts can be short-lived when considering the increased racial tension in the country and the new focus of exclusivity advanced by the current presidential administration.

Uptown University provides multiple examples of interest convergence. In 1970, Uptown University became an open enrollment institution to benefit from the funds available to schools that increased higher education access to ethnically underrepresented students. In 1980, the leaders of Uptown University created the MEP program to increase the low first year retention rate of underrepresented engineering students. However, Uptown University adjusted both efforts after receiving a reduction in state and local funds. Currently, Uptown University is a Hispanic Serving Institution (HSI), which provides the university with access to federal funds designated to support HSIs. While some may pressure Uptown University to increase the admissions standards and in turn reduce the Latino student population that primarily comes from the area surrounding the school, the former dean capitalizes on interest convergence to maintain the school's Latino enrollment.

> *Faculty are interested in research, and they may not say it so much but a lot of the grants that we get are because we're a …Hispanic serving institution. What I see as a trend is there is a move to increase the admissions criteria to the school, which is not necessarily a bad thing so long as there is support to bring in some more students... Twenty-five percent have to be Hispanics in order to be a Hispanic serving institution... So, some faculty are aware of that, and some administrators are aware of that. So that is a drive for them to try to bolster up minority population, too, because that hits them directly…*

The current focus on diversity and inclusion in the engineering school at East Coast University is another example of interest convergence. While the personal commitment of the dean make diversity and inclusion a constant priority, the multiple protests on college campuses in 2015, particularly the protest at the University of Missouri at Mizzou, motivated the school to address issues of bias comprehensively. The looming threat of a racial crisis resulted in interest convergence and brought about change.

Racial battle fatigue can destroy morale and negatively affect an engineering community. Racial battle fatigue is the stress and tension that can adversely affect people of color when they encounter repeated incidences of discrimination (Smith, et al., 2011). This condition can affect the physical and mental health of students, staff, faculty and administrators. Developing diverse and inclusive engineering communities makes the climate of academic institutions collegial and creates a healthy environment for everyone in the community. It is in this type of climate that students and professionals from underrepresented groups can thrive. Executive leaders, deans and administrators can create academic spaces that are inclusive and free of discrimination and bias to eliminate the side effects of emotional stress, anxiety, and poor physical and mental health for students, staff, faculty and administrators that result from contentious and racially charged environments (Smith, Yosso & Solórzano, 2011)

Uptown University is a higher education institution that experienced significant change over the years. In the 1970s, the school changed its admission standard to provide students from ethnically underrepresented groups more access to the University. In the 1980s, the engineering school developed a minority engineering program that received attention as a national model. In 2000, the dean of the school stepped down from his leadership post and stayed at the institution as a faculty member. In 2010, the University discontinued the MEP while the former dean who helped to develop the program watched from the sidelines as the strong support system that once existed for Black students begin to unravel. These changes have taken their toll on the former dean who has invested a great deal of work into this community. Additionally, there is a sense of frustration in the current dean and many of the faculty and staff of the school who feel overextended.

The MEP staff at East Coast University is hardworking, dedicated and committed to supporting their students. In fact, it is common to find them working in the office well beyond the end of the business day to support their students and the program. While these characteristics are admirable, they create the perfect formula for burnout. Deans, associate deans and other leaders of engineering schools should monitor the well-being of all engineering staff and faculty, especially those who work in the trenches to support marginalized students. They can support these professionals by developing a shared approach where everyone cares for ethnically underrepresented students. The engineering leadership can also work to ensure that MEP professionals do not experience the same marginalization that students experience in chilly climates.

7.2 IMPLICATIONS FOR FUTURE RESEARCH

Based on the findings of this study, researchers can explore other related topics to gain additional information on the type of environments that best support and engage Black engineering undergraduates. Some of future research areas to explore include:

- Complete a quantitative study of engineering deans and associate deans to determine how they prepare for leadership while examining how they prepare to be intentional and racially (or culturally) responsive.
- Complete a comprehensive document study of engineering schools to determine to what extent schools possess the capacity and structure for diversity and inclusion. This investigation can be completed by examining the university mission, engineering school mission, strategic plan, accreditation self-studies, annual reports, leadership structure, capital campaign plans, engineering student retention information in a disaggregated format, six-year graduation rates for engineering students in a disaggregated format, and successes in the areas of diversity and inclusion. This study will create a broader understanding of how engineering schools are integrating diversity and inclusiveness into everyday practices.
- Complete a study investigating the professional and emotional well-being of ethnically underrepresented engineering education professionals and individuals who primarily work to support ethnically underrepresented engineering students. This study will focus on ethnically underrepresented administrators, faculty, and staff as well as MEP professionals of all races.
- Using the Smith (2009), Framework to develop a comprehensive qualitative study of engineering schools structured in the same fashion as the James Irvine Foundation Campus Diversity Initiative (Smith, 2004). This study would require engineering schools to complete an initial self-study using the framework for diversity and develop a proposal to build

capacity for diversity with the engineering school. Following the previous steps, the schools would develop an evaluation plan to measure the progress of the proposal, complete an interim report of progress, and attend a retreat to discuss process and brainstorm with other schools about solutions to challenges.

7.3 IMPLICATIONS FOR POLICY AND PRACTICE

As an educator who has worked in an engineering school for over twenty years, I frequently interact with engineering faculty members and administrators. Many of these well-intentioned professionals are not always aware of educational issues related to diversity and inclusion, so they contribute to some of the challenges discussed in this paper. Therefore, it is important to provide faculty and administrators with tools for success.

As the American Society of Engineering Education (ASEE) continues to serve as an organization committed to preventing marginalization and encouraging inclusivity, its leadership can provide training for all new deans to become intentional and racially responsive leaders who are advocates of diversity and inclusion and individuals who are equipped to have courageous conversations. Once those deans return to their campuses, they can employ knowledgeable experts to conduct a diversity strategic planning session in a fashion like the diversity session at East Coast University. Hearing from other faculty, staff members, administrators and students, and contributing to a discussion about the issues can help to provide an open dialogue and the foundation necessary for change.

After participating in a diversity planning session and gaining an understanding of issues of importance related to diversity and inclusion, engineering faculty can complete a diversity instrument, based on the Smith (2009) framework, to measure the progress of the school by observing it as a whole, by department, and by groups. A draft copy of this instrument is included in Appendix F. This document will serve as a tool to facilitate further discussions about adjustments to make the engineering community more inclusive and supportive of all groups. This approach will facilitate a collaborative change process within the school where faculty, staff and students take ownership for change.

Engineering faculty and staff can participate in professional development on instructional approaches that are equitable and inclusive, and receive support to incorporate these approaches into their courses. This training can include information discussing benefits of inclusivity and the negative consequences of exclusive educational environments. In addition, new faculty members can receive an orientation on the diversity priorities of the school related to students so that they can contribute to the effort.

While addressing the culture of the school from a faculty and staff perspective, the student services staff can explore ways to work collaboratively, particularly when interacting with students who have multiple identities or different views of ethnicity, culture or gender. For example, engineering student services professionals can explore the broadened identities of ethnically underrepresented students and determine their engagement preferences to reduce the number of students who slip through the cracks. Additionally, the engineering school recruiter, the MEP program staff and the WIE program staff can work together to see how to most effectively market the school to students with multiple identities. Programs such as MEP and WIE can also work together to address diversity and inclusion from an intersectionality perspective. Engineering schools can encourage discipline-based student organizations and diversity student organizations to collaborate, which could encourage discipline-specific organizations to reach out to underrepresented students and encourage underrepresented students to join discipline-specific engineering organizations.

Organizations such as the American Society of Engineering Education (ASEE) and the National Association of Multicultural Engineering Program Advocates (NAMEPA) can prepare policy statements that speak to the responsibilities of professionals who work to support underrepresented students and provide recommendations that promote a healthy well-being for these professionals. These organizations can share this information with deans, associate deans and professionals who work to support underrepresented students.

Finally, the engineering school can evaluate its progress by conducing periodic assessments to measure the climate of the school, track the progress of students as a whole and disaggregated by group, and determine the satisfaction of the faculty and staff as a whole and disaggregated by group. A collaborative team of faculty and staff can lead this effort so that progress is the result of a community investment. These assessments can determine additional needs regarding interventions and professional development.

7.4 CLOSING COMMENTS

With almost 45 years of investment in the effort to make engineering education inclusive and diverse, there is still a great deal of work to be completed. The ASEE Engineering Dean Council letter, included in Appendix A, urges the community to improve the culture of the profession and provide equitable and inclusive educational experiences (American Society of Engineering Education, 2017). To date more than 200 deans have signed this letter, committing to: develop a school diversity plan; create a new pipeline program to impact pre-college or transfer students; develop a partnership with other higher education institutions, and develop strategies to increase the representation of underrepresented groups in engineering. These efforts require groups to stop working in silos and invite all engineering representatives such as ASEE, the various engineering discipline-based professional organizations, the GEM Consortium, the National Action Council for Minorities in Engineering (NACME), NAMEPA, the Women in Engineering ProActive Network (WEPAN), and the professional diversity engineering organizations to the table to develop solutions. They also require the engineering education community to come together for difficult, yet courageous, conversations.

As the engineering dean at East Coast University shared during our conversation, "moving inertia or changing the direction of a ship is hard work…and it just takes painstaking, constant, persistent effort to improve the situation…but people have to care about it and make it work". While some schools have started the effort to make their engineering schools more diverse and inclusive, there has been no public update from the American Society of Engineering Education on progress. To move this effort forward, the ASEE along with the various diversity organizations can request a report from the engineering schools who signed the diversity letter. These schools can report on their diversity plans, K-14 pipeline activities, partnerships with other colleges, and strategies to increase representation of underrepresented faculty. In order to truly affect change those of us who care about engineering education and the future of the engineering profession must demand both accountability and tenacity.

APPENDIX A

ASEE ENGINEERING DEANS COUNCIL DIVERSITY LETTER

In 2015, following what the American Society for Engineering Education (ASEE) designated as its Year of Action in Diversity, the organization's Engineering Deans Council developed a letter affirming the importance of diversity as a core value and committing to engage in activities to support this value. To demonstrate commitment to diversity and inclusion at their individual institutions, as of January 2017, over 200 engineering deans signed the letter linked below:

https://www.asee.org/documents/member-resources/edc/EDC-DiversityInitiativeLetterFinal.pdf

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ASEE AMERICAN SOCIETY FOR ENGINEERING EDUCATION

January 3, 2017

Engineering is empowering society in unprecedented ways. It is at the core of all innovation, resulting in tremendous societal and economic benefits; it is the most important discipline to address current and emerging challenges in the US and on a global scale; and it provides new, imaginative ways to enrich life. A fundamental requirement for growth of this enabling power, however, is for the engineering community to attract and engage people from all segments of our society. The evolving demographic landscape of the US, the need for constant economic competitiveness and the upholding of our core values to ensure equal opportunity and access to all who seek it, all point to the importance of actively embracing diversity and inclusiveness in all our endeavors. Diversity and inclusiveness are essential for the development of creative solutions to the world's challenges and to enrich life.

While gains have been made in the participation of women, African-Americans, Hispanics, and Native Americans in engineering in recent decades, significant progress is still needed to reach a level where the engineering community fully embraces all segments of our increasingly diverse and vibrant society. In particular, we must further promote the pursuit of engineering education to all those who have been historically under-represented within our discipline; provide an educational experience that is demonstrably equitable and inclusive; and actively work to improve the broader engineering culture to fully engage the diverse generations to come.

The year 2014-2015 was declared by ASEE as the Year of Action in Diversity. The undersigned deans of engineering schools across the United States commit through specific action to provide increased opportunity to pursue meaningful engineering careers to women and other underrepresented demographic groups. We further commit to ensuring that our institutions provide educational experiences that are inclusive and prevent marginalization of any groups of people because of visible or invisible differences. We affirm the importance of such aims as a reflection of our core values, as a source of inspiration for drawing a generation to the call of improving the human condition. Recognizing the urgency to act, the undersigned colleges/universities commit to establishing at each of our institutions programs that include the following:

1. Develop a Diversity Plan for our engineering programs with the help and input of national organizations such as NSBE, SHPE, NACME, GEM, SWE, AISES, WEPAN and the ASEE that would: articulate the definition and the vision of diversity and inclusiveness for the institution; assess its need or justification; provide a statement of priorities and goals; commit to equity, implicit bias and inclusion training across the school; define accountability; and the means of assessing the plan through various means including surveys.
2. Commit to at least one K-12 or community college pipeline activity with explicit targeted goals and measures of accountability aimed at increasing the diversity and inclusiveness of the engineering student body in our institution.
3. Commit to developing strong partnerships between research-intensive engineering schools and non-PhD granting engineering schools serving populations underrepresented in engineering.
4. Commit to the development and implementation of proactive strategies to increase the representation of women and underrepresented minorities in our faculty.

A measure of success will be the notable increase in diversity in enrollments, retention and graduation rates of engineering students, and increased diversity in our faculty and in the engineering workforce, over the next decade. Combined with changes in engineering education, for example as envisioned in the Grand Challenges Scholars Program, we envision the evolution of our engineering schools as the places which will prepare the graduates with the diversity, inclusiveness and engineering educational preparation to help make the world a better place.

Signed:

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Sharon A. Jones, Ph.D., P.E., BCEE
Dean, Donald P. Shiley School of Engineering

UNIVERSITY OF PORTLAND

Wendi B. Heinzelman

Wedni B. Heinzelman
Dean of Hajim School of Engineering and Applied Sciences

UNIVERSITY OF ROCHESTER

John W. Steadman

John W. Steadman, Ph.D., PE
Dean, College of Engineering

UNIVERSITY OF SOUTH ALABAMA

Hossein Haj-Hariri

Hossein Haj-Hariri
Dean, College of Engineering and Computing

UNIVERSITY OF SOUTH CAROLINA

Robert H. Bishop

Robert H. Bishop, Ph.D., P.E.
Dean, College of Engineering

UNIVERSITY OF SOUTH FLORIDA

Yannis C. Yortsos Ph.D.
Dean, Viterbi School of Engineering

UNIVERSITY OF SOUTHERN CALIFORNIA

Wayne T. Davis
Dean, College of Engineering
Endowed Dean's Chair and Professor of Civil & Environmental Engineering

UNIVERSITY OF TENNESSEE KNOXVILLE

Mark W. Spong
Dean, Erik Jonsson School of Engineering & Computer Science

UNIVERSITY OF TEXAS AT DALLAS

Devdas Shetty, Ph.D., P.E.
Dean, School of Engineering and Applied Science
Professor of Mechanical Engineering

UNIVERSITY OF THE DISTRICT OF COLUMBIA

Cristina Amon
Dean, Faculty of Applied Science & Engineering, Alumni Chair Professor of Bioengineering, Department of Mechanical & Industrial Engineering

UNIVERSITY OF TORONTO

Richard Brown
Dean, College of Engineering

UNIVERSITY OF UTAH

Craig H. Benson, Ph.D., P.E., NAE
Dean, School of Engineering & Applied Science

UNIVERSITY OF VIRGINIA

Michael B. Bragg

Michael B. Bragg
Frank & Julie Jungers Dean of Engineering

UNIVERSITY OF WASHINGTON

Dr. Pearl Sullivan
Dean, Faculty of Engineering

UNIVERSITY OF WATERLOO

Ian M. Robertson
Dean, College of Engineering

UNIVERSITY OF WISCONSIN MADISON

Brett A. Peters, Ph.D.
Dean and Professor of IME

UNIVERSITY OF WISCONSIN MILWAUKEE

Molly M. Gribb, Ph.D., P.E.
Dean, College of Engineering, Mathematics & Science

UNIVERSITY OF WISCONSIN PLATTEVILLE

Eric W. Johnson
Dean, College of Engineering

VALPARAISO UNIVERSITY

Philippe M. Fauchet, Ph.D.
Dean, College of Engineering
Professor of Electrical Engineering

VANDERBILT UNIVERSITY

Barbara D. Boyan, Ph.D.
Alice T. and William H. Goodwin Chair in Biomedical Engineering
Dean, School of Engineering

VIRGINIA COMMONWEALTH UNVIERSITY

G. Don Taylor
Interim Dean, College of Engineering

VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY

Candis Claiborn
Dean and Professor of College of Engineering & Architecture

WASHINGTON STATE UNIVERSITY

Aaron F. Bobick

Aaron F. Bobick
Dean and James M. McKelvey Professor
School of Engineering & Applied Science

WASHINGTON STATE UNIVERSITY IN ST. LOUIS

David L. Ferrro
Dean, College Applied Science and Technology

WEBER STATE UNIVERSITY

Zeljko Torbica, Ph.D.
Dean, L.C. Nelson College of Engineering & Sciences

WEST VIRGINIA INSTITUTE OF TECHNOLOGY

Eugene V. Cilento
Glen H. Hiner Dean and Professor
Benjamin M. statler College of Engineering & Mineral Resources

WEST VIRGINIA UNIVERSITY

Jeffery L. Ray, Ph.D., F.ASEE

Dean of Construction Management & Technology

WESTERN CAROLINA UNIVERSITY

Houssam Toutanji

Houssam Toutanji, Ph.D., P.E., F.ASCE
Dean, College of Engineering & Applied Sciences

WESTERN MICHIGAN UNIVERSITY

S. Hossein Cheraghi, Ph.D., GDTP
Dean, College of Engineering

WESTERN NEW ENGLAND UNIVERSITY

David Cyhanski
Bernard M. Gordon Dean of Engineering,
Ad Interim

WORCESTER POLYTECHNIC INSTITUTE

APPENDIX B

REQUEST FOR PARTICIPATION IN RESEARCH STUDY

The dean of the Swanson School of Engineering at the University of Pittsburgh assisted with the recruitment of my study participants. The information below includes the text of his email sent to prospective schools as well as a request for participation in research study letter the researcher.

Dear Colleague,

I am writing to request your assistance. Alaine Allen is the director of the pre-college and undergraduate diversity programs here in the Swanson School of Engineering. She is also a doctoral candidate in the higher education management program in the University of Pittsburgh, School of Education. Alaine's dissertation research focuses on understanding how predominately White research institutions ranked as top degree producers of Black engineering undergraduates include and engage their students. She has identified a group of engineering schools that are top producers of Black undergraduate degree recipients, and you are on that list. She would like to meet with you for a forty to sixty-minute interview; she would also like to meet with others in your school for similar interviews. Attached is her study recruitment letter for potential participants. Please consider allowing her to study your engineering school to collect valuable information that can support our goal to increase the diversity of the engineering profession.

Thank you in advance for your cooperation.

Sincerely,

Gerald Holder, PhD
U.S. Steel Engineering Dean
Swanson School of Engineering
University of Pittsburgh

University of Pittsburgh

Swanson School of Engineering
Pre-College and Undergraduate Diversity Programs
INVESTING NOW
Pitt EXCEL Program

152C Benedum Hall
3700 O'Hara Street
Pittsburgh, PA 15261

February 10, 2017

Dear Dean:

I am the director of the University of Pittsburgh pre-college and undergraduate diversity programs in the Swanson School of Engineering. I am also a doctoral candidate at the University of Pittsburgh in the higher education management program in the School of Education. As an educational practitioner, I am interested in understanding how predominately White research institutions ranked as top degree producers of Black engineering undergraduates include and engage their students. This interest is line with the country's need to increase the number of students from historically underrepresented groups completing degrees in engineering as well as the commitment to diversity from the American Society for Engineering Education (ASEE). Since *Diverse Issues in Higher Education* recognized your school as a top degree producer of engineering undergraduates for the past five years, I believe your school can serve as model to provide information regarding how engineering schools can build the capacity for diversity.

I would like to interview you, your associate dean of academic affairs, a representative from your minority engineering program, a student services professional in your school and two engineering faculty members. While the group of schools I plan to use in this study are very specific, the name of your institution and the name of the individuals interviewed at each institution will remain anonymous. I would greatly appreciate it if you are able to direct me to the individuals in the categories listed above who are best able to discuss the approaches you use to engage your marginalized students, specifically your Black engineering undergraduates. Each interview will take 45 – 60 minutes and I will contact each person interviewed for one follow up to confirm the contents of their transcribed comments. I will use my time with everyone to learn about how your institution includes and engages Black engineering undergraduates.

I will be contacting you within a week to follow up on your receipt of this correspondence and your interest in participating in this study. This study can provide significant knowledge considering our need to increase the representation of Blacks and other marginalized groups in the field of engineering. I look forward to connecting and learning about the great work that you do at your institution.

Sincerely,

Alaine M. Allen

Alaine M. Allen
EdD Doctoral Candidate
School of Education
University of Pittsburgh

APPENDIX C

OPEN-ENDED INTERVIEW QUESTIONS

The researcher will use the protocol below to conduct semi-structured interviews with the participants. The numbered questions will lead the interview and the bulleted questions will serve as probes.

1. Please tell me about yourself. What is your background? What role have you played in engaging and supporting marginalized groups, especially Black engineering undergraduates?

2. What do you know about the history of Black engineering students at this institution?
    - What are some of the changes that have taken place over the years?
    - Who initiated these changes?
    - To what extent does the school earn the buy-in of faculty and staff in this effort?

3. How are diversity and inclusion defined within your engineering school? How are diversity and inclusion incorporated into the mission, strategic plan and operation of your engineering school?
    - How does the organization structure reflect this connection?
    - How is diversity and inclusion emphasized to new faculty and staff as a school priority?
    - How do the school's finances (budget, source of funding, scholarships) reflect this connection?
    - How does your engineering school reflect its commitment to diversity and inclusion in its regular operations (research, teaching, student and faculty recruitment, alumni recognition, fundraising, school publications and reports)?
    - How does the tenure and promotion process consider a faculty member's diversity efforts?
    - Please discuss any training that your administrators, faculty, staff, teaching assistants, and others attend in the areas of diversity and inclusion.

4. What practices does the school use to provide an inclusive and engaging environment for its Black students?
    - What support systems exist for your Black students?
    - How does the school integrate Black students into its engineering community and the engineering profession?
    - How are new faculty and staff prepared to contribute this process?

- How do you use student feedback and other tools to measure the climate for Black students?

5. How does your engineering school socialize Black engineering undergraduates into the academic culture and the expectations of the engineering profession?
    - How does the curriculum engage students from a variety of learning styles, cultural experiences, and perspectives?
    - How does the school engage Black students in research opportunities, study abroad experiences, internships, cooperative education work experiences, leadership development, mentoring experiences and other academic enrichment opportunities?

6. Many institutions market their schools by highlighting successful students and alumni. How does your engineering school identify and measure the success of its Black engineering undergraduates?
    - How does your engineering school recruit Black engineering undergraduates?
        - How do you connect with pre-college students?
        - How do you connect with potential transfer students?
    - How does your school develop success in your Black engineering undergraduate students?
    - How does the school re-engage Black undergraduates if they stumble academically?
    - How does the school highlight the success of Black engineering students and alumni?

APPENDIX D

INFORMATIONAL SCRIPT

Each year *Diverse Issues in Higher Education* publishes a list of institutions that award the most degrees to students of color. This list provides information on various groups across disciplines and within specific fields (*Diverse Issues in Higher Education*, 2016). Your school has been a top producer of Black BS degree recipients in engineering for the past five years. Therefore, this study will seek to understand how your engineering school was able to accomplish this notable achievement by investigating the policies and procedures in your engineering school related to diversity and inclusion.

As a part of the study, I will be interviewing engineering administrators, faculty, and staff from multiple institutions for 45 – 60 minutes. If you are willing to participate, I will ask questions about the role you play in supporting marginalized groups, particularly Black engineering undergraduates, as well as the capacity of your engineering school in the areas of diversity and inclusion. There are no foreseeable risks associated with this study, nor are there any direct benefits to you. This is an anonymous study of top producing schools, so your responses will not be identifiable. All responses are confidential and will be under lock and key. Your participation is voluntary, and you may withdraw from this project at any time. .

APPENDIX E

IRB DOCUMENTATION AND DATA MANAGEMENT PLAN

University of Pittsburgh
Institutional Review Board

3500 Fifth Avenue
Pittsburgh, PA 15213
(412) 383-1480
(412) 383-1508 (fax)
http://www.irb.pitt.edu

Memorandum

To: Alaine Allen

From: IRB Office

Date: 2/7/2017

IRB#: PRO17010433

Subject: PWIs Producing a High Number of Black Engineers

The above-referenced project has been reviewed by the Institutional Review Board. Based on the information provided, this project meets all the necessary criteria for an exemption, and is hereby designated as "exempt" under section
45 CFR 46.101(b)(2)
There are no items to display

Please note the following information:

- Investigators should consult with the IRB whenever questions arise about whether planned changes to an exempt study might alter the exempt status. Use the "**Send Comments to IRB Staff**" link displayed on study workspace to request a review to ensure it continues to meet the exempt category.
- It is important to close your study when finished by using the "**Study Completed**" link displayed on the study workspace.
- Exempt studies will be archived after 3 years unless you choose to extend the study. If your study is archived, you can continue conducting research activities as the IRB has made the determination that your project met one of the required exempt categories. The only caveat is that no changes can be made to the application. If a change is needed, you will need to submit a NEW Exempt application.

Please be advised that your research study may be audited periodically by the University of Pittsburgh Research Conduct and Compliance Office.

Principal Investigator: Alaine M. Allen **IRB#: PRO17010433**

Investigators must complete this form when data is collected, transmitted, or stored electronically. The completed form must be uploaded in Section 5, question 5.15 of the IRB application. We highly recommend the Data Security Guidance and Tip Sheet for Completing Assessment Form documents, available in the A-Z Guidance of the HRPO website, be reviewed before answering the questions. The IRB may request a consultation from data security experts from either Pitt or UPMC to ensure risks to research participants are minimized and appropriate safeguards are in place. **It is important that all relevant questions are addressed to prevent a delay in review.** If you have any questions, email us at irb@pitt.edu.

- It is important to remember that the research data belongs to the University of Pittsburgh
- All purchase agreements should be processed by the University Purchasing Office. Contact the Pitt Purchasing Office at 412-624-3578 or http://cfo.pitt.edu/pexpress/CustomerService/inquiry.php

Part A – Identifiers to be collected (check all that apply):

Resource: http://technology.pitt.edu/security/security-guideline-de-identifying-health-information

☒ Anonymous data – at no time will any of the identifiers below be collected, including IP addresses

Check all identifiers that will be collected during any phase of the research:
(If any identifiers will be collected, a data security review may be required)

☐ Name	☐ Biometric identifiers, including finger and voice prints
☐ Electronic mail address	☐ Full face photographic images and any comparable images
☐ Social security number	☐ Health plan beneficiary numbers
☐ Telephone number	☐ Account numbers
☐ Fax number	☐ Certificate/license numbers
☐ Internet protocol (IP) address	☐ Vehicle identifiers and serial numbers, including license plate numbers
☐ Medical record number	
☐ Device identifiers/serial numbers	
☐ Web Universal Resource Locators (URLs)	

Certain dates, age, zip codes or other geographic subdivision that could be personally identifiable per the standards below.
☐ All geographic subdivisions smaller than a State, including street address, city, county, precinct, zip code, and their equivalent geocodes.
☐ All elements of dates (except year) for dates directly related to an individual, including birth date, admission date, discharge date, date of death; and all ages over 89 and all elements of dates (including year) indicative of such age, except that such ages and elements may be aggregated into a single category of age 90 or older

☒ **List any other unique identifying number, characteristic, or code to be collected:** The individuals interviewed will be asked to provide their titles, which will be useful for understanding the case and coding the interview transcripts in the future.

(DSR required if any identifiers checked above and data is not coded)
For **ALL** the identifiable data collected above, will you be coding the data by removing the identifiers and assigning a unique study ID/code to protect the identity of the participant? ☒ Yes ☐ No
Indicate how the coded data will be stored separately from the identifiable data:

Will you be collecting any **sensitive data**? ☐ Yes ☒ No (DSR required if identifiable, limited data set, or coded sensitive data)
Data is considered to be sensitive when the disclosure of identifying information could have adverse consequences for subjects or damage their financial standing, employability, insurability, or reputation.

Part B – What technologies will be used to collect data?

Mobile App ☒ Not applicable
(DSR required)

1. Name of the app:
2. Identify the mobile device platform(s) (IOS/Android/Windows) to be used:
3. Identify who created the app:
4. Whose device will be used: ☐ Personal phone ☐ Researcher provides phone
5. Address how the app is downloaded to the device:
6. Will data be stored on device for any period of time? ☐ Yes ☐ No
    a. If yes, please describe (e.g. queue on phone and then transmit to server, stored on device indefinitely)?
    b. Is the data encrypted on device? ☐ Yes ☐ No
7. How is the app secured on the device:
    a. Is a password or PIN for app required? ☐ Yes ☐ No
    b. Is a password or PIN for the device required? ☐ Yes ☐ No
8. Will the app be able to access other device functionality such as Location, Contacts, Notifications, etc.?
9. Where is data transmitted by device?
    a. How is it encrypted in transit?
10. Address how the data is coded:
    a. Are phone numbers or mobile identification numbers stored with data: ☐ Yes ☐ No
11. When data is transmitted from the device, please list all locations where it will reside (even temporarily):
12. Provide any additional information:

Web-based site, survey or other tool ☒ Not applicable
(DSR required except if all data recorded is anonymous)

If you select any of the first 4 options, jump to question 6:
☐ Pitt licensed Qualtrics ☐ CTSI REDCap
☐ WebDataXpress ☐ TrialSpark

☐ If Other**,** you are required to answer all 8 questions below:

1. Name the site you are using:
2. Who created the site, survey or tool?
3. Where is it hosted:
4. What version of the software is being used, if applicable?

5. How is the data encrypted:
6. Is informed consent being obtained using the same site? ☐ Yes ☐ No
   a. If yes, how is re-identification prevented:
7. Once collection is complete, how will you access the data:
8. Does the technology utilized allow for the explicit exclusion of the collection of Internet Protocol (IP) address of the participant's connection? ☐ Yes ☐ No
   If Yes, will you utilize this option to exclude the collection of IP addresses? ☐ Yes ☐ No
9. Provide any additional information:

Wearable Device ☒ Not applicable
(DSR required except if all data recorded is anonymous and device registered by research team)

* Also complete the mobile app section above if a mobile app will be used with the wearable device

1. Name of device:
2. Is wearable **provided** by participant or research team: ☐ Personal device ☐ Researcher provides device
3. Is wearable **registered** by participant or research team: ☐ Participant registers device ☐ Researcher registers device
4. Where is data transmitted by device:
   a. How is it encrypted in transit:
5. How is data coded:
   a. Are phone numbers or mobile identification numbers stored with data?
   b. Will GPS data be collected to identify locations?
6. When data is transmitted from the device, please list all locations where it will reside (even temporarily):
7. Provide any additional information:

Electronic audio, photographic, or video recording or conferencing ☐ Not applicable
(DSR required)

1. Describe the method of capturing the photograph, video, or audio: I will be using a digital audio recording device to record the interview of study participants.
2. Will the photographs, video, or audio be transmitted over the internet? ☐ Yes ☒ No
3. How will the photographs, video or audio be secured to protect against unauthorized viewing or recording: Initially, while collecting the data, the recording device will be stored in a locked bag until the electronic files of the interview can be placed on Pitt Box and deleted from the original recording device. This file will be transcribed and the transcripts of the interviews will be stored on Pitt Box.
4. Provide any additional information: The interviews will be transcribed by a professional transcriptionist. A CD of the interview with no identifying information, will be given to the transcriptionist. Once the interviews are transcribed, a transcription document will be given to me on a flash drive and the transcriptionist's document will be destroyed once it is verified that I have safely saved the document on my Pitt Box.

Text messaging ☒ Not applicable
(DSR required)

1. Are you using the current text messaging available on the device or a separate application:
   a. If the latter, ensure mobile app section above is completed.
2. Whose device will be used: ☐ Personal phone ☐ Researcher provides phone
3. What is the content of the messaging:

4. Will messages be limited to appointment reminders? ☐ Yes ☐ No
5. Is the communication one-way or two-way:
6. Is any other technology being used to collect data? ☐ Yes ☐ No
   a. If Yes, describe:
7. Provide any additional information:

Part C - Once data collection is complete, where will it be transmitted, processed, and stored

- If sharing data outside Pitt/UPMC, contact the Pitt Office of Research at http://www.research.pitt.edu/ as a Data Use Agreement or Contract may be required

1. Server
   ☒ Pitt CSSD NOC Managed Server
   ☐ Pitt Department Managed Server
   ☐ UPMC Managed Server
   ☐ Other (describe):
2. Cloud File Storage
   ☒ Pitt Box
   ☐ Pitt OneDrive/SharePoint Online
   ☐ UPMC My Cloud
   ☐ Other (describe):
3. Any computers (laptops or desktop PCs) or devices (tablets, mobile devices, portable storage devices) used to access data stored on systems identified in questions 1 or 2 above
   ☒ Pitt owned desktop or laptop, or other device
   ☐ UPMC desktop or laptop, or other device
   ☒ Personal desktop or laptop, or other device
   Will research data be stored on the computer or device ☐ Yes ☒ No
   If Yes, what product is used to encrypt data?
   Is anti-virus software installed and up to date? ☒ Yes ☐ No If Yes, what product and version? Windows Defender and Symantics
   Is the operating system kept up to date with Windows or Apple updates? Yes
4. Third-party collaborator or sponsor:
5. Provide any additional information:

Part D - During the lifecycle of data collection, transmission, and storage

(DSR required if identifiable, limited data set, or coded data is shared with external site)

1. Who will have access to the data: Alaine Allen, the researcher will have access to the data.
2. How will that access be managed: The data will be kept on the Pitt Box.
3. Who is responsible for maintaining the security of the data: Alaine Allen, the researcher is responsible for maintaining the security of the datea
4. Describe your reporting plan should your electronic data be intercepted, hacked, or breached (real or suspected): The data will be anonymouse information, so there is no risk if it is intercepted, hacked or breached.
5. Describe what will happen to the electronic data when the study is completed as University policies require that research records be maintained for at least 7 years after the study has ended: The anonymous data can remain on Pitt Box for the designated 7 years and kept in a locked file cabinet drawer in my home as a back-up.
    a. If children are enrolled, provide your plan for ensuring that the records will be retained until the child reaches the age of 23, as required by University Policy: Not applicable
6. Is this an application where Pitt will be the data coordinating center? ☐ Yes ☒ No (If Yes, DSR required)
7. Is this a coordinating center application and response to CC2.8 is YES? ☐ Yes ☒ No (If Yes, DSR required)
8. Provide any additional information:

I certify I have reviewed and am in compliance with the **terms of service** for all technologies to be used for research activities: ☒ Yes ☐ N/A as no third-party technologies are being used

APPENDIX F

DRAFT – INSTRUMENT FOR ENGINEERING SCHOOLS

The questions in this survey are slight adjustments and engineering-specific variations of the probes related to the dimensions in Smith's Framework for Institutional Diversity (Smith, 2009).

Institutional Vitality and Viability:

- What is the history of the school regarding efforts to diversify and be more inclusive?
- How is diversity and inclusion incorporated into the vision and mission of the engineering school?
- What strategies in the strategic plan relate to the areas of diversity and inclusiveness and what is the current progress of the engineering school in these areas?
- What is the diversity of the engineering school and engineering department leadership?
- What is the diversity of the engineering faculty and staff by department and by level?
- What is the perception of the school from various constituents such as alumni, students, faculty and staff? What are the perceptions of the various departments?
- How does the school incorporate diversity and inclusiveness into areas of visibility such as recruitment, school publications, reports and presentations?

Education and Scholarship

- What professional development exists to train faculty, staff and students on the topics of diversity and inclusion?
- Does the engineering school participate in networks to enhance the teaching skills of its graduate students and faculty? To what extent do graduate students and faculty participate in these services?
- Do the engineering classes incorporate a variety of teaching methods into its courses or present the material according to a variety of learning styles?
- Is there a diverse set of learning experiences available to engineering students through research, service learning, study abroad, internships and other experiences?
- Do faculty or staff conduct research related to engaging marginalized groups in engineering instruction or experiences?

Climate and Intergroup Relations

- Has your school conducted a climate survey to determine how students, staff and faculty perceive the engineering environment? If so, what were the results?
- What are the types and quality of interaction between groups?
- To what extent do students participate in student organizations within the engineering school? How does this participation vary by group such as ethnicity, race, gender and department?
- How are new students, staff members and faculty integrated into the culture of the engineering school?

Access and Success:

- What is the enrollment, first year retention and graduation rate of engineering undergraduates disaggregated by ethnic groups, race, gender and department?
- What is the enrollment of engineering graduate students disaggregated by ethnic groups, race, gender and department?
- What is the enrollment, retention and graduation rate of students who enter the school as transfer students disaggregated by ethnic groups, race, gender and department?
- To what extend do students participate in academic enrichment and leadership activities disaggregated by ethnic groups, race, gender and department?
- How many undergraduates move onto graduate school upon graduation disaggregated by ethnic groups, race, gender and department?
- How many undergraduates move into industry upon graduation disaggregated by ethnic groups, race, gender and department?

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