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Access and Success for African American Engineers and Computer Scientists: A Case Study of Two Predominantly White Public Research Universities

A dissertation submitted in partial satisfaction of the

requirements for the degree

Doctor of Philosophy in Education

by

Christopher Bufford Newman

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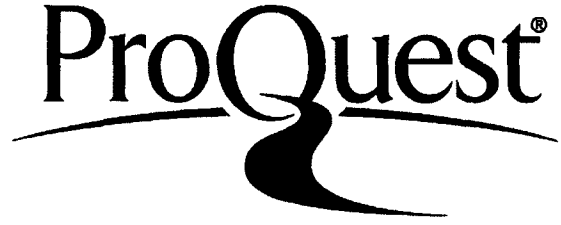

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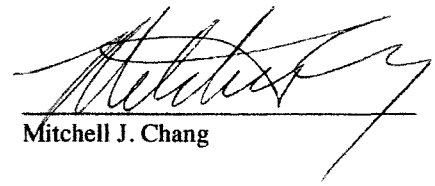
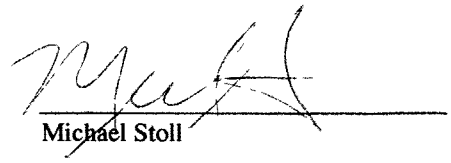
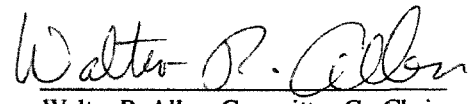


Mitchell J. Chang

Sylvia Hurtado



Michael Stoll



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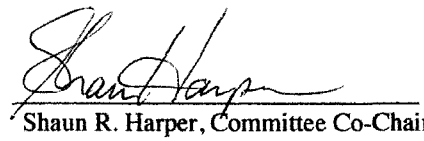

Shaun R. Harper, Committee Co-Chair

Dedications

This volume is dedicated:

To the African American pioneers in engineering and technology, your blood, sweat, and tears are not forgotten. A new generation is ready to carry the torch.

To my wife, Qiana Lynn Jackson-Newman, Ed.D., thank you for supporting me in chasing my dream.

To my son, Jackson Christopher Newman, you are my inspiration.

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Acknowledgments

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Vita

December 28, 1980	Born, Los Angeles, California
1998	High School Diploma Loyola High School Los Angeles, California
2002	B.A., Sociology University of California, Santa Barbara Santa Barbara, California
2004	M.A., Leadership Studies University of San Diego San Diego, California
2004-2007	Recruiting and Admissions Counselor Rossier School of Education University of Southern California Los Angeles, California
2007	Dean's Award Rossier School of Education University of Southern California Los Angeles, California
2007-2008	Research Analyst CHOICES Project University of California, Los Angeles Los Angeles, California
2008	M.A., Education University of California, Los Angeles Los Angeles, California
2008-2011	Research Analyst Higher Education Research Institute University of California, Los Angeles Los Angeles, California

2009-2011	Teaching Assistant Department of Education University of California, Los Angeles Los Angeles, California
2010	Faculty Award Higher Education and Organizational Change Department of Education University of California, Los Angeles Los Angeles, California
2010-2011	Institute of American Culture Fellowship Ralph Bunche Center for African American Studies University of California, Los Angeles Los Angeles, California

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Allen, W. R., Jayakumar, U., Vue, R., Haslerig, S., & Newman, C. B. (2009). *Successful college transitions: College culture and cultural integrity in the A Better Chance and Young Black Scholars programs.* Prepared for the Lumina Foundation for Education Indianapolis, IN.

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Abstract of the Dissertation

Access and Success for African American Engineers and Computer Scientists:

A Case Study of Two Predominantly White Public Research Universities

By

Christopher Bufford Newman

Doctor of Philosophy in Education

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Professor Walter R. Allen, Co-Chair

Professor Shaun R. Harper, Co-Chair

Over the past decade, three rationales have emerged for emphasizing the reinforcement of the United States' science, technology, engineering, and mathematics (STEM) pipeline. The first rationale pertains to U.S. global competitiveness, the second revolves around the benefits of a diverse workforce, and the third argument points to social justice and inequity. Taking into consideration these three rationales, this study focuses on ways universities may bolster the success of African American engineers and computer scientists through a mixed methodological approach. First, I examine the experiences of 657 African American students who entered college with the intentions of majoring in engineering or computer science. I analyze data from the 2004 Freshman Survey (TFS) administered by UCLA's Higher Education Research Institute (HERI), which was matched with 5-year degree attainment data from the National Student Clearinghouse. I utilize a multinomial logistic regression to discern how individual and

institutional factors differentially affect engineering and computer science baccalaureate degree attainment for African American students, who entered college with the intention of majoring in engineering or computer science.

The results indicate survey respondents (as compared to respondents who graduated with a degree in a non-STEM field) were more likely to complete a degree in engineering or computer science if they attended a private high school (13.6% more likely) or attended a Top 50 producer of African Americans with baccalaureate degrees in engineering (19.8% more likely). Additionally, a one grade category increase (i.e., from a B+ to an A-) in average high school grade garnered 7% increased likelihood of completing a degree in engineering or computer science.

Among students who completed a degree in science or mathematics, respondents were more likely not to switch to a non-STEM field if they attended an HBCU (7.5% more likely) or if they took four years of mathematics (as compared to those who took only three years) (5.9% more likely). Also, a one grade category increase (i.e., from a B+ to an A-) in average high school grade garnered a modest 1% increased likelihood of completing a degree in science or mathematics.

Next, I conducted case studies of two predominantly White public research universities characterized as Top 50 producers of African American baccalaureate degrees in engineering. I interviewed 70 individuals: 37 African American engineers/computer scientists, 9 engineering or computer science faculty members, 16 administrators, and 8 recent baccalaureate recipients. Through qualitative data analyses of

the case studies, seven themes emerged as important factors in the academic careers of the successful African American participants, which include:

1. The role of Minority Engineering Programs (MEP)
2. The importance of outreach and pre-college programs
3. The role of the National Society of Black Engineers (NSBE)
4. Successful students have challenges too and strategies for success
5. The role of same race versus different race faculty interactions
6. African American women's experiences in engineering and computer science
7. Post baccalaureate decisions: graduate school or industry

These findings provide examples of the multiple ways the two predominantly White public research universities support the success of the African American student participants. Also, the findings highlight the institutional agents, programmatic interventions, co-curricular involvement, and engagement opportunities, which contribute to the success of the 37 current students and the 8 recent alums.

Findings from this research study provide university administrators, policy makers, faculty, and scholars with a better understanding of the role universities play in motivating or inhibiting the success of African American engineers.

Chapter One – Introduction

The Dean of Porter State University's School of Engineering told me the following story:

> 20 years ago, A young lady who was an undergraduate student at [a university] young latina, and so they are doing exit interviews, and apparently the Associate Deans asked her what can [this university] do to increase its minority student enrollment. And this young lady, being very candid says, "well it's not happening because it's not a priority." And they respond "what do you mean, we have all these statements" and her answer was "that doesn't mean anything." If this university, if it says that it wants to have an artifact from ancient Middle Eastern history, it goes out and gets it. You see what I am getting at right? So this can't be a priority here, because it isn't happening. So what happened was they hired her, to lead this effort and gave her carte blanche. It turns out that [the University] had never sent anybody out to places like [racial minority communities], or places like this just to interact. They basically said "we think you're right" you know, so "we will make it a priority, and we're going to hire you and you tell us the resources you need and all that." Fast forward ten years later significant increases in the student population, in fact the university received awards nationally and [University] I think has a reputation now. Now the biggest beneficiary of this is [University], because it's like the tipping point. Once you have something, people want to come there because they have the environment; they have the culture. They know that this is a place where this type of thing is valued. We talk about this in terms of Porter State. Have we reached the tipping point or not? We're not

> sure, we have numbers, we're big, you know that, but you can be big, and have pathetic numbers, so we know we've definitely surpassed some threshold, but we really aspire to more.

Porter State's Dean places the onus on universities to provide the context for underrepresented students' success. Far too many research studies focus solely on students and do not ascribe adequate responsibility to institutions. As a result, the institution never changes and the status quo remains intact. A lack of focus on the institution enables inequities to go unchecked and thousands of students to fall through the cracks.

In this study, I focus on successful African American undergraduate engineers and the higher education institutional contexts enabling or impeding their achievements. Specifically, I investigate the experiences of African American engineers as they navigate their respective universities. The central focus of this inquiry is on the policies, support structures, pedagogical practices, and opportunities, which encourage or dissuade African American engineers to succeed. Findings from this research study provide university administrators, policy makers, faculty, and scholars with a better understanding of the role universities play in motivating or inhibiting the success of African American engineers.

Significance

Over the past decade, three rationales have emerged for emphasizing the reinforcement of the United States' science, technology, engineering, and mathematics

(STEM) pipeline. The first rationale pertains to U.S. global competitiveness, the second revolves around the benefits of a diverse workforce, and the third argument points to social justice and inequity. The global competitiveness rationale spurs from the 2007 report, *Rising Above the Gathering Storm,* which focuses on a number of national and international indicators suggesting the U.S. is not keeping pace with other countries in STEM academic preparation and subsequent knowledge production. An example of the evidence presented to support this claim is the rates at which countries around the world are producing undergraduate students with natural science and engineering undergraduate degrees: 67% in Singapore, 50% in China, 47% in France, and 38% in South Korea. On the other hand, institutions of higher education in the U.S. only confer 15% of its students with natural science and engineering degrees. This example suggests the U.S. will not have adequate human capital to compete in the global economy if there is a persistently low production of well-trained U.S. citizens in STEM fields.

The second rationale for the need to reinforce the U.S. STEM pipeline is the benefit of having a diverse workforce. From this perspective major employers of individuals with STEM degrees in the U.S., like Microsoft and General Electric (GE), have affirmed the value of a diverse workforce in the drive for innovation. For instance, Bill Gates, Chairman of Microsoft, stated, "At Microsoft, we recognize a workforce made up of smart people from different backgrounds and with different perspective is what drives innovation." From Microsoft's point of view, the experiences of a diverse constituency will create an atmosphere challenging organizations to think outside of the box for innovative solutions and revolutionary products.

Moreover, GE, the world's third largest publicly traded company, played an important role in advocating for a diverse workforce (Slaughter, 2009). In 1973, GE worked in partnership with several deans of engineering from historically Black colleges and universities (HBCUs) to advocate for the creation of the National Advisory Council for Minorities in Engineering (NACME) (Slaughter, 2009). The creation of NACME and subsequent other committees and consortiums drew national attention to the underrepresentation of racial minorities in engineering. GE has continued to push for a diverse workforce, which is best characterized in an advertisement placed in a 2008 issue of *Black Enterprise* magazine:

> The more perspectives we have, the clearer the picture. GE employees are as diverse as our products and services. That's because we bring together the best imaginations from diverse people. We're 315,000 minds operating in 100 countries, making over 25,000 products. Without diversity, we just wouldn't be GE (p. 19).

In order for GE to compete in an ever-increasing global economy, they have to cater their products and services to a diverse constituency. GE is just one of a multitude of corporations espousing the economic necessity of a diversified labor workforce. In the premiere issue of *Diversity Employers* (2011), the magazine is filled with advertisements similar to GE's noted above. Furthermore, this issue highlights the overall "Top 100" employers of a diverse workforce and has a disaggregated list for specific majors. Among engineering majors some of the top employers include BAE Systems, Dow Chemical, DuPont, Intel, GE, Lockheed Martin, Northrop Grumman, Nokia, Raytheon, Verizon

Wireless, Tyson Foods, and Whirlpool to name a few. Clearly, a sustained effort in developing a more racially diverse pool of engineering talent may help the U.S. compete in an increasingly global economy where different perspectives are vital for success and innovation (Leggon & Pearson, Jr., 2007). Consequently, identifying factors leading to Black student's successful navigation of the engineering pipeline may increase the retention rates and as a result fuel a more racially diverse workforce.

The final rationale for reinforcing the U.S. STEM pipeline concerns social justice and inequity. Another example from *Rising Above the Gathering Storm* is about one-third of U.S. students intending to major in an engineer field switch majors before graduation. The National Science Foundation (NSF) (2007) reported 22.8% of Blacks entered college with the intention of majoring in a STEM field, which is slightly higher than their White American (21%) counterparts. Researchers have found a number of African American undergraduates enter college with strong SAT scores, high grade point averages, and previous success in science and mathematics courses, but disproportionate numbers of underrepresented racial minorities (URMs) leave the STEM pipeline (Seymour & Hewitt, 1997). The ramification of these findings is displayed in the disproportionate employment rates in the engineering and computer science fields. As listed in Table 1.1, the National Science Foundation's (2011) most recent report on engineering employment reveals African Americans account for only 3.4% of all careers in engineering and 4.9% of all careers in computer and information science. These data are particularly troubling because, based on the 2010 U.S. Census, African Americans make up 12.6% of the United States' population (Humes, Jones, & Ramirez, 2011). In comparison, White

Americans account for 74.9% of engineering and 68.2% of computer science positions while making up 63.7% of the U. S. population; Asian Americans account for 14.4% of the engineering and 20.9% of the computer science profession while constituting 4.8% of the U. S. population.

These statistics suggest engineering talent is disproportionately underdeveloped for African Americans and highly interested students are being lost in the higher education pipeline. From a social justice perspective, these statistics also bring into question whether African Americans are systematically being diverted from this higher skilled labor market. In all, the three rationales of U.S. global competitiveness, diverse workforce, and social justice serve as compelling rationales for a call to action among researchers, practitioners, policy makers, and corporate industries. However, I express caution in the rationale for the U.S. global competiveness argument because it may be perceived by some as propagating a nationalistic and colonialist rhetoric, which may focus on domination and continued subordination of "third world" countries and peoples of color.

Table 1.1 – Racial Breakdown of U.S. Population, Careers in Engineering, and Careers in Computer and Information Science

Race	U.S. Pop.	Careers in Eng.	Careers in CS & IS
African American	12.6%	3.2%	4.9%
Asian American	4.8%	14.4%	20.9%
Latino/Hispanic American	16.3%	5.2%	3.9%
Native American	0.9%	0.3%	0.3%
White American	63.7%	74.9%	68.2%

Statement of Problem

A number of researchers have studied URMs in STEM fields, but the focus of their research perpetually revolves around the same issues of STEM major non-persistence (e.g., Seymour & Hewitt, 1997) and academic under preparedness (e.g., Russell & Atwater, 2005). Studies like these have identified the challenges racial minority students face, but have rarely contextualized the persisting challenges of African American undergraduates to include racism, the history of exclusion, segregation, and the bombardment of negative stereotypes. For the most part, researchers have placed the onus on the students instead of on the different ways institutions structure or perpetuate inequities. Instead of blaming the student, the goal of this work is to better understand how institutions can improve the persistence rates for African American undergraduates in engineering and computer science.

In the following chapters, I discuss the historical context of African American engineers in the U.S. Then, I describe empirical research on students of color in STEM and the roles of institutions, faculty, and gender. I conclude by providing a detailed description of my research methodologies, which include quantitative analyses of student and institutional level data from a national dataset and a qualitative multiple case study of two higher education institutions located in the Midwestern and Southeastern regions of the U.S. The following research questions guide this mixed methodological inquiry:

Quantitative

1. How do individual and institutional factors differentially affect Engineering and Computer Science baccalaureate degree attainment for African American

students, who entered college with the intention of majoring in Engineering or Computer Science?

Qualitative

2. How do schools of engineering, characterized as top producers of African Americans with Baccalaureate degrees in Engineering, encourage or impede the support of African American engineering and computer science students?
3. How do institutional agents, programmatic interventions, co-curricular involvement, and engagement opportunities support or discourage participants' persistence through the engineering pipeline?

Key Terms

The following terms will be used frequently throughout this manuscript. Here are clear definitions of these terms:

African American – I am referring to citizens of the United States citizens, who are descendants of Africans. Black or African American may be used at times interchangeably due to its usage in the literature. I conceive "Black" as a more general term to describe peoples of African ancestry, who may or may not be citizens of the U.S.

Engineering – Is the study or practice of eight major subfields, which include aerospace, agricultural, biological/biomedical, chemical, civil, electrical, mechanical, and computer science.

Historically Black College and University (HBCU) – A college or university founded to serve African Americans following the period of enslavement and subsequent legal

segregation in the U.S. These colleges and universities have open doors to all students, but the "historical" label is used to preserve the institutions historical legacy and mission.

Institutional agents – Adapted from Stanton-Salazar's (2001) description of school agents like counselors and teachers who transmitted support and social capital to Mexican youth in K-12 settings. In the context of this study, institutional agents may be university faculty members or administrators who provide support for and information about navigating the university, field of study, or career.

Institutional contexts – Refers to the circumstances that form the setting for student experiences and provides a description of the environment for which the experience can be fully understood and assessed.

Predominantly White Institution – A higher education institution historically founded to serve White Americans. In subsequent years, these institutions have opened their doors to people from different racial backgrounds. However, these institutions are still characterized as having student bodies with White majorities. Additionally, these campuses may also have overwhelmingly White senior administrators, often, in spite of a more diverse student body.

STEM – An aggregated description of the fields of Science, Technology, Engineering, and Mathematics

URM – An aggregated description of citizens of the U.S., who are underrepresented racial minorities in various aspects of education and civic life.

Outline

In chapter two, I discuss the historical context, which helped shape the porous pipeline for African American engineers and computer scientists. Then, I review previous research generally focused on the experiences of URMs in STEM and specifically on African American engineers. Chapter two concludes with a discussion of the conceptual framework utilized to explore the experiences of African American engineers and computer scientists. The conceptual framework draws from Hurtado et al.'s (1998) campus racial climate framing, as well as, Bensimon (2005), who focuses on the role of institutions in perpetuating inequities and Harper's (2010) anti-deficit framework.

In chapter three, I describe the broad aims of this project. Next, I give a detailed description of the qualitative and quantitative mixed methods approach utilized to answer the research questions. Lastly, I address my role as a researcher, which acknowledges the potential biases and personal perspectives I carried into this study. I conclude this section with a discussion of study limitations and the steps I took to minimize these limitations.

In chapter four, I present the first phase of inquiry derived from 657 African American undergraduate students, who entered college with the intention of majoring in engineering or computer science. I introduce the multinomial logistic regression models for African American students who entered college with the intention of majoring in engineering or computer science and completed a degree in this same field and students who completed a degree in a science or mathematics field. Both models are compared to African American students who entered college with the intention of majoring in engineering or computer science, but completed a degree in a non-STEM field.

In chapter five, I offer findings from two qualitative case studies conducted at Porter State and Baldwin Universities, which are both characterized as Top 50 producers of African Americans with baccalaureate degrees in engineering. I begin with a description of each university In chapter six, I continue my qualitative findings and I explore the role of race and gender and the influence these identities have on participants' interpersonal relationships. In chapter seven, the last qualitative findings chapter, I focus on students' challenges and their strategies for success. I conclude by giving attention to student participants' immediate plans (e.g., graduate school or begin professional career in industry) after they complete the bachelor's degree.

This study concludes in chapter eight where I utilize the quantitative results and the qualitative findings to answer the three research questions guiding this study. Then, I make connections with the findings and previous literature. Lastly, I provide important implications for policy, practice, and future research.

Chapter Two - Literature Review and Conceptual Framework

In this chapter, I first discuss the historical context, which helped shape the porous pipeline for African American engineers and computer scientists. I follow this with a review of previous research generally focused on the experiences of URMs in STEM and specifically on African American engineers. I conclude this chapter with a discussion of the conceptual framework I utilize to explore the experiences of African American engineers and computer scientists.

Historical Context

The racial stratification pervading the United States with White Americans controlling political rhetoric, financial markets, and social norms can be traced back to Europe's underdevelopment of Africa (Rodney, 1972). Rodney (1972) contends modern underdevelopment "expresses a particular relationship of exploitation: namely the exploitation of one country by another" (p. 14). Through aggressive expansionist actions, European countries developed imperialist and colonialist regimes to govern and exploit African countries of their natural resources and labor. Europeans instituted a system where African wealth flowed outward, which incited dependency on foreign industries (Rodney, 1972).

Through the slave trade, Europeans continued the subjugation of Africans throughout European colonies like America. A number of scholars have stressed the importance of understanding the historical roots of contemporary and persisting challenges of African Americans' underperformance in academic achievement and

underrepresentation in key areas of civic and social life (e.g., Allen, Teranishi, Dinwiddie, & Gonzalez, 2002; Feagin, 2006; Slaton, 2010; Wharton, 1992). Insights into the historical practices of excluding and disenfranchising African Americans from the fields of engineering and technology will lead to a better understanding of the persisting challenges observed by educators and policy makers, who seek to strengthen the engineering pipeline for African Americans.

African American Inventors During the Period of Enslavement

In documenting the history of African Americans in engineering and technology, Wharton (1992) traces the foundation of Blacks' underrepresentation in engineering to the enslavement of Africans in the U.S. and the period of intense racism following the civil war. Wharton presents evidence, in the form of archived letters to the U. S. patent's office, which demonstrated how several enslaved persons invented labor saving devices, but were prohibited from patenting their inventions.

James (1989) details the invention of one such enslaved African American, Ned, who was a mechanic in Pike County Mississippi. Ned invented a much improved upon cotton scraper, which was acclaimed as a labor saving device. A laborer using Ned's cotton scrapper could do four times the work, which increases efficiency, productivity, and profitability. However, Ned's dilemma was his enslavement; in 1857 when he invented this machine enslaved African Americans were not considered U.S. citizens and therefore could not obtain a patent. Ned's slave owner Oscar Stuart sought to capitalize on this predicament by filing the patent for himself. Mr. Stuart wrote letters to the U.S. Patent Office describing the device and he even went as far as to mention his slave

invented the device. He went on to assert his ownership over the invention because as the slave owner he was "the owner of the fruits of the labor of the slave both intellectual, and manual" (James, 1989, p. 49). Ultimately, in 1860, the Commissioner of Patents and the Attorney General agreed neither slaves nor slave owners could receive a patent for devices invented by an enslaved person. James points out this remained the precedent until after the Civil War and the Thirteenth and Fourteenth Amendments were passed. However, Ned was never heard from again and "O. J. E. Stuart and his family went into the full-time business of manufacturing and marketing Ned's Double Cotton Scrapper" (James, 1989, p. 52).

Oscar Stuart was not the only slave owner to capitalize on the intellectual properties of African Americans; other White American male proprietors, during the time of legal African American enslavement, were credited with important innovations and inventions such as Eli Whitney, who was credited with inventing the cotton gin, and Cyrus McCormick, who was credited with the reaper. There has been considerable speculation regarding the proper attribution of the cotton gin and the reaper to powerless African American inventors (James, 1989). A result of the racist laws and institutions, in this time period, was the exclusion in history books of the contributions of African Americans to the early development of the United States.

Moreover, White men were canonized as being the only great thinkers of this era. A clear example of this is found in Goddard's (1906) book, *Eminent Engineers*. In this volume, Goddard describes thirty-two inventors and engineers, who made meaningful contributions to society and Goddard also included portraits. All thirty-two inventors

were White males from the U.S. and Europe and Goddard's biographies often characterized them as noble and heroic. The contributions of non-White men are absent, which leads readers to erroneously assume there were no important African American inventors in this time period. African Americans and other non-White men had to fight to gain their deserved recognition.

Jim Crow: The Period of Many Challenges and Successes

In the 100-year period following the Civil War (1865) and prior to the civil rights movement (1965), commonly referred to as the Jim Crow era, free African American inventors faced severe racism (James, 1989; Wharton, 1992). The experiences of Granville Woods (1856-1910) and Garrett A. Morgan (1877-1963) are pertinent examples of how successful Blacks were often stripped of their African American identity, had difficulty competing with Whites economically in business ventures, and faced parlous racism even if they were able to manage the previous two challenges.

One example is Granville Woods, who held 45 patents and was the inventor of a number of railroad devices and the telephone transmitter (Fouché, 2003). Woods inventions were so popular at the time, Cosmopolitan Magazine published a story about his inventions, "but to advance a [B]lack American inventor in the era following the civil war would have been difficult" (Wharton, p. 6). Instead, Cosmopolitan avoided this situation by reconstructing Woods' background as part aboriginal from Australia and part Malaysian Indian. In addition to being stripped of his racial background, Woods had to fight through court cases to retain his patents and he struggled to finance the enterprises of the Woods' Electric Company. Many bankers during in this period either provided

inadequate funding or outright refused to fund African Americans (Wharton, 1992). The lack of financial capital was a crucial hindrance for African American inventors (James, 1989). Woods was forced to defend his patent for the railway telegraph systems against Thomas Edison and Lucius Phelps, who claimed to invent similar devices. Although Woods won the legal dispute, the court expenses considerably drained his financial resources and Woods had to later sell his inventions to his rivals Thomas Edison and Alexander Graham Bell's companies; Edison and Bell are now revered for their inventions, which were heavily influenced by the work of Woods (Fouché, 2003).

Another example of an African American inventor who faced significant challenges from racist institutions was Garrett A. Morgan. One of Morgan's most important inventions was an early version of the gas mask, which was used by firemen around the world and later used during World War I (1914-1918) by the U.S. military. Morgan's National Safety Device Company manufactured the gas masks and Morgan traveled throughout the U.S. demonstrating his invention. However, Morgan had to hire a White man to conduct the demonstrations in the South because of disparaging racial attitudes. As the rumors spread through southern states that the gas mask was invented by a Black man, sales in the South "virtually ended" (Wharton, 2002, p. 11). The example of Morgan's experience demonstrates it did not matter his invention could save countless lives; the fact the inventor was Black superseded all other consideration.

During the Jim Crow era, a number of African American engineers did not publicly take credit for their inventions because it may have sabotaged the commercial success of their products. Additionally, African Americans, like Woods, often sold their

patents and the buying company usually stripped the African American inventor from the records. The biographies of Woods and Morgan are important because "the lingering effects of the lack of recognition, the inability to secure financing, the elimination of the true identity of many contributors, and the phase-out of many [B]lack role models meant [B]lacks could not look with the pride of ownership at the new technologies," which signaled Blacks were "consumers not contributors" (Wharton, p. 19). As generations of White Americans were inspired by the contributions of Edison and Bell, so too should generations of African Americans have been inspired by the contributions of Woods and Morgan.

The second part of the history of African American engineers, in the Jim Crow Era, is inextricably linked to the education of African Americans and the ideologies of Booker T. Washington (1856-1915) and W. E. B. Du Bois (1868-1963). Although a number of scholars have reinterpreted the Washington and Du Bois debate through a contemporary lens, I believe the context specific rhetoric of these two scholars is pertinent to understanding the lasting impact on the engineering and technology training of African Americans. Washington and Du Bois' historic intellectual debate was sparked by the diverging views each scholar had in regards to the tools needed for African Americans' social mobility; Washington emphasized vocational and industrial training, while Du Bois stressed more theoretical and academic instruction similar to a liberal arts curriculum.

Washington (1901/2007) stated his principal position on the education of African Americans in the south when he described his goal for the Tuskegee Institute[1]:

> We wanted to give them such an education as would fit a large portion of them to be teachers, and at the same time cause them to return to the plantation districts and show the people there how to put new energy and new ideas into farming, as well as into the intellectual and moral and religious life of the people (p. 61).

In essence, Washington focused on educating African Americans to become more productive and efficient agricultural laborers[2]. Northern and southern Whites strongly supported Washington's focus on vocational and industrial training; prominent Whites provided considerable financial backing to institutions implementing Washington's educational strategies. This financial support came at a time when Black colleges struggled to keep their doors open, so a number of institutions followed Hampton and Tuskegee and implemented curricula geared toward agricultural vocations. Although Washington provided thousands of Blacks with access to education and some immediate economic returns, his focus on vocational education and civic patience[3] provided little access to higher skilled labor markets like engineering.

On the other hand, Du Bois (1903/1994) vehemently believed Washington's ideologies "practically accepted the alleged inferiority" of all Black people (p. 30). Du

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[1] Washington helped found the Tuskegee Institute

[2] Tuskegee gave rise to people like George Washington Carver and his many uses of the peanut and soybean.

[3] In his Atlanta Exposition address, Washington encouraged Blacks to be patient with social change and in time, Whites would see that Blacks were worthy of things like voting rights. In essence, Du Bois insinuates Washington is surrendering to the notions of Black inferiority.

Bois advocated for higher education institutions like Fisk, Spelman, and Howard, which provided a more liberal arts curriculum similar to Harvard, Yale, and Oberlin. Du Bois believed this type of training would give Blacks an opportunity for social mobility through access to professional careers. Du Bois was convinced particularly capable Blacks (i.e., the talented tenth) should be educated at the highest levels. Through educational attainment, these Blacks would serve as leaders of the Black populace and uplift their communities across the nation. Du Bois' pointed out a trend, which seems to have persisted to the present by stating:

> [Washington's] doctrine has tended to make the [W]hites, North and South, shift the burden of the Negro problem to the Negro's shoulders and stand aside as a critical and rather pessimistic spectators; when in fact the burden belongs to the nation, and the hands of none of us are clean if we bend not our energies to righting these great wrongs (p.35)

Undoubtedly, Du Bois' efforts inspired higher education institutions like Howard[4] to continue to persevere and educate Blacks in highly skilled fields like science and engineering.

The experiences of Woods, Morgan, and nameless African American inventors and the philosophies of Washington and Du Bois help to contextualize the turbulent formation of an engineering pipeline for African Americans in the United States. In the formative years of a newly freed citizenry, African Americans were denied membership

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[4] Wharton points out that Howard awarded the first bachelor's degrees in engineering to African Americans and not Hampton or Tuskegee.

into highly skilled fields like engineering through law, policy, rhetoric, sabotage, influence, and coercion. Generations were not afforded the wealth and resources they deserved and future generations began an arduous journey significantly behind their White counterparts.

Higher Education Institutions' Historical Role in Educating African American Engineers

With the historical roots of African Americans' entry into the engineering and technology field in perspective, I will focus specifically on the role of universities in providing or refusing opportunities for African Americans participation in engineering and technology education. Slaton (2010) recounts the involvement of six universities by describing the institutional policies and practices utilized to maintain the status quo of African American exclusion or diversion from engineering education. Slaton focuses on three time periods, which include two universities from the University of Maryland system in the 1940s, two universities in Chicago during the 1960s, and the two universities from the Texas A&M system in the 1990s. I will focus specifically on Slaton's discussion of the University of Maryland system because it is a pertinent example of how universities systematically denied opportunities to African Americans in engineering education.

In the University of Maryland system example, Slaton (2010) focuses on a number of policies like the disproportionate funding of the College Park and Princess Anne (modern day Eastern Shore) campuses. The disparate funding streams for each campus are emblematic of the social ideologies of then system president Harry Byrd, who propagated social inequality through his racist beliefs in the subordination of African

Americans in Maryland. He used education policies and practices to ensure African Americans did not participate in highly skilled labor markets like the engineering profession. Furthermore, African Americans were relegated to rural agricultural trade occupations.

In one of many examples of racists policies the University of Maryland Board of Regents offered African Americans scholarships, beginning in 1932, to attend universities outside of the UMD system (Slaton, 2010). Slaton chronicles how the scholarships were instituted to support out of state study for African Americans who were unable to find suitable college degree programs in the UMD system. Slaton argues:

> The $600 scholarship fund intended to cover the expenses of multiple students at the undergraduate and graduate level, was pathetically small, but represented a decision to fund scholarships instead of improvements at Eastern Shore (p.29).

Unequal policies like the scholarship fund helped to give rise to increasingly powerful political organizations like the NAACP, who began to challenge "separate but equal" policies in Baltimore, MD. The scholarship fund was a clear indicator of how little the UMD system invested in the education of their African American citizenry and how blatantly the UMD Board of Regents opposed providing equal opportunities to African Americans.

Although, the scholarship fund was started prior to President Harry "Curly" Byrd's reign, Byrd launched his own campaign to enhance the opportunities for White Americans at the expense of HBCUs in the state of Maryland. The College of

Engineering at the College Park campus became one of President Byrd's most effective "institution-building" enterprises (Slaton, 2010). Slaton states:

> As Byrd developed engineering programs at College Park, he systematically denied the need for any such agenda at Eastern Shore, a setting he saw as removed from UMD's main branch both geographically and conceptually. (p.34)

For example, there are clear disparities in the amount of investment in the infrastructure (i.e., buildings, equipment, and land cultivation) at the College Park versus Eastern Shore campuses; spending at College Park was estimated to be approximately $4 million while Eastern Shore was only $100,000.

During the first full decade of Byrd's presidency (1940-1949), Eastern Shore operated on about $500,000, although the UMD system had a budget of nearly $50 million dollars. This datum encapsulates the inequitable resources and allocations of the higher education institution designated for African Americans in Maryland. For decades, Harry Byrd held a reign of terror over the HBCU campuses where he used any and every means necessary to repress African American Marylanders. The few African Americans who were fortunate enough to navigate this blatantly racist education system in Maryland were forced to attend universities in other states and those who attended the designated Black campuses were forced to endure substandard facilities and equipment.

The irony of this historical context as it relates to the University of Maryland is the A. James Clark School of Engineering at the College Park campus currently has an African American Dean Dr. Darryl Pines. This deanship signals the immense progress made, but as I will discuss in subsequent sections of this volume institutional culture and

historical legacies are changed over long periods of time and through intentional actions by key stakeholders. The University of Maryland case is just one example of how an institution systematically eliminated and limited opportunities for African Americans to develop a strong Engineering pipeline. UMD was not the only system, in the Jim Crow Era, operating in a blatantly racist manner. The intentional actions of the system of education during this time period severely undermined the long term participation of African Americans in engineering. It has taken and will continue to take decades to strengthen and restore the Engineering pipeline.

Empirical Research

There have been a number of contemporary empirical studies and scholarly publications focusing on students of color in STEM fields (e.g., Bonous-Hammarth, 2000; Espinosa, 2008; Hackett, Betz, Casas, & Rocha-Singh, 1992; Leslie, McClure, & Oaxaca, 1998; Russell & Atwater, 2005; May & Chubin, 2003; Seymour & Hewitt, 1997). However, a number of these scholarly works have reported students of color and academic fields of study in the aggregate. In other words, all students of color and all STEM majors are not disaggregated by race or specific majors, which lend itself to a monolithic perspective in understanding the experiences of specific racial/ethnic groups within specific academic STEM disciplines (i.e., engineering or computer science). Furthermore, very few scholars even hint at the historical legacies of racism and exclusion as possible explanations in their analyses of racial minority underrepresentation.

Nevertheless, these studies have found the factors negatively influenced persistence among students of color include racial isolation (Seymour & Hewitt, 1997; Moore, Madison-Colmore, & Smith, 2003), racial stereotypes (Seymour & Hewitt, 1997), institutional selectivity (Bonous-Hammarth, 2000), inadequate program support (Seymour & Hewitt, 1997), and inadequate academic preparation (Russell & Atwater, 2005). Additionally, researchers have found a number of positive factors supporting the persistence of students of color in general and African Americans in particular include academic indicators like high school grade point average and SAT mathematics scores (Bonous-Hammarth, 2000), early interest in STEM fields, familial support and strong aptitudes in STEM (Moore, 2006; Russell & Atwater, 2005). However, there are bodies of literature focusing on four specific areas of study: institutional contexts, faculty, women in STEM, and African Americans in Engineering.

The Role of Institutional Contexts

The institutions of higher education established to educate African Americans in the U. S. played a pivotal role in producing professionals in highly technical areas like science and engineering (Trent & Hill, 1994). HBCUs still confer a large portion of bachelor's degrees in STEM among Black students (NSF, 2007). Research has indicated environmental factors, and not academic preparation and interest, have an impact on Black students' persistence in STEM majors (Reichert & Absher, 1997). For example, in an ethnographic study of 88 students of color, Seymour and Hewitt (1997) reported four themes summarizing the challenges students of color had to overcome in their STEM college experiences, which are differences in cultural values and socialization,

internalization of stereotypes, isolation and perceptions of racism, and inadequate program support. These themes demonstrate there are multiple dimensions (institutional, social, and psychological) to the challenges associated with underrepresented racial minorities' college experiences.

Researchers have paid particular attention to the role institutional contexts played in shaping the experiences of African American collegians (Allen, 1992; Davis, 1994). With a sample of 1,800 Black students, Allen (1992) found statistically significant differences among Black students who attended predominantly White and historically Black institutions. More specifically, Allen found African American students at HBCUs reported greater social involvement and better academic performance than their counterparts at predominantly White institutions, which suggests HBCUs are providing more socially and academically supportive environments.

Davis (1994) conducted a comparative analysis of the college impact of 742 African American men who attended both historically African American and predominately White institutions (PWIs). Davis' study examined the impact the perception of social support has on college grades. Similar to Allen (1992), Davis' findings indicated the perception of a high level of social support at historically Black institutions has a positive impact on the average college grade received, which resulted in higher grades than their PWI counterparts. Interestingly, the African Americans who attended the PWIs entered college with higher quantitative indicators typically used to predict success (standardized tests and high school grades). Both Davis' and Allen's

findings suggests peer support found in heterogeneously African American college environments may be more affirming of an academic identity or outcome.

Feelings of isolation and negative university environments diminish the experience of African American students at PWIs. D'Augelli and Hershberger (1993), with a matched sample of 73 African Americans and 73 White Americans at a mid-Atlantic PWI, found African American students knew considerably fewer people upon their arrival to the university with more than a third reported not knowing anyone as compared to only 10% for White students. Also, African Americans were far less satisfied with their college experiences than their White counterparts. The African American students in this study reported "hearing disparaging remarks" with 41% indicated hearing these occasionally, 28% often, 20% frequently, and only 11% reported never hearing such comments. Additionally, 59% of the students reported being verbally harassed or insulted by roommates (30%), university staff members (43%), faculty (18%), administrative personnel (18%), and their on-campus job supervisors (13%). D'Augelli and Hershberger demonstrate how African American students at PWIs may often feel isolated and have to withstand hostile campus environments.

In a more recent study focusing on standardized test scores, Fleming (2004) found Black high achievers attending HBCUs tended to have higher self-esteem and their academic performance was more consistent with their abilities (i.e., previous academic performances). Conversely, she found Black high achievers at PWIs had more psychosocial challenges, which diverted their attention away from their academic goals. Flemings' findings suggest HBCUs provide environments promoting academic

achievement and psychological well-being among Black students. Slaughter (2009) suggests, "Engineering students at HBCUs are typically exposed to the principles and practices of research and are much more likely to be surrounded by role models and mentors than those African American students in predominantly [W]hite intuitions (PWIs)" (p. 202). As Slaughter points out, seven of the top ten bachelor's degree producers of African American engineers are HBCUs and a large portion of African American doctoral degree recipients in engineering matriculated through HBCU undergraduate institutions.

Although HBCUs have a proven record of success with producing African American talent there have been instances of other university settings with comparable positive outcomes. Perhaps the most acclaimed institutional efforts in increasing the retention of students of color in STEM fields is the Meyerhoff Program at the University of Maryland, Baltimore County (UMBC). Robert and Jane Meyerhoff donated $500,000 to tackle the underrepresentation of African Americans in the STEM pipeline. The half a million dollar gift funded extensive financial aid packages, recruitment efforts, a summer bridge program, and a program office which helped facilitate study groups, tutoring, mentoring, and summer research internships.

Maton, Hrabowski, and Schmitt (2000) conducted an assessment of the Meyerhoff program using matched samples of non-Meyerhoff scholars at UMBC (n=358) and students who were offered a Meyerhoff scholarship, but decided to attend another university (n=35). Also, the study sample included 93 Meyerhoff scholars from the first three cohorts from 1990-1992. Maton, Hrabowski, and Schmitt's results

indicated Meyerhoff scholars were nearly twice as likely to graduate in a STEM major, had higher GPAs, and were more likely to attend graduate school as compared to students who declined the Meyerhoff program and attended another university. Additionally, the Meyerhoff helped close previous achievement gaps with participants having comparable retention in STEM fields, GPAs, and graduate school enrollment. This assessment of the Meyerhoff program helps to explicate the relationship between institutional support and commitment with measureable academic outcomes. For over a decade, the Meyerhoff program has served as a model for transforming an institutions culture toward creating a supportive and nurturing environment for African American and other underrepresented students of color.

The Role of Faculty

A number of studies on the impact of college on student outcomes suggest faculty interactions play an important role in undergraduate students' academic success (e.g., Astin, 1993; Kuh & Hu, 2001; Pascarella & Terenzini, 2005). Some of the outcomes of faculty interaction include increased levels of satisfaction in coursework, cognitive development, and persistence through graduation. However, recent research has started to differentiate students' experience with part-time versus full-time faculty members (Eagan & Jaeger, 2008). In a study of four universities in the southeastern U. S., Eagan and Jaeger found increased exposure to part-time faculty members decreased the likelihood of students persisting to their second year. More specifically, students at doctoral granting institutions were 20% less likely and students at master's comprehensive institutions were 37% less likely to continue to their second year "for every percentage point increase

in exposure to part-time faulty in gatekeeper courses" (p. 46). These findings indicate although it is important for students to be exposed to faculty members, the type of faculty members may make a difference in the impact on student retention.

Although not focusing specifically on students within STEM majors, Cole (2007) and Lundberg and Schreiner (2004) focused on faculty-student interactions. After controlling for background characteristics, Cole (2007) found students who indicated they challenged a professor's idea in the classroom had increased positive faculty contact. Also, Cole found "faculty not taking students' comments seriously" had a negative impact on faculty-student interactions (p. 268). Lundberg and Schreiner (2004) disaggregated faculty-student interactions by race and ethnicity and they found "working harder due to instructor's feedback" was a very strong predictor for African American students' faculty interaction (p. 557). In Lundberg and Schreiner's (2004) study, African Americans had the highest faculty interaction score, but the lowest perception of faculty relationships. These two studies indicate faculty play a key role in engaging students in the learning process whether it is through encouraging critical thinking or giving constructive feedback to students.

Further differentiation is needed to understand the experiences of URM students. Researchers have found faculty interaction and pedagogical practices play important roles in the persistence of students of color (e.g., Bernold, Spurlin, & Anson, 2007; Seymour & Hewitt, 1997). More specifically, Seymour and Hewitt (1997) reveal student perceptions of faculty as "approachable" or "intimidating" and experiences and grading in gatekeeper or "weed-out" courses play an important role in students' decision of nearly 25% of non-

persisters to leave a STEM major. Moreover, there is a clear link to the gatekeeper function of introductory courses and the perception of faculty as "intimidating." Hurtado, Eagan, and Sharkness (2009) found these introductory gatekeeper courses tend to give too much attention to the "acquisition of knowledge" and less to critical thinking skills. Therefore, grading systems may more accurately evaluate a student's ability to "cram for an exam" than their ability to "think like a scientist" or engineer.

In a study focusing specifically on engineering, Bernold, Spurlin, and Anson (2007) focus on the relationship between pedagogical practices and the way students learn. Bernold and his colleagues investigated the experiences of 1,022 freshmen at North Carolina State University. The sample population was only 12% women and just over 10% were "underrepresented minorities." The study participants completed four surveys including the Learning Type Measure (LTM), the Learning and Study Skills Inventory (LASSI), the Pittsburgh Freshman Engineering Attitude Survey, and a series of online journals. The study was longitudinally designed to include students' academic performance at the end of their freshman year and at the beginning of their senior year. The researchers were able to track engineering persisters and movement across majors. Bernold, Spurlin and Anson define success, with a fairly low barometer, as "continuation in the College of Engineering along the prescribed curriculum."

Bernold, Spurlin, and Anson's (2007) findings suggest a mismatch between the espoused pedagogical practices of faculty members at a leading institution with clear outcomes for students. In focusing on academic performance and retention, the researchers found:

> ...students who are not retained may be those who are more oriented toward creativity and innovative, "out of the box" thinking processes, and who thrive in environments where divergent thinking, opinion generating and subjective interpretations are encouraged.

As noted in the *Rising Above the Gathering Storm* volume, innovation is what drives an economy. Bernold and his collaborators suggest the status quo method of "chalk/talk" and passive students may be a significant negative factor for honing in on retention in engineering across racial classifications.

Other studies have found faculty support and encouragement (Cole & Espinoza, 2008) and opportunities to engage in research with faculty members (Espinosa, 2008) provided an increase in GPA and academic self-concept for students of color. These findings show the important association between faculty support and encouragement and measures of academic performance. Carlone and Johnson (2007) developed a theoretical model of science identity, which emphasizes the importance of faculty recognition of student's abilities as a "science person" and not just a student in a science course. In a mixed methods study, Hurtado and her colleagues (2011) found students received positive outcomes not only when faculty recognized a student's promise as a future scientist, but also when faculty members expressed interest in a student's academic and personal well-being. This interest in the "whole person" broke down barriers and softened the perception of faculty being unapproachable.

Additional bodies of literature stress the importance of same race and gender faculty role models in engineering (Slaughter, 2009; Leggon, 2010). However, African

Americans make up only 2% of the engineering faculties at top research universities in the U.S. (Slaughter, 2009). Slaughter and Leggon point out that the lack of Black faculty is connected to paltry participation rates of Blacks in STEM doctoral degree programs. Even when racial minorities make it to the professoriate, Allen, Epps, Guillory, et al. (2002) found faculty of color typically carry the burden of counseling and mentoring students of color. Although faculty may be motivated to help students of color succeed, "these advisory activities can be very consuming, draining time and energy away from research and writing" (Allen et al., p. 193). In addition to mentoring responsibilities, faculty of color often devote substantial time to university service through committees on "issues of color and gender, campus security, race relations, recruiting faculty/students of color, university relations, and community outreach" (Allen et al. p. 193). In all, these non-academic responsibilities may lead to faculty of color not receiving tenure or promotion, which creates a cycle of underrepresentation. Although Black faculty members may positively influence Black undergraduates to persist in engineering they may be doing so at the expense of their own career.

Women in Engineering and Science

Although women have become the new majority (57%) among undergraduates (NSF, 2007), women are still dramatically underrepresented in the field of engineering. In 2004, only 2.9% of first time freshman women entered college with the intention of majoring in engineering as compared to 15.1% of men. In the same year, women were only conferred 20% of bachelor's degrees in engineering (NSF, 2007). However, among African American students, women engineers comprise 33% of bachelor's degrees

awarded (Slaughter, 2009). Although, Black female undergraduate engineers have made substantial gains, they still have to deal with not only being one of few women, but also one of few African Americans.

Consistent with previous research pointing to the roles of gender in the selection of academic majors and subsequent careers (Correll, 2004), Mannon and Schreuders (2007) found the women in their study were more likely to major in biological, biomedical, and chemical engineering; while the men were more likely to major in electrical, civil, and mechanical engineering. This suggests even within the field of engineering women are seemingly being diverted to less mathematics and technology oriented sub-fields of study, which is why a number of researchers have sought a better understanding of gender inequities in engineering education (e.g., Capobianco, 2006; Han, Sax, & Kim, 2007; Mannon & Schreuders).

A number of studies have found role models helped to mediate respondents' negative experiences and served as inspirations for striving for a career in engineering. Similar to Carlone and Johnson (2007), Capobianco (2006) focused on women's identity construction as they sought to become professional engineers. Through in-depth interviews over a four year period with four female engineering undergraduates, Capobianco found study participants relied on female role models, which included mothers, professors, and professionals, to mediate negative experiences of "being silenced or ignored by male faculty or students" (p. 111). Mannon and Shreuders (2007) found women, who had an engineer in the family, were more likely to enter college with a particular engineering major. Women who did not have an engineer in the family

tended to enter college as an undecided engineering major or switched into engineering after entering college. This finding speaks to role models providing inspiration and a transference of engineering capital from family members.

Carlone and Johnson (2007) found competence and performance were important contributors to women's identity as a scientist. Similarly, Han, Sax, and Kim (2007) found although the men and women survey respondents rated themselves equally high in regards to academic self-confidence, the women tended to doubt themselves in group settings. Similarly, Mannon and Schreuders (2007) found women were less comfortable presenting in class. This lack of self-assurance in social environments has also been found to have a negative impact on women's perception of positive opportunities after graduating with a bachelor's degree (Hackett, Betz, Casas, & Rocha-Singh, 1992). Carlone and Johnson (2007) argue as women find ways to reinforce their efficacy in terms of competence and performing science roles the more likely they will be to identify as a scientist or in this case as an engineer. A strong engineering identity will strengthen women's confidence in engaging in engineering activities.

A study by Trenor, Yu, Waight, Zerda, and Sha (2008) attempts to disentangle ethnicity and gender among engineering students as it related to college and career goals. Trenor and her colleagues conducted a mixed methods study of 160 women engineers at the University of Houston; African Americans (11%), Whites (34%), Latinas (30%), Asians (20%), and other ethnicities (6%) were represented in this study. The web based survey results indicated no statistically significant differences in the participants' perceived social supports or sense of belonging based on race/ethnicity. The African

American women reported 35% had engineering parents, only 6% were first generation college students, 41% reported no family financial support, and 31% reported annual family incomes lower than $40,000. Although Trenor et al. found some differences across ethnicity in the qualitative findings (e.g., sense of belonging, barrier of academic preparation, and purpose for pursuing engineering), they had very few findings specifically for African American women. A majority of the African American women, who participated in the qualitative portion of this study, indicated difficulty adjusting because of poor study habits and time management. Using the aggregated experiences of these women engineers Trenor et al. found students frequently cited the importance of collaborative learning, student organizations (i.e., Society of Women Engineers (SWE)), and learning communities.

Although these studies have provided interesting insights into how women differentially experience engineering, these studies provide little clarification of the unique role of gender among African American engineers. Although it is clear gender plays a significant role in the participation of African American women in STEM, researchers rarely disaggregate gender data by race (Leggon & Pearson, Jr., 2007). The relatively small sample sizes of Black respondents made it difficult to discern significant findings. More research is needed to better understand the unique experiences of African American women engineers, who must overcome the psychological and social challenges associated with being a double minority (i.e., a woman and a racial minority in a White and male engineering field).

African American Engineers

There have been relatively fewer studies focused specifically on the experiences of African American undergraduate engineers. While some studies like Vogt (2008) completely disregard the importance of race/ethnicity as it relates to the study of retention and performance in engineering, there are scholars who have focused on the primacy of race in the experiences of African American engineers (e.g., Brown, Morning, & Watkins, 2008; Good, Halpin, & Halpin, 2002; Moore, 2006; Newman, in press; Moore, Madison-Colmore, & Smith, 2003).

Moore, Madison-Colmore, and Smith (2003) conducted a qualitative study of 24 African American men who were juniors and seniors majoring in engineering at a single institution. The participants in this study described how they adapted and coped in a highly competitive engineering environment. Participants reported overcoming obstacles of being a first generation college student, financial hardships, and getting to know professors. Lastly, students also indicated the professors, student peers, and society at large, who have doubted their ability to succeed in higher education in general and engineering in particular, motivated them to achieve, which the researchers coined "to prove-them-wrong syndrome." This finding is consistent with Carlone and Johnson (2007), who suggest students may identify their engineering potential through the perceptions of "meaningful others." Although students seek to prove faculty members wrong about their abilities, they know they have proven them wrong when faculty members recognize their talents.

In another study specific to African American engineering majors, Moore (2006) conducted a qualitative study of 42 students at a university in the southeast. This study focuses primarily on the factors leading students to pursue engineering as an academic major and career. Moore's findings indicate the factors positively influencing Blacks to pursue the engineering field include encouragement from family, strong aptitude in science and math, meaningful academic experiences, significant relationships with high school teachers and counselors, and engaging enrichment programs, opportunities, and academic experiences.

From a slightly different approach, Good, Halpin, and Halpin (2002) conducted a program evaluation of a minority engineering program (MEP) at a southeastern university. The study participants consisted of 58 Black students: 34 participated in the MEP and 24 did not. Using cross tabulations and *t*-tests, the researchers found no significant difference in MEP participant and non-participant grades, but they did find MEP participants were more likely to be retained in the college of engineering. Good, Halpin, and Halpin conducted qualitative interviews with 12 of the 58 survey respondents: 6 MEP participants and 6 non-MEP participants. Similar to Mannon and Shreuders (2007), the researchers found the participants who remained in engineering were more familiar with the profession through exposure to engineering professionals like parents or family friends. Among the participants who left engineering, the students tended to not participate in any support programs compared to MEP participants who pursued an average of three additional academic support programs during their pre-engineering coursework. Lastly, the students who participated in the MEP program felt a

greater sense of belonging to the university, "whereas all the non-MEP participants felt disconnected" (Good, Halpin, & Halpin, 2002, p. 359). A number of the MEP participants attributed the MEP program as the single factor increasing their sense of belonging. This study shows the importance of minority engineering programs and the crucial role they can play in retaining African American engineers.

Although not focusing solely on African Americans in engineering, Riegle-Crumb and King (2010) analyzed data from the Educational Longitudinal Study (ELS). The ELS houses data on a nationally representative cohort of students beginning in their sophomore year of high school in 2002 and had two follow up surveys in 2004 and 2006. Riegle-Crumb and King focus on Black, Hispanic, and White students' declaration of college majors. After holding academic preparation constant, the researchers found Black males were nearly two and a half times more likely than their White male counterparts to declare a physical science or engineering major. Riegle-Crumb and King conclude, "we do not find evidence of a consistent White male advantage in entrance into STEM post-secondary fields" (p. 660). A major limitation of this study, which is acknowledged by the authors, is the outcome measure of students' declaration of an engineering major. This measure may lead to premature proclamations of parity between African American and White men because they are missing a key component, which are persistence and graduation data. A number of scholars and agencies like the NSF point to lower persistence and degree completion rates of African Americans in STEM (e.g., Griffith, 2010; NSF, 2011). Riegle-Crumb and King's findings are encouraging because it suggests African Americans have strong interest in engineering, but in the context of

students full academic career declaring a major is an early step in an often arduous journey through the engineering pipeline.

In examining the experiences of African American declared engineering majors, Brown, Morning, and Watkins (2005) focus on the perception of the campus climate and the ways this may or may not influence academic performance and graduation rates. Brown and her colleagues conducted a quantitative study of 514 Black engineers who attended two National Society of Black Engeineers (NSBE) regional conferences, a NSBE national conference and the Black Engineer of the Year awards conference. Using ANOVA and ANCOVA analyses, Morning and her associates found students who attended HBCUs tended to have higher grade point averages and a "more favorable perception" of the campus climate than students who attended other universities, which is consistent with Allen (1992) and Davis (1994). However, graduation rates were higher at the more selective universities. Additionally, Brown, Morning, and Watkins focused specifically on the influences of "Student Perceptions of the Campus Climate" with variables including: 1) classroom experiences, 2) faculty and staff interactions, 3) institutional support services, 4) racism and discrimination, 5) peer interactions, 6) student effort to learning, 7) goal commitment, and 8) institutional commitment. Of these eight campus climate measures, the authors found a statistically significant relationship with higher graduation rates being associated with lower perceptions of racism and discrimination and with higher institutional commitment. A key limitation to this study is that participants were conveniently sampled among NSBE conference attendees. First, not all African American engineers are members of NSBE. Second, not all NSBE

members attend national or regional conferences. Therefore, Brown, Morning, and Watkins have surveyed a very select group of African American engineers, who are not representative of neither NSBE members nor African American engineers.

In a recent qualitative study, Newman (in press) focused specifically on 12 African American undergraduate engineers from three universities in the western region of the United States. Newman's research revealed faculty play an important role in encouraging or dissuading the African American engineers in his study to persist in their respective majors. Additionally, the involvement in faculty research laboratories and the referral by faculty to other opportunities and internships relevant to careers in engineering gave participants a much-needed practical application of their coursework. However, Newman found faculty members could also have an equally paralyzing function in students' academic and subsequent career goals through hierarchically authoritarian and outright racist dispositions. The African American engineers in his study cited examples of both faculty members who were inspiring and supportive and those who were barriers to participants' academic and career goals.

Among these studies of Black undergraduate engineers, the researchers tended to rely on sampling participants from a single institution or a convenient sample of engineers at a NSBE conference. Very few studies have examined the perspectives of the main drivers of an institutions context (i.e., faculty and administration). Given the importance of institutional contexts for African American students, more research is needed on the role institutions play in the success of Black engineers. It is also paramount

to better understand the outlook from key stakeholders like engineering faculty and administrators (both within engineering and university wide).

Conceptual Framework

Similar to Brown, Morning, and Watkins (2005), I recognize the role institutions have played and continue to play in shaping the experiences and outcomes of African American engineering students. Many scholars have described the institutional context for racial minorities through the campus racial climate. Hurtado (1992), through a longitudinal study, examined the responses of over 4,500 White, Black, and Chicano students' perceptions of racial tension among students, faculty, and administrators. A key component of this study was students' perceptions of an institutions priorities and commitment to diversity. Hurtado (1992) found Black students, who perceived an institution to have a high commitment to diversity, were less likely to perceive racial tension. However, institutional selectivity as well as Black students who considered the institution to have high resource and reputation priorities increased students' sense of racial tension on campus. Findings from this study point to the importance of universities not only espousing notions of diversity and inclusiveness, but also showing a commitment to these causes through action.

Harper and Hurtado (2007) catalogued the nearly two decades of research (35 studies), which followed Hurtado's (1992) seminal piece. The authors organized the literature into three categories, which include "differential perceptions of campus climate by race," "minority student reports of prejudicial treatment and racist campus environments," and "benefits associated with campus climates that facilitate cross racial

engagement." White students tended to have lower perceptions of negative campus racial climate while racial minorities reported more negative racial incidents like racist remarks or being the target of hostility. Moreover, researchers found racial minorities often reported perceptions of inferiority by white students and faculty or were dismissed as a special admit. One of the key findings of the literature on campus racial climate are the ways institutions may help to mitigate these negative perceptions by providing opportunities for students to have meaningful engagement with diverse constituents.

Hurtado, Milem, Clayton-Pedersen, and Allen (1998) outline a framework for understanding campus racial climates. Hurtado and her colleagues posit institutions often focus solely on increasing the numbers of underrepresented racial minorities on their respective college campuses and pay relatively little attention to what happens to these students once they arrive. Hurtado et al.'s campus racial climate framework focuses specifically on how institutional contexts shape the experiences of racial minorities. This framework is a psychosocial system incorporating student's perceptions and experiences with race relations, which shapes the campus racial climate at each higher education institution. Often overlooked are institutions' historical legacy of excluding African Americans and other racial minorities. Although seemingly invisible, past inequities shape the culture and campus racial climate of an institution. At the same time, the legacies of institutions, which have a history of providing access and opportunities to African Americans, play an equally important role in fostering a supportive environment for African American success. In addition, the campus racial climate framework focuses on the psychological impact of student's perceptions of the inclusiveness of the

environment. A negative perception of racial or gender discrimination can alienate students from feeling a sense of belonging to the university. Lastly, the campus racial frame also incorporates a behavioral dimension, which focuses on social interactions and race relations on campus.

From a similar orientation as Hurtado and her collaborators, Bensimon (2005) believes well-meaning scholars employ a "deficit cognitive frame" in their research on underrepresented racial minorities. The deficit framework suggest the academic and social barriers URM students face are either "self-inflicted or natural outcome[s] of socioeconomic and educational background[s]" (p. 102). Moreover, the deficit frame is oriented toward "stereotypical characteristics associated with the culture of disadvantage and poverty" and the discourse of this pessimistic approach is focused on the "lack of preparation, motivation, study skills, blaming students and/or their backgrounds" (p. 103). The typical strategies of those who espouse a deficit perspective promote "compensatory educational programs, remedial courses, special programs," which are "all focused on fixing the student" (p. 103). Like Hurtado et al. (1998), Bensimon argues researchers' focus should be placed on institutional practices producing inequitable outcomes for URM students, which include things like "institutional racism" and a better "awareness of white privilege" to name a few (p. 103).

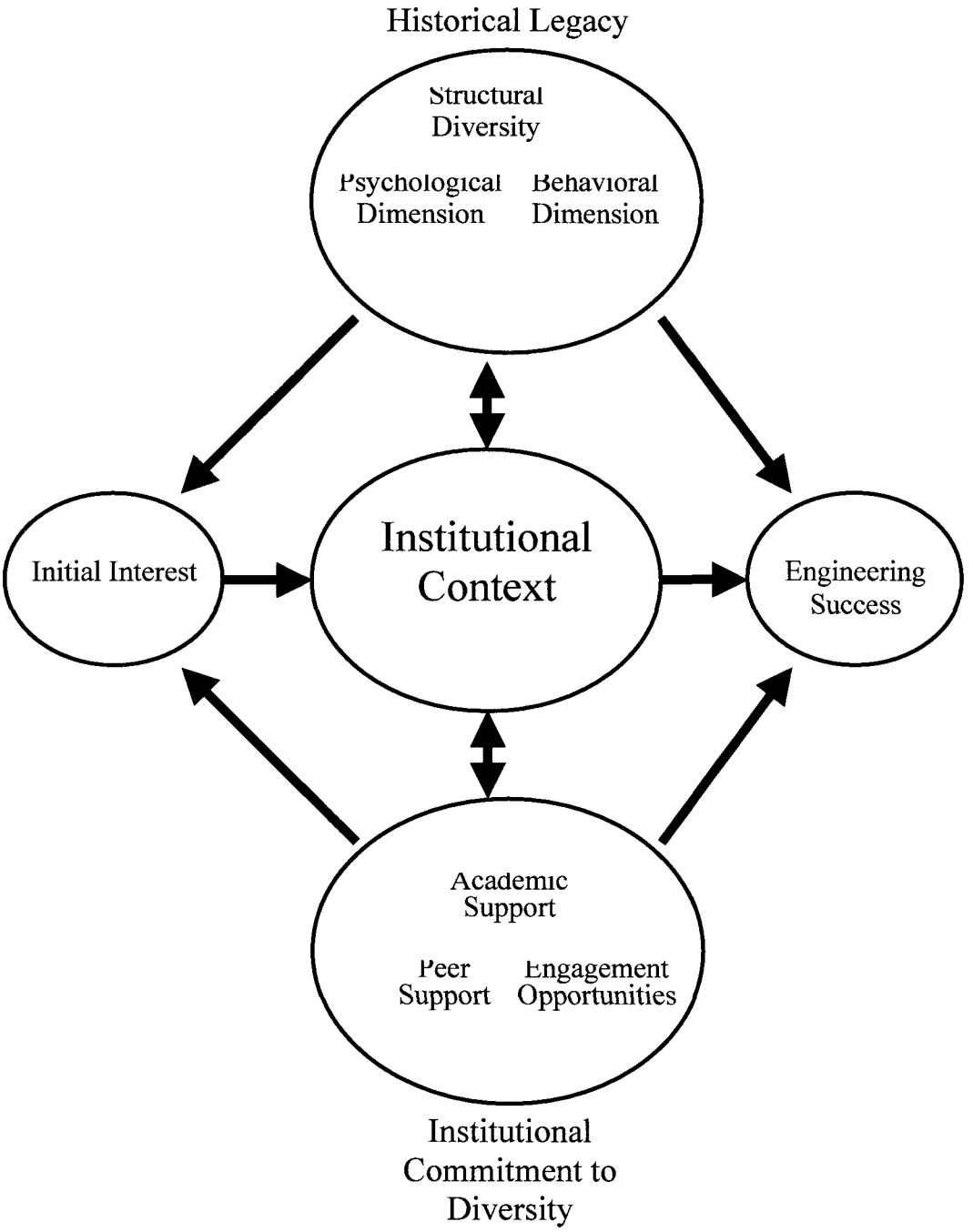
While Hurtado et al. (1998) and Bensimon (2005) focus on the role of institutions in perpetuating inequalities; Harper (2010) focuses on the need to better understand the experiences of high achieving Black students. Instead of adding to the "exhaustive body of literature" focusing on why Black college students' educational participation and

attainment are so low, Harper's "Anti-Deficit Achievement Framework" offers an informative view of how Black men navigate social settings like schools and colleges. Harper's research highlights "institutional agents, policies, programs, and resources that help Black men achieve desired educational outcomes" (p. 66). Harper's framework focuses on what leads Black students to succeed instead of what leads these students to fail. This is important because a better understanding of what leads African American engineers to succeed can illuminate ways institutions can create meaningful change for the high achievers, who are often inaccurately portrayed as having few challenges requiring little attention or support.

Accordingly, I combine Hurtado et al. (1998), Bensimon (2005), and Harper's (2007) perspectives to inform the overall research design of this study. In examining data from student participants, I concentrate on how African American engineers and computer scientists perceive the campus racial climates while paying particular attention to the role of institutional contexts, policies, and programmatic initiatives. I focus on how these characteristics contribute to or inhibit the success of African American engineering undergraduates. Figure 2.1 provides a model of the conceptual framework utilized in this study.

As African American collegians are initially interested in becoming an engineer they must navigate their respective university to achieve their academic and career goals. I placed the institutional context in the middle of the model because it plays an important role in the success of African American engineers. I postulate the institutional context as the circumstance(s) forming the setting for student experiences and provide a description

Figure 2.1 – Conceptual Framework for Engineering Success for African American undergraduates at Universities



of the environment for which the experience can be fully understood and assessed. Like Bensimon (2005), I believe the onus for success should not be placed solely on the shoulders of students. Institutions must recognize the important contribution they make in providing opportunities for positive student outcomes. At the top of the model are the four dimensions of the campus racial climate (Hurtado et al., 1998), which influences students' perception of the institutional context. I separated the campus climate dimensions to signify the unique contribution each makes in affecting students' perception of the institutional context.

The historical legacy component is especially significant at the PWIs because the perception of a welcoming environment may be in part attributed to the universities historical reputation of support for or hostility against African American students. Although universities cannot undo past wrongs, ignoring these injustices will only further exacerbate a university's reputation.

The structural diversity element focuses on not only a diverse student body, but a diverse faculty, senior administrators, and staff members. A number of PWIs no longer have a majority White undergraduate student body, but when you look at faculty, staff, and senior administrators you still see an overwhelming White and male structure. It is important to look at diversity beyond the composition of an undergraduate student body, but through how diversity is represented in all facets of a campus community.

The psychological dimension is important as many studies of campus racial climate have shown, African Americans students' perception of a campus environment as hostile or unwelcoming may have negative influences on success. The behavioral

dimension includes how universities respond to challenging situations like racial incidents and how their institutional behaviors like policies, initiatives, and funding support either a welcoming and nurturing context for engineering success or not. Universities must demonstrate an institutional commitment to diversity to overcome any challenges associated with negative psychological perceptions and actions, which brings me to the next components of the engineering success model.

Finally, I placed the support mechanisms and opportunities at the bottom of the model to symbolize the foundation of the institutional contexts. The institutions commitment to diversity, peer support, and engagement opportunities help to mitigate students' negative experiences and enhance students' positive experiences as well. Institutional commitment to diversity characterizes tangible ways to demonstrate behaviors that support espoused mission statements. African American students' success in engineering encompasses mechanisms for peer support through student organizations like NSBE and peer mentorship through MEP offices.

All six components are important to engineering success because they are major catalysts for persistence. Notwithstanding, the academic support and engagement opportunities elements are the main drivers of this model because of how I operationalize success. Success includes: a.) Completing a baccalaureate degree in engineering with a competitive grade point average (3.0 or higher), and b.) Participating in undergraduate research or industry internships. These two benchmarks will enable a student to acquire a career in engineering or prepare him or her for graduate school in engineering or beyond. Therefore, the academic support universities provide must go beyond simply offering

remediation or tutoring when needed, but must inculcate a culture of teaching and learning, which encourages all students to master the material and think innovatively about engineering challenges. Likewise, the engagement opportunities the campus provides may play an instrumental role in students making connections to the material and developing career aspirations and goals.

Chapter Three – Methodology and Methods

In this chapter, I first describe the broad aims of this project and reiterate the research questions guiding this study. I then give a detailed description of the qualitative and quantitative mixed methods approach utilized to answer my research questions. Lastly, I address my role as a researcher, which acknowledges the potential biases and personal perspectives I carried into this study. I conclude this section with a discussion of study limitations and the steps I took to minimize these limitations.

Statement of Purpose and Research Questions

This inquiry has the potential to help scholars better understand how institutional contexts influence the experiences of African American students in engineering and computer science. Findings can assist faculty, directors of minority student services, and others on university campuses in their efforts to improve student retention, engagement, and success in engineering. I address the following research questions:

Quantitative

1. How do individual and institutional factors differentially affect Engineering and Computer Science baccalaureate degree attainment for African American students, who entered college with the intention of majoring in Engineering or Computer Science?

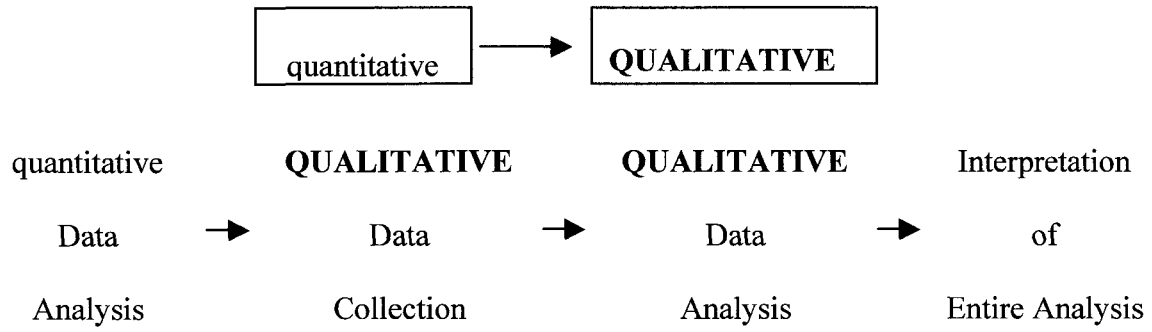
Qualitative

2. How do schools of engineering, characterized as top producers of African Americans with Baccalaureate degrees in Engineering, encourage or impede the support of African American engineering and computer science students?
3. How do institutional agents, programmatic interventions, co-curricular involvement, and engagement opportunities support or discourage participants' persistence through the engineering pipeline?

Mixed Methods Research Design

I utilize a mixed methods research design to answer the above research questions. In Figure 3.1, I adopt Creswell's (2009) sequential exploratory design. The qualitative methods are capitalized to indicate the priority given to this particular method. The sequence of data analyses indicate the qualitative analysis builds from the quantitative data analysis. The sequential exploratory strategy gave me the opportunity to use the quantitative data results to frame the qualitative findings. Creswell (2009) suggests the purpose of this approach is to "initially explore a phenomenon" (p. 211). This mixed methods approach allows me to extend the findings of the quantitative data analysis to better inform potential recommendations for policy and practice.

Figure 3.1 – Adaptation of Creswell's Sequential exploratory design



Quantitative Data Sources

In the first phase of this study, I analyzed quantitative data to provide an overarching contextual description of the background characteristics and institutional contexts, which are significant predictors or not of undergraduate engineering degree attainment among African Americans. I analyzed data derived from The Freshman Survey (TFS) administered by the Cooperative Institutional Research Program (CIRP) at the Higher Education Research Institute (HERI) at UCLA. For over forty-five years, the TFS has been administered annually to entering freshmen at hundreds of colleges and universities across the United States. The survey includes questions about students' background (e.g., parents' education and the type of high school attended), high school experiences, anticipated involvement in college, and educational and career aspirations. I have analyzed data from the CIRP TFS administered to the entering cohort of 2004 during their respective summer orientations or the first few weeks of the fall term. The TFS has a baseline sample of 289,452 students at 440 institutions (Sax et al., 2004).

Please see Sax et al. (2004) for the full survey methodology and Appendix A for the complete survey.

In addition to the student data sources described above, I included institutional level variables obtained from the Integrated Postsecondary Education Data System (IPEDS), which is "a system of interrelated surveys" collected annually by the National Center for Education Statistics (NCES). IPEDS gathers information from every college and university participating in the federal student financial aid programs (IPEDS, 2011).

Lastly, HERI, through a special acquisition, has linked the 2004 TFS respondents with data collected by the National Student Clearinghouse (NSC). The NSC collects information from over 3,300 colleges and universities on students' enrollment status and degree attainment (NSC, 2010). As a result of the NSC collecting data from the institutions as opposed to individual students, the NSC has more accurate and complete information on students' enrollment status and degree attainment. Therefore, respondents to the 2004 TFS survey have been matched with data gathered by the NSC in 2009, which is 5 years after the 2004 cohort began college. This pairing gives researchers the ability to examine degree completion rates of students, who indicated an initial interest in a given field (i.e., engineering or computer science).

It is worthy to note the CIRP also conducts a college senior survey (CSS), which asks a number of questions about student's college experiences. Unfortunately, only 8% (n=160) of African Americans, who listed engineering or computer science as a probable major on the TFS, completed the CSS. On the other hand, the NSC has degree information for over 30% of the TFS respondents. As a result, this study utilizes the TFS,

IPEDS, and NSC data sources to pair respondents' background characteristics with institutional attributes and match these data with student success outcomes (i.e., degree attainment).

Quantitative Data Sample and Analysis

Quantitative Data Sample

The sample for this study includes African American students, who entered a baccalaureate degree granting college or university (in 2004) with the intention of majoring in engineering or computer science. The TFS provides nine options for engineering or computer science, which includes aeronautical, civil, chemical, computer, electrical, industrial, mechanical, other engineering, and computer science. Computer science was included because some schools/colleges of engineering house computer science programs. In total, 2,097 African American students attending 277 institutions indicated a probable major of engineering or computer science on the 2004 TFS. Women are outnumbered and make up only 27% of this sample. However, 1,443 of the 2,097 students do not have 2009 NSC degree attainment data. First, although a large percentage of colleges and universities participate in the NSC, the colleges or universities attended by some students may not participate in the NSC. Secondly, a student who took the TFS may be still enrolled in school, but have yet to complete their bachelor's degree. Although there is information regarding enrollment status, this data does not provide information about the major these students are pursuing. Furthermore, the major only becomes finalized when a student receives a degree. Thirdly, TFS respondents without degree information and spotty enrollment information may no longer be enrolled in any

higher education institutions, but this cannot be deciphered with absolute certainty. Therefore, this study focuses on 657 African American TFS respondents (in 2004) who have degree attainment information from the NSC (in 2009) because more accurate conclusions can be made about this group.

Quantitative Data Analysis

A binary quantitative dependent variable with values of 0 and 1 is not suitable for multiple regression (Pampel, 2000). Due to the three discrete unordered outcome measures, as indicated in the dependent variable, multinomial logistic regression is the most appropriate data analysis technique for this study (Borooah, 2002).

Pampel (2000) states dummy variables "show the change in the predicted proportion of respondents with a value of 1 due to a one-unit change in the independent variables" (p. 2). The dependent measure under study has three binary measures, which are a.) Either a student completed a degree in engineering/computer science (1) or not (0), b.) A student completed a degree in science or mathematics (1) or not (0), or c.) A student completed a degree in a non-STEM field (1) or not (0). The multinomial logistic model is used to estimate the probability of being a member of one of the three groups (Pampel, 2000).

The results for the multinomial logistic regression analyses are reported as delta-p statistics. The Delta-p statistics provide for an easier interpretation of results compared to odds ratios or the raw log-odds coefficients. I used the method described by Petersen (1985) to calculate the delta-p statistics. According to Cruce (2009), the Delta-*p* statistic is the difference between the baseline probability and the estimated probability given a

one-unit change in the independent variable, holding all other variables constant at their mean values.

I analyzed quantitative data to provide an overarching contextual description of the background characteristics and institutional contexts, which are significant predictors or not of undergraduate engineering success among African Americans. I analyzed data derived from The Freshman Survey (TFS) administered by the Cooperative Institutional Research Program (CIRP) at the Higher Education Research Institute (HERI) at UCLA. I have analyzed data from the CIRP TFS administered to the entering cohort of 2004 during their respective summer orientations or the first few weeks of the fall term. In addition, to the student data sources, I included institutional level variables obtained from the Integrated Postsecondary Education Data System (IPEDS). Lastly, HERI, through a special acquisition, has linked the 2004 TFS respondents with data collected by the National Student Clearinghouse (NSC). The NSC has accurate and complete information on students' enrollment status and degree attainment. Respondents to the 2004 TFS survey have been matched with data gathered by the NSC in 2009, which is 5 years after the 2004 cohort began college. Therefore, I utilize the TFS, IPEDS, and NSC data sources to pair respondents' background characteristics with institutional attributes and match these data with student success outcomes (i.e., degree attainment).

In regards to goodness-of-fit measures, unlike linear regression, where coefficients are selected to maximize the R square (a measure for explained variance), in multinomial logistic regression it is difficult to maximize any goodness-of-fit indicators because unlike continuous or ordinal outcomes there is not variance to explain due to

respondents being members of one group or another. For example, in a continuous outcome like GPA, respondents may have a wide range of GPAs from 2.0-4.0 with multiple tenths of point iterations of a GPA like 2.3, 2.4, 3.0, or 3.1. Therefore, the R square measures how the independent measures explain these tenth of a point variations in the outcome GPA. On the other hand, in logistic regression there are only two options; either a student completed a degree in engineering or not. In a degree attainment outcome measure, like the one included in this study, there is no variance. Borooah (2002) suggests any goodness-of-fit measures may be misleading when applied to multinomial models.

Due to the sampling strategy of the HERI CIRP TFS, survey commands in the program STATA are used to account for clustering of students within institutions (Rabe-Hesketh & Skrondal, 2008). STATA can be utilized to account for error due to respondent clustering, in this case colleges, having greater homogeneity in their responses than if students had been selected randomly and individually from all colleges (Eltinge & Sribney, 1996). Accounting for this type of clustering is a more rigorous data analysis technique, which adds additional validity to the data analysis results. Lastly, with regard to missing values, I replaced missing values for continuous variables with less than 15% of cases with missing data. I used the expectation maximization (EM) algorithm to impute missing values.

Qualitative Research Design

Within a case study design, a phenomenological approach guides this research investigation to study how schools of engineering encourage or obstruct the support of

successful African American engineers and computer scientists. According to Patton (2002), the underlying assumption of this methodology is an "essence or essences to shared experiences" (p. 106). Merriam (1998) believes a phenomenologist's role is to "depict the essence or basic structure of experience" (p. 16). A phenomenological account gets inside the experience of a person or group of people by capturing how the phenomenon is perceived, described, judged, and how this person or group makes sense of it (Patton, 2002). This study seeks to better understand the lived experiences of the participants. Similar to Harper (2007), this study focuses on the sources of participants' inspiration to pursue the engineering field, what faculty relationships and pedagogy they found most beneficial, and how have their experiences shaped their trajectories. However, the multi-case study approach adds a layer by understanding the experiences of faculty and administrators, which may give a more nuanced insight into the obstacles and barriers faced by those who look to support African American engineering and computer science students.

It is important to note institutions' contextual conditions shape the respective experiences of these successful African American engineering undergraduates. Therefore, I utilized a multiple-case study with the student participants as the first embedded unit of analysis and administrators and faculty as the second. In addition to interviewing students, I interviewed key administrators, and faculty who student participants cite as contributing to her or his success. Yin (2009) suggests a case study is an "empirical inquiry that investigates a contemporary phenomenon in depth and within its real-life context" (p. 18). The case study approach "relies on multiple sources of evidence, with

data needing to converge in a triangulating fashion" (Yin, p. 18). The institutional agents may provide important insight into the institutional processes that encourages or discourages the support of the student participants. Figure 3.1 is a conceptual model of Yin's case study design with multiple embedded units of analysis. The dashed lines between the different layers of the case signify there may not be a sharp distinction between the layers. A clear example of this in the context of this study is found in the distinction between a university and the school of engineering. The university's culture may permeate the school of engineering through traditions and institution wide initiatives. Therefore, it may be difficult at times to distinguish the unique identity of the school of engineering as compared to the umbrella institution.

Figure 3.2 – Yin's case study design with multiple embedded units of analysis

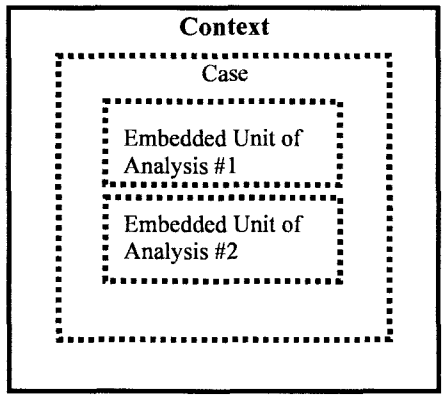
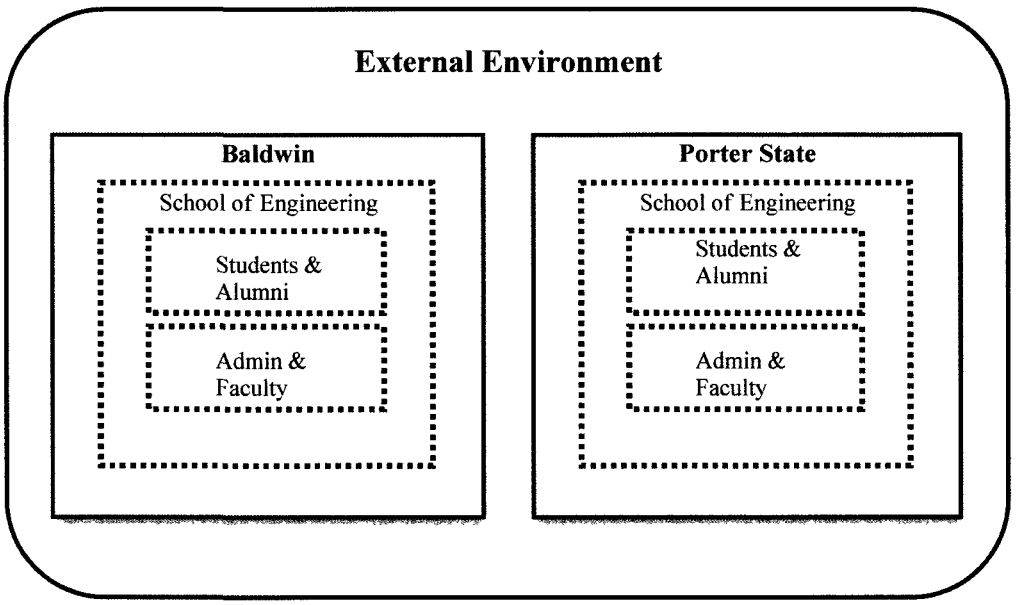


Figure 3.3 illustrates the conceptual model adapted from Yin's (2009) case study design. The school of engineering serves as the case under study with the university providing the institutional context for the case. Students, administrators, and faculty serve

as the embedded units of analysis. The dashed lines signify an unclear boundary. In these cases, the students, administrators, and faculty are nested in the school of engineering, so when students, administrators, and faculty refer to "the school of engineering" they are not necessarily referring to the concrete concept like a physical building, but the more abstract collective formation of students, faculty, and administration.

Figure 3.3 – Conceptual model of multiple case study design



I targeted administrators who are in senior level (i.e., deans and associate deans) positions within the school of engineering. Additionally, I interviewed directors of minority engineering programs. The administrator interviews provide very important data on the intentionality of the school of engineering to support African American students. In addition, the administrators may also help me better understand the institutional challenges serving as barriers in the support of African American engineers and computer

scientists. The faculty interviews provide rich data on the experiences of faculty members, who are highly supportive of African American students. In all, the administrator and faculty interviews help me answer an important question, which is: Are the high rates of production of African American baccalaureate degree recipients in engineering a result of institutional commitment or are these African American engineers succeeding purely on their own intrinsic motivation and ability?

Qualitative Data Sources

This study is based on qualitative data collected from 70 participants: 37 African American engineers/computer scientists, 9 faculty members, 16 administrators[5], and 8 recent baccalaureate recipients. Study participants were from one of two predominantly White public research universities: Porter State University, which is in the Southeastern region of the U.S., and Baldwin University, which is in the Midwestern region of the U.S. Pseudonyms are used for both the universities and the study participants due to the small population of African American students and faculty in computer science and engineering in the U.S.

My goal was to find universities with records of success in supporting African American engineers. Therefore, I utilized *Diverse Issues in Higher Education's* annual report of the Top 50 undergraduate degree producers of baccalaureate degrees in engineering among African Americans in the United States to identify several institutions to request participation in this study. I formally requested participation to the study via

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[5] Some administrators are faculty members also, but those placed in the administrator category have a primary responsibility in an administrative capacity.

email and telephone requests to the respective campus' School of Engineering Dean's Office. The request was sent out to seven universities, which included three HBCUs and four public research universities. Two Schools of Engineering approved my request. Both universities have a proven record of success in producing African American engineers and computer scientists.

Once institutions were identified and all approvals were received, student participants were recruited through the respective university's minority engineering program. The director of the program emailed a study recruitment announcement to potential participants (Please see Appendix C for the recruitment email). The criteria for participation in this study included the following:

1. Students must identify as African American or Black (including multi-racial backgrounds)
2. Students must be a declared undergraduate engineering or computer science major or recent alum (completed baccalaureate degree within 3-5 years)
3. Students must have achieved success, which is defined as maintaining at least a 3.0 GPA, involvement with faculty's research or relevant corporate internship, and persisting to upper division coursework.

Building on the works of Freeman (1999) Fries-Britt (1998), Griffin (2006), and Harper (2010) the concept of success is operationalized to include persisting in the major past the introductory gatekeeper courses, serving in co-curricular leadership positions, participating in internships relevant to career goals, and/or engaging in research outside of the required coursework.

Additionally, key administrators were asked to participate in this study if they had formal responsibilities within the boundaries of the current case study. Administrators included the Deans and Associate Deans of the School of Engineering, directors and senior administrators of university wide multicultural student affairs or diversity initiatives, and directors of minority engineering programs. Lastly, the directors of MEP identified faculty members, who from their experiences were supportive of African American undergraduates. Additional faculty participants were selected through a more organic process of asking students about faculty members, "who were particularly supportive of their academic career." Student participants cited supportive faculty members as those who provided mentoring and support, provided opportunities to research experiences, and/or recommended internships. Although students cited faculty members who were already identified by the MEP director there were several cases of faculty members who were identified through the student-nomination process.

Through this case study approach, I purposefully sampled study participants. Maxwell (2005) suggests purposeful sampling gives the researcher the opportunity to include a representative sample, which provide more confidence in the proposed conclusions. Miles and Huberman (1994) propose that researchers who conduct purposeful sampling must first set study boundaries and then must create the framework for the "basic processes or constructs that undergird" the study (p. 27) (i.e., successful African American undergraduate engineers or computer scientists).

Data Collection

Demographic questionnaire

Student participants completed a short demographic questionnaire before the start of the interview. This brief questionnaire gathered information on a range of relevant background characteristics (e.g., SES background, high school attended, and racial demographic of the neighborhood the participant grew up in). Please see appendix D for the full student demographic questionnaire.

Individual and Focus Group Interviews

I asked students to participate in either an individual or focus group interview (Hesse-Biber & Lewey, 2006). The individual interviews lasted approximately sixty minutes and focused on the student's path to and through the engineering pipeline. I focused on what sparked their initial interest in engineering and what support mechanisms they found particularly helpful in their experience. Please see the individual interview protocol in Appendix E for my guiding questions. As presented in Table 3.1, of the 45 current undergraduate and alumni participants, 28 participated through an individual interview and 9 participated through a focus group. The focus group interviews, which were all conducted at Porter State, lasted approximately 75 minutes and focused on the students' collective and individual experiences at their respective university. I conducted two focus groups of 4-5 current undergraduate students at Porter State and no focus group interviews were conducted at Baldwin. Please see the focus group protocol in Appendix F. The administrators and faculty interviews were individual

and either face-to-face or via telephone lasting between 30 to 60 minutes. I conducted a total of two interviews with faculty or administrators over the telephone.

Table 3.1 – Qualitative study participants and method of data collection

	Baldwin University		Porter State University		
	Individual	Focus Group	Individual	Focus Group	Totals
Students	12	0	16	9	37
Faculty Members	6	0	3	0	9
Administrators	9	0	7	0	16
Alums	2	0	6	0	8
Totals	29	0	32	9	70

I utilized a semi-structured technique for all of the interviews, which allowed me to respond "to the situation at hand, to the emerging worldview of the respondent, and to new ideas on the topic" (Merriam, 1998). Maxwell (2005) suggests the semi-structured technique increases the "internal validity and contextual understanding, and are particularly useful in revealing the processes that led to specific outcomes" (p. 80). I audio-recorded all interviews; the recordings were professionally transcribed verbatim and checked for accuracy.

Qualitative Data Analysis

In analyzing the case study data, my goal is not to simply generalize the experiences of African American engineers and computer scientists, but to "preserve the multiple realities, the different and even contradictory views" of how African American students experience the various institutional contexts (Stake, 1995, p. 12). First, several

techniques prescribed by Bogdan and Biklen (2007) and Miles and Huberman (1994) were used to code and analyze the data collected from the interviews with students, administrators, and faculty. First, I spent time listening to the audio recordings and writing notes and memos related to preliminary themes. Then, I bracketed my thoughts and perceptions as I read each line of participants' transcripts. I marked the margins of the transcripts with comments regarding initial reactions and summarization(s) of participants' main point(s). After bracketing, the transcripts were sorted and key phrases were arranged under codes using Hyper RESEARCH a qualitative data analysis software package. I identified three main coding categories which include, "perspectives held by subjects," "subjects' ways of thinking about people and objects," and "strategy codes" (Bogdan and Biklen, p. 175). The first two coding types are self-explanatory, but the "strategy code" references the "tactics, methods, techniques, maneuvers, ploys and other conscious ways" student participants described achieving academic success in their engineering related coursework and research experiences (Bogdan and Biklen, p. 177). For administrators or faculty members strategy codes referred to their description of strategic initiatives, policies, or pedagogical strategies making a difference in supporting African American engineers and computer scientists.

After all the transcripts were coded, I utilized cross-case analytical techniques (Miles & Huberman, 1994). Demographic information collected on the pre-interview questionnaire was entered in Hyper RESEARCH as individual participant attributes, which includes students' socio-economic background, engineering sub-field, participants' career aspirations, and institutional characteristics. These various forms of background

and institutional characteristics gave me the opportunity to sort the qualitative data based on a wide range of attributes to analyze differences and similarities across particular traits.

Role of the Researcher

Merriam (1998) points out researchers are human and susceptible to mistakes and personal biases. Therefore, Creswell (2009) suggests researchers should identify attributes in their backgrounds that may lead to a readers' "better understanding of the topic, the setting, or the participants and the researcher's interpretation of the phenomenon" (p. 177).

I was born and raised in Los Angeles. My father, Calvin Newman, is a retired Industrial Engineer, who worked for over 30 years in the aerospace industry for Northrop Grumman. Throughout his service, he worked on the B-2 bomber and the F-18 Superhornet. When I was younger I remember people asking me what my dad did for a living. I used to say he worked on airplanes. One of my grade-school teachers overheard this conversation one day and interjected, "your dad is probably an airplane mechanic." I went home and asked my mom if my dad was a mechanic and she was outraged. She exclaimed, "no your dad is an engineer and has a master's degree from [the University of Southern California]." My mother was upset because she felt the teacher was sending a message to me, "African Americans can only be a mechanic and not an engineer." Needless to say, my mother had a talk with the teacher. Although my mother went to great lengths to make sure I knew my father was an engineer, I never fully comprehended

what an engineer was and I never really thought much more about being an engineer. However, I was interested in the sciences.

My high school had a number of rigorous academic programs and I fell in love with geology. I took two years of geology with a course in Earth Science and an Honors Geology course my senior year. I was also enrolled in Pre-Calculus/Trigonometry my senior year. While I did well in the geology courses, I struggled a bit in my senior mathematics courses. I received my first "D" ever on a midterm. Moreover, about 75% of the classes received equally low grades. Although, I previously received Bs and B+s in Algebra, Geometry, and Algebra II, all of a sudden I felt as though I was unable to perform well in mathematics. Thankfully, my mother advocated for me and I received after school tutoring from an administrator, Mr. Frank Kozakowski. He was very helpful and for some reason, I seemed to get it with him. I finished out the semester with a "C" and the next semester, Mr. Kozakowski placed me with a different mathematics instructor. I finished the second semester with a "B." The teacher I had in the fall semester was new to Loyola and that was her final year there (i.e., she was let go).

Although I improved dramatically in the second semester, I entered college with a low mathematics self-concept. I was highly interested in majoring in Geology, so I took four of the lower division courses my freshman year at the University of California, Santa Barbara. I did quite well in these courses where I received Bs and B+s. However, there were two reasons I decided not to move forward with a Geology major. First, the major had multiple prerequisites in mathematics. After struggling through mathematics my senior year, I wanted no part of college calculus. Secondly, the Geology major was

practically all White and male including the faculty members. I was the only African American and/or racial minority in the Geology courses. I slowly lost my interest in Geology.

At the time, UCSB was 66% White and only 2.7% African American. I grew up in a predominantly African American neighborhood in Los Angeles. I lived through racial episodes like the 1992 Los Angeles riots, the O. J. Simpson trial, and my own personal experiences with race at a predominantly White, all boys, and Jesuit high school. Therefore, I entered UCSB with my senses heightened to race relationships and cross-racial interactions. My freshman year, I took several sociology courses and I became highly engaged in issues of oppression, social movements, racism, and inequities. I was fascinated to learn people made careers of studying all the topics I always wondered about. I found my passion with sociology even though the courses were still predominantly White; sociology had women faculty, a few faculty of color, and the students in the courses came from more diverse backgrounds.

It was not until after I began my Ph.D. program and took the first introduction to quantitative methods course did I realize my phobia in mathematics was unwarranted. I have since come to the conclusion I let a bad mathematics teacher (i.e., my first semester senior mathematics teacher) turn me off to mathematics. The introductory quantitative course forced students to make all statistical calculations by hand. I quickly became reacquainted with mathematics. Although introductory statistics equations and calculations are not as complicated as an advanced calculus problem-set, I realized I was fully capable of doing the mathematics I avoided in college.

As a result of my new found increase in mathematics self-concept, I began quantitative research focusing on the impact of racial minorities' mathematics self-concept on higher education outcomes. This topic eventually evolved into my interest in why students choose to stay or leave STEM fields. I reflected on my own personal experiences, I have a parent who is an engineer; yet, I never considered engineering as a career goal. I was interested in Geology, but I did not declare it as a major because I felt racially isolated and my mathematics self-esteem was low.

So how does my personal experiences relate to this current study? I may share similar experiences as some of the participants. For example, I empathize with the feelings of being the only African American student in a college classroom. However, I would not consider myself a complete insider because my experiences, as an undergraduate sociology major, may be different from an engineering major. The similar experience may serve as a benefit because participants may have been more comfortable sharing deeply personal feelings. On the other hand, my background may potentially biased the interpretations of the participants' comments and experiences. The case study approach helps to reduce potential biases because I have triangulated findings among students and alumni, faculty, and administrators (Patton, 2002).

Limitations

This study has a few important limitations to consider, which are the lack of comparisons for unsuccessful African American engineering majors, the secondary data analyses of the quantitative data, the utilization of minority engineering programs as the primary source for recruiting qualitative participants, and the voluntary nature of the case

studies, which resulted in unequal participation. This study focuses on successful engineers and therefore cannot make any conclusions about the experiences of unsuccessful engineers. A number of scholars (e.g., Seymour and Hewitt, 1997) have identified why students leave the science and engineering fields. Instead of adding to the substantial body of literature focusing on student failure, this study seeks to identify which institutional factors serve as barriers or enablers of highly successful African American undergraduate engineering students' persistence.

Secondly, I conducted a secondary analysis of the quantitative data. The quantitative data were already collected, which did not give me the opportunity to add specific questions related to African American experiences in engineering or computer science. Additionally, due to the limited response rate, I was not able to utilize the "college senior survey" (collected in 2008), which limits my ability to quantify the impact of student experiences in college and the role these experiences play in degree attainment. Therefore, the quantitative data may not provide a complete outlook on students' full set of experiences.

In addition, although all eligible African American students were sent a recruitment email, my university connection was through the respective campus' minority engineering program office. As a result, nearly every participant has been a participant in a MEP sponsored event. While there are varying degrees of MEP participation, students who volunteered to participate in this study may have exhibited some selection bias to participate due to their relationship with his or her respective MEP office.

Lastly, I had variation in participation due to the voluntary nature of the qualitative data collection. I interviewed all voluntary participants who met the study inclusion criteria. As a result, I ended up with more student and alumni interviews at Porter State University, but more faculty interviews at Baldwin University. Additionally, I conducted two focus groups at Porter State with 9 participants, but I did not conduct any focus groups at Baldwin because of the relatively fewer student participant volunteers. While the focus groups gave me the opportunity to delve into the collective experiences of African American engineers at Porter State, the focus groups provided relatively few new insights than the individual interviews. Therefore, I do not believe the lack of focus groups at Baldwin University skews my analyses and subsequent interpretations.

Chapter Four – Quantitative Methods and Results

In this chapter, I present the first phase of inquiry derived from 657 African American undergraduate students, who entered college with the intention of majoring in engineering or computer science. First, I describe the data sources and sample. Next, I introduce the multinomial logistic regression model for African American students who entered college with the intention of majoring in engineering or computer science and completed a degree in this same field. Then, I present the multinomial logistic regression model for African American students who entered college with the intention of majoring in engineering or computer science and completed a degree in a science or mathematics field. Both models are compared to African American students who entered college with the intention of majoring in engineering or computer science, but completed a degree in a non-STEM field.

Quantitative Data Sources, Sample, and Analyses

In the first phase of this study, I analyzed quantitative data to provide an overarching contextual description of the background characteristics and institutional contexts, which are significant predictors or not of undergraduate engineering success among African Americans. I analyzed data derived from The Freshman Survey (TFS) administered by the Cooperative Institutional Research Program (CIRP) at the Higher Education Research Institute (HERI) at UCLA. I have analyzed data from the CIRP TFS administered to the entering cohort of 2004 during their respective summer orientations or the first few weeks of the fall term. In addition, to the student data sources, I included

institutional level variables obtained from the Integrated Postsecondary Education Data System (IPEDS). Lastly, HERI, through a special acquisition, has linked the 2004 TFS respondents with data collected by the National Student Clearinghouse (NSC). The NSC has accurate and complete information on students' enrollment status and degree attainment. Respondents to the 2004 TFS survey have been matched with data gathered by the NSC in 2009, which is 5 years after the 2004 cohort began college. Therefore, I utilize the TFS, IPEDS, and NSC data sources to pair respondents' background characteristics with institutional attributes and match these data with student success outcomes (i.e., degree attainment).

Quantitative Data Sample

The sample for this study includes African American students, who entered a baccalaureate degree granting college or university (in 2004) with the intention of majoring in engineering or computer science. The TFS provides nine options for engineering or computer science, which includes aeronautical, civil, chemical, computer, electrical, industrial, mechanical, other engineering, and computer science. Computer science was included because some schools/colleges of engineering house computer science programs. In total, 2,097 African American students attending 277 institutions indicated a probable major of engineering or computer science. Women are outnumbered and make up only 27% of this sample. In this study, I focus on TFS respondents who have degree attainment information from the NSC (in 2009) because more accurate conclusions can be made about this group (n=657).

Quantitative Data Analyses

I employ a multinomial logistic regression to analyze the dependent measure, which are a.) Either a student completed a degree in engineering/computer science or not, b.) A student completed a degree in science or mathematics, or c.) A student completed a degree in a non-STEM field or not. The multinomial logistic model is used to estimate the probability of being a member of one of the three groups (Pampel, 2000). The results for the multinomial logistic regression analyses are reported as delta-p statistics. According to Cruce (2009), the Delta-p statistic is the difference between the baseline probability and the estimated probability given a one-unit change in the independent variable, holding all other variables constant at their mean values. Survey commands in the program STATA are used to run the multinomial logistic regression models.

Dependent Variable

The dependent variable for this analysis measures baccalaureate degree attainment within five years of enrolling as a freshman (in 2009). The sample for this study consists of TFS respondents, who entered college with an intention to major in engineering or computer science. The dependent variable provides data on the actual degree the respondents received within five years. There are three categories of degree completers who entered college with the intention of majoring in an engineering or computer science field:

1. They completed a degree in engineering or computer science.
2. They completed a degree in another STEM field, but not engineering or computer science.

3. They completed a degree in a non-STEM field.

Of the 657 respondents with degree information, 51.6% (n=339) received a bachelor's degree in an engineering field or computer science, 9.3% (n=61) received a bachelor's degree in a science or mathematics field, and 39.1% (n=257) received a bachelor's degree in a non-STEM field. Table 4.1, 4.2, and 4.3 provides breakdowns of the specific degree awarded within each of the three dependent outcome measures. Students who completed degrees in engineering or computer science finished most frequently with a bachelor's degree in computer science (30.1%) followed by electrical or electronic (20.9%) and mechanical engineering (16.2%). Among students who switched from engineering to another STEM field, mathematics (37.3%) and biology (19.4%) were the most frequent choices. Lastly, TFS respondents who entered college with an intention to major in engineering but ended up leaving engineering for a non-STEM field selected business, economics, or finance (34.2%) most frequently followed by psychology (6.1%).

Table 4.1 – Specific majors among bachelor's degree completers in engineering or computer science

Degree Major	n	Proportion
Computer science	102	30.1%
Electrical or electronic	71	20.9%
Mechanical	55	16.2%
Other	49	14.5%
Civil	30	8.8%
Chemical	25	7.4%
Aerospace	5	1.5%
Industrial	2	0.6%
Totals	339	100.0%

Table 4.2 – Specific majors among bachelor's degree completers in science or mathematics

Degree Major	n	Proportion
Mathematics	25	41.0%
Biology	13	21.3%
Chemistry	6	9.8%
Physics	6	9.8%
Medicine, dentistry, veterinarian	6	9.8%
Other technical	2	3.3%
Zoology	1	1.6%
Other physical science	1	1.6%
Agriculture	1	1.6%
Totals	61	100.0%

Table 4.3 – Specific majors among bachelor's degree completers in non-STEM fields

Degree Major	n	Percentage
Business, Economics, or Finance	88	34.2%
Psychology	16	6.5%
Other arts and humanities	15	6.1%
Communications	13	5.3%
Art, fine and applied	11	4.5%
Political science (government, international relations)	11	4.5%
Sociology	9	3.7%
Ethnic Studies	6	2.4%
All Other Majors	88	34.2%
Top 10 Totals	257	100%

I further examine the dependent variable and the association with three key independent measures of institutional typologies. First, I computed a cross-tabulation of the dependent variable (i.e., field of degree attained) and whether or not the survey respondents attended a Top 50 producer of African American engineers with a

baccalaureate degree in engineering. As presented in Table 4.4, nearly two out of three (64.1%) students who attended a Top 50 producer completed a degree in engineering or computer science. Conversely, students who did not attend a Top 50 producer only completed a degree in engineering or computer science 44.7% of the time. Moreover, only 30.7% of students who attended a Top 50 producer completed a degree in a non-STEM field as compared to 43.7% of those who did not attend a Top 50 producer.

Table 4.4 – Cross-Tabulation of Dependent Variable and Attended a Top-50 Producer of African American Engineers

Top 50 Producer	Non-STEM	Science & Mathematics	Engineering or Computer Science	Totals
Yes	72	12	150	234
No	185	49	189	423
Totals	257	61	339	657

Then, I computed a cross-tabulation of the dependent variable (i.e., field of degree attained) and whether or not the survey respondents attended an HBCU. As displayed in Table 4.5, nearly one in two (49%) students who attended an HBCU completed a degree in engineering or computer science. Similarly, students who did not attend an HBCU completed a degree in engineering or computer science 52.3% of the time. Also, 37.9% of students who attended an HBCU completed a degree in a non-STEM field as compared to 39.5% of those who did not attend an HBCU. There are relatively moderate differences in the outcomes of attending an HBCU or not.

Table 4.5 – Cross-Tabulation of Dependent Variable and Attended an HBCU

HBCU	Non-STEM	Science & Mathematics	Engineering or Computer Science	Totals
Yes	55	19	71	145
No	202	42	268	512
Totals	257	61	339	657

Lastly, I computed a cross-tabulation of the dependent variable (i.e., field of degree attained) and the percent of the colleges' and universities' study body majored in a STEM field. I divided this variable into quartiles due to institutions' percent STEM students being a continuous variable as compared to the dichotomous variables presented above (i.e., Top 50 producer and HBCU). Among the universities represented in this study, the top 25% of institutions had STEM student populations ranging from 7.5% to 32.54% and the bottom 25% of institutions had populations between 0.08% and 2.45%. The distribution of students is equal. As exhibited in Table 4.6, there is an increase in the percentage of engineering or computer science degree completers with each quartile increase. Students who attended the lowest 50% of institutions (i.e., 0.08% - 4.84% STEM students) completed degrees in engineering or computer science at a rate of 41.8% and students who attended the highest 50% of institutions (i.e., 4.85% - 32.54%) completed degrees in engineering 61.1% of the time.

Table 4.6 – Cross-Tabulation of Dependent Variable and Percent STEM student in Quartiles

STEM Student Percent Quartiles	Non-STEM	Science & Mathematics	Engineering or Computer Science	Totals
0.08% - 2.45%	78	16	68	162
2.46% - 4.84%	79	16	69	164
4.85% - 7.49%	50	17	97	164
7.5% - 32.54%	50	12	103	165
Totals	257	61	339	657

Independent variables

I used previous research and my conceptual framework to guide my selection of independent measures. As indicated in Table 4.7, fourteen variables are used to better understand significant predictors for African American degree completion in engineering or computer science. The independent variables are divided into three groups:

1.) Background characteristics

2.) High school context and performance

3.) College contexts

Most of the independent variables are dummy coded "0" and "1." The "1" code indicates an affirmative response to the variable in question and a "0" indicates a negative response. In the dummy coding scheme it is easy to deduce the portion of respondents to particular codes by observing the means for these variables. Please see Appendix B for a detailed description of how each variable is coded.

Table 4.7 – Descriptive Statistics for Independent Variables

Independent Variables	n	Min.	Max.	Mean	Std. Dev.
Background Characteristics					
Gender: Female	657	0	1	.35	0.477
Parent is an engineer or computer scientist	657	0	1	.17	0.376
Highest parent's education	657	1	8	5.9	1.742
High School Context and Performance					
Attended a private HS	657	0	1	.16	0.365
Average HS grade	657	1	8	6.42	1.415
Years of HS math: 4yr or more	657	0	1	.90	0.302
SAT (100 pt scale)	657	6.60	15.40	11.01	1.658
College Contexts					
Reported any financial concerns upon entering college	657	0	1	.72	0.450
Attended a top 50 producer of Black engineers	657	0	1	.36	0.479
Attended an HBCU	657	0	1	.22	0.415
Attended a private college or university	657	0	1	.43	0.496
Institution's STEM student percent	657	.08	32.54	6.72	5.984
Institution's average SAT score (100 pt scale)	657	7.55	14.67	11.18	1.615
Revenue per full time equivalent student (1000 pt scale)	657	2.9	667.7	58.1	103.5

Mannon and Shreuders (2007) found women, who had an engineer in the family, were more likely to enter college with a specific engineering major. Women who did not have an engineer in the family tended to enter college as an undecided engineering major or switched into engineering after entering college. Mannon and Shrueders suggest parent's occupation plays a key role in undergraduates' decision to pursue a particular engineering field. It would be interesting to see if having a parent, who is an engineer or computer scientist, is a significant predictor of completing a degree in engineering. 17%

of respondents had at least one parent who was an engineering or computer programmer/analyst.

Prior academic performance and SAT scores have been found by a number of research studies as being significant predictors of persistence. An analysis of the correlation among academic performance indicators revealed high levels of multicollinearity (i.e., high levels of correlation between independent variables, which may skew data results), so I decided to use the average high school grade received. However, I still included the SAT variable (combined mathematics and verbal sections) on the independent variables list to provide more information about this sample of African American engineers and computer scientist. The respondents had an average SAT score of 1101 with a range of 660-1540.

Scholars like Davies and Guppy (1997) and Goyette and Mullen (2006) have found students' socioeconomic status plays an important role in the decision to choose majors. These researchers found students from higher SES backgrounds were more likely to select a science or more financially lucrative major and were more likely to pursue graduate study. I included two SES indicators, which are the highest level of either parents' education or whether students' had financial concerns. A number of students (72%) in this study indicated they had financial concerns upon entering college.

The "attended a Top 50 producer" variable was derived from a *Diverse: Issues in Higher Education* report, which utilized the Department of Education's aggregated degrees awarded information from the 2008-09 academic year (Borden, 2010). In this report, data are presented on the number of baccalaureate degrees awarded in engineering

among African Americans. The "Top 50" institutions awarded between 145 and 18 degrees in engineering. Among the TFS respondents, 36% attended a top 50 degree producer of African American engineers with 19 of the top 50 institutions represented. This variable may serve as a proxy for student success at the institutional level. However, this variable is limited because it only measures the output and does not take into consideration an institutions' retention rate of African American engineers. Unfortunately, there are no variables in the IPEDS dataset pointing to the retention rates specific to engineering. It is also important to note the "Top 50" list data were collected for the 2008-2009 school year, which is the same year as the National Student Clearinghouse data (i.e., outcome/dependent variable).

There is ample evidence supporting the inclusion of an HBCU variable. HBCUs have long stood as the beacons of hope and educational opportunity for African Americans. It should be noted that seven of the top twelve producers of African American engineers are HBCUs. A number of studies have pointed to the benefits for attending an HBCU in general and particularly for STEM students (Allen, 1992, Davis, 1994, Leggon & Pearson, 1997). 22% of the students in this dataset attended an HBCU.

In addition to Hurtado (1992), who found selectivity was linked to increasing perceptions of racial tension, Chang and his colleagues (2008) found underrepresented racial minorities had a higher chance of departing from a biomedical or behavioral science major if they attended a more selective institution. However, at HBCUs higher selectivity increased the persistence rate in these STEM fields of study. Similar to Chang

et al. (2008) and Hurtado (1992), I included a measure of an institution's average SAT score to serve as a proxy for institutional selectivity.

Finally, I included a variable focusing on the amount of total revenue per full time equivalent (FTE) student in order to control for differences in institutions' financial resources. Total revenue per FTE undergraduate student was calculated by dividing the amount of revenue the institution received for a given year by the number of FTE undergraduate students enrolled. Revenue per FTE undergraduate student was rescaled so that a one-unit increase in each variable corresponds to a $1,000 increase in expenditures or revenue per FTE.

Multinomial Logistic Regression Analyses Results

Engineering Degree Completers

For the multivariate analyses, I utilize both individual characteristics and institutional characteristics. To account for this multilevel approach, I first ran the multinomial logistic regression analyses separate for student level data (see Table 4.8) and institutional level data (see Table 4.9). Then I combine both the student level and institution level variables into one analysis (see Table 4.10).

Table 4.8 – Preliminary Analysis Multinomial logistic regression analysis of degree completers in engineering or computer science with only the individual characteristics (n=657)

Independent Variables	Coef.	S.E.	Sig.^	Delta-*p*
Background Characteristics				
Gender: Female	-0.293	0.206		
Parent(s)' highest level of education	0.086	0.571		
Parent is an engineer or computer analyst/programmer	0.276	0.236		
High School Context and Performance				
Attended a private high school	0.533	0.282		
Average high school grade	0.316	0.066	*	6.9%
Years of high school mathematics: 4-years	0.227	0.270		
College Contexts				
Reported any financial concerns	0.013	0.174		

Note: The base outcome is students who received a degree in a non-STEM field
^ ***p< .001, ** p< .01, * p< .05

Table 4.9 – Preliminary Analysis Multinomial logistic regression analysis of degree completers in engineering or computer science with only the institutional characteristics (n=657)

Independent Variables	Coef.	S.E.	Sig.^	Delta-*p*
College Contexts				
Attended a top 50 producer of Black engineers (B.S.)	0.700	0.304	*	19.20%
Attended a historically Black college or university	-0.122	0.397		
Attended a private college or university	0.224	0.253		
Institution's percent of students with STEM majors	0.037	0.020		
College or university's average SAT score	-0.035	0.119		
Revenue per full time equivalent student	0.765	0.179		

Note: The base outcome is students who received a degree in a non-STEM field
^ ***p< .001, ** p< .01, * p< .05

In the multinomial models presented in Table 4.10, TFS respondents who entered college with the intention of majoring in engineering and completed a baccalaureate degree in engineering are compared to those who completed a degree in a non-STEM field. There are three statistically significant variables, which are positive predictors for completing a bachelor's degree in engineering. These include attending a private high school, the average high school grade, and attending top 50 producers of baccalaureate degrees in engineering among African Americans.

Table 4.10 – Multinomial logistic regression analysis of degree completers in engineering or computer science (n=653)

Independent Variables	Coef.	S.E.	Sig.^	Delta-*p*
Background Characteristics				
Gender: Female	-0.328	0.22		
Parent(s)' highest level of education	0.075	0.06		
Parent is an engineer or computer analyst/programmer	0.326	0.23		
High School Context and Performance				
Attended a private high school	0.624	0.27	*	13.6%
Average high school grade	0.327	0.07	***	7.0%
Years of HS mathematics	0.180	0.28		
College Contexts				
Reported any financial concerns	0.020	0.17		
Attended a top 50 producer of Black engineers (B.S.)	0.725	0.30	*	19.8%
Attended a historically Black college or university	-0.290	0.40		
Attended a private college or university	0.223	0.25		
Institution's percent of students with STEM majors	0.034	0.02		
College or university's average SAT score	-0.215	0.12		
Revenue per full time equivalent student	0.033	0.04		

Note: The base outcome is students who received a degree in a non-STEM field

^ ***$p < .001$, ** $p < .01$, * $p < .05$

First, students who attended a private high school were a little more than 13% more likely to complete a bachelor's degree in engineering or computer science than their peers who completed a degree in a non-STEM field. Private high schools may have more financial resources, which may garner better preparation for students interested in highly technical fields like engineering and computer science. Some of the resources may include an increase in the probability of taking science and mathematics courses from properly credentialed instructors. Also, higher resources may include lower school counselor to student ratios, which may assist students in gathering information about potential colleges and a major like engineering. Private high schools might also have lower computer to student ratios and access to computer software. An early introduction to computers in an academic setting may be particularly important for those who seek computer related engineering majors. Additionally, private high schools might push students toward high status careers like engineering, so students may enter college with a better understanding of what is required to succeed.

Second, a one-category (i.e., from a B- to a B) increase in a respondent's average high school grade increased the likelihood of completing an engineering or computer science degree by 7% as compared to those who completed a degree in a non-STEM field. This finding confirms scores of researchers who have found academic preparation is an important factor in STEM persistence and degree attainment (e.g., Bonous-Hammarth, 2000). The average grade in high school may also reflect students' ability to develop effective study habits and transfer this skill to the college setting.

Among institutional measures, the only statistically significant variable was "attending a top 50 producer of African American engineers." Respondents who attended one of these institutions were nearly 20% more likely to complete a degree in engineering or computer science. 20% is a considerable increase in the likelihood of completing an engineering degree. However, it is not clear what exactly about institutions characterized as "Top 50 producers" enables such a dramatically different likelihood of completion. The many questions arising from the positive role Top 50 producers play will be further examined in the qualitative portion of this study where I traveled to two universities distinguished as top 50 producers of African American engineers. The purpose of the qualitative portion of this study is to better understand the intuitional policies and practices, pedagogical strategies, and support structures that encourages or dissuades the success of African Americans in engineering.

Science and Mathematics Degree Completers

For the multivariate analyses, I utilize both individual characteristics and institutional characteristics. To account for this multilevel approach, I first ran the multinomial logistic regression analyses separate for student level data (see Table 4.11) and institutional level data (see Table 4.12). Then I combine both the student level and institution level variables into one analysis (see Table 4.13).

Table 4.11 – Preliminary Analysis Multinomial logistic regression analysis of degree completers in science or mathematics with only the individual characteristics (n=657)

Independent Variables	Coef.	S.E.	Sig.^	Delta-*p*
Background Characteristics				
Gender: Female	-0.022	0.319		
Parent(s)' highest level of education	0.058	0.098		
Parent is an engineer or computer analyst/programmer	-0.536	0.442		
High School Context and Performance				
Attended a private high school	0.505	0.397		
Average high school grade	0.299	0.138	*	0.7%
Years of high school mathematics: 4-years	1.259	0.567	*	6.0%
College Contexts				
Reported any financial concerns	0.157	0.392		

Note: The base outcome is students who received a degree in a non-STEM field

^ ***$p < .001$, ** $p < .01$, * $p < .05$

Table 4.12 – Preliminary Analysis Multinomial logistic regression analysis of degree completers in science or mathematics with only the institutional characteristics (n=657)

Independent Variables	Coef.	S.E.	Sig.^	Delta-*p*
College Contexts				
Attended a top 50 producer of Black engineers (B.S.)	-0.492	0.587		
Attended a historically Black college or university	1.023	0.453	*	9.9%
Attended a private college or university	0.361	0.395		
Institution's percent of students with STEM majors	0.023	0.048		
College or university's average SAT score	0.221	0.213		
Revenue per full time equivalent student	-0.319	0.394		

Note: The base outcome is students who received a degree in a non-STEM field
^ ***$p < .001$, ** $p < .01$, * $p < .05$

In the model presented in table 4.13, TFS respondents who entered college with the intention of majoring in engineering and completed a baccalaureate degree in a STEM field (excluding engineering and computer science) as compared to those who completed a degree in a non-STEM field. There are three statistically significant variables, which are all positive predictors for completing a bachelor's degree in a STEM discipline. These include the average high school grade, years of high school mathematics, and attending a HBCU.

Table 4.13 – Multinomial logistic regression analysis of degree completers in science or mathematics (n=657)

Independent Variables	Coef.	S.E.	Sig.^	Delta-*p*
Background Characteristics				
Gender: Female	-0.034	0.27		
Parent(s)' highest level of education	0.113	0.02		
Parent is an engineer or computer analyst/programmer	0.079	0.091		
High School Context and Performance				
Attended a private HS	0.440	0.375		
Average high school grade	0.331	0.14	*	1.0%
Years of HS mathematics	1.376	0.560	*	5.9%
College Contexts				
Reported any financial concerns	0.235	0.39		
Attended a top 50 producer of Black engineers (B.S.)	-0.604	0.56		
Attended a historically Black college or university	0.856	0.44	*	7.5%
Attended a private college or university	0.419	0.40		
Institution's percent of students with STEM majors	0.027	0.04		
College or university's average SAT score	-0.011	0.22		
Revenue per full time equivalent student	-0.031	0.39		

Note: The base outcome is students who received a degree in a non-STEM field

^ ***$p < .001$, ** $p < .01$, * $p < .05$

Similar to the model for engineering degree completers, a one category (i.e., from a B+ to an A-) increase in a respondent's average high school grade increased the likelihood of completing a STEM degree by 1% as compared those who completed a degree in a non-STEM field.

In addition, respondents who completed 4 or more years of mathematics were nearly 6% more likely to complete a degree in STEM (excluding engineering and computer science), as compared to students who only completed three or fewer years of

high school mathematics. 90% of the study participants completed 4 or more years of high school mathematics, which is very telling for the 10% who only completed three years or fewer. It is important to note, this variable was not significant for completing an engineering or computer science major, which means the significance of mathematics is not necessarily an important factor for those who switched from engineering to another STEM field, but it is a very important factor for students who leave STEM all together. A number of scholars (e.g., Bonous-Hammarth, 2000; Russell & Atwater, 2005) have focused on the importation of academic preparation in general and mathematics training in particular. Students, who can enter college without being bogged down in "remedial" mathematics courses, may have a smoother transition to college. These students might spend their first semester sharpening their mathematics skills, as opposed to learning new material and potentially falling behind their engineering peers.

Lastly, respondents who attended a HBCU were 7.5% more likely to complete a degree in STEM. Again, this variable was not significant for completing an engineering or computer science major, which means HBCUs play an important role in retaining students in STEM fields. Scholars like Slaughter (2009) and Leggon and Pearson (1997) have highlighted the many ways HBCUs may provide a particularly nurturing environment for students interested in STEM fields. Students at HBCUs are considerably more likely to have a same race faculty member in STEM and may face far fewer challenges associated with psychological dimensions like prejudice, stereotyping, and racism.

Surprisingly, African American women were not any less likely than their male counterparts to complete a degree in Engineering or STEM. My initial impression of these data results postulate the impact of gender was mitigated by the other significant variables like previous academic performance (i.e., average high school grade) and preparation (i.e., years of high school mathematics). I isolated "gender: female" by rerunning the multinomial regression without any other independent variable. "Gender: female" was still a non-significant predictor of both STEM (excluding engineering and computer science) and engineering and computer science degree dependent outcomes.

Summary

First, students who attended a private high school were a little more than 13% more likely to complete a bachelor's degree in engineering or computer science than their peers who completed a degree in a non-STEM field. Additionally, a one category (i.e., from a B- to a B) increase in a respondent's average high school grade increased the likelihood of completing an engineering or computer science degree by 7% as compared those who completed a degree in a non-STEM field. Lastly, respondents who attended a "Top 50 producer" were nearly 20% more likely to complete a degree in engineering or computer science.

Secondly, a one category (i.e., from a B+ to an A-) increase in a respondent's average high school grade increased the likelihood of completing a STEM degree by 1% as compared those who completed a degree in a non-STEM field. In addition, respondents who completed 4 or more years of mathematics were nearly 6% more likely to complete a degree in STEM (excluding engineering and computer science), as

compared to students who only completed three or fewer years of high school mathematics. Finally, respondents who attended a HBCU were 7.5% more likely to complete a degree in STEM.

Chapter Five – Qualitative Methods and Findings: Institutional Contexts and Support Structures

In this chapter, I offer findings from two qualitative case studies conducted at Porter State and Baldwin Universities, which are both characterized as Top 50 producers of African Americans with baccalaureate degrees in engineering. I begin with a description of the interview participants and the two universities. Then, I will describe the respective institution's minority engineering program and other venues student participants relied on for support, which includes summer bridge programs and the National Society for Black Engineers student organization.

Qualitative Data Sources

This study is based on qualitative data collected from 70 participants: 37 African American engineers/computer scientists, 9 faculty members, 16 administrators[6], and 8 recent baccalaureate recipients. Study participants were from one of two predominantly White public research universities: Porter State University, which is in the Southeastern region of the U.S., and Baldwin University, which is in the Midwestern region of the U.S. Pseudonyms are used for both the universities and the study participants due to the small

[6] Some administrators are also faculty members, but those placed in the administrator category have a primary responsibility in an administrative capacity.

population of African American students and faculty in computer science and engineering in the U.S.

My goal was to find universities with records of success in supporting African American engineers. Therefore, I utilized *Diverse Issues in Higher Education's* annual report of the Top 50 undergraduate degree producers of baccalaureate degrees in engineering among African Americans in the United States to identify several institutions to request participation in this study. I formally requested participation to the study via email and telephone requests to the respective campus' School of Engineering Dean's Office. Two Schools of Engineering (Porter State University and Baldwin University) approved my request and both universities have a proven record of success in producing African American engineers and computer scientists.

Once institutions were identified and all approvals were received, student participants were recruited through the respective university's minority engineering program. The director of the program emailed a study recruitment announcement to potential participants. The criteria for participation in this study included the following:

1. Students must identify as African American or Black (including multi-racial backgrounds)
2. Students must be a declared undergraduate engineering or computer science major or recent alum (completed baccalaureate degree within 3-5 years)
3. Students must have achieved success, which is defined as maintaining at least a 3.0 GPA, involvement with faculty's research or relevant corporate internship, and persisting to upper division coursework.

Additionally, key administrators were asked to participate in this study if they had formal responsibilities within the boundaries of the current case study. Administrators included the Deans and Associate Deans of the School of Engineering, directors and senior administrators of university wide multicultural student affairs or diversity initiatives, and directors of minority engineering programs. Lastly, the directors of MEP identified faculty members, who from their experiences were supportive of African American undergraduates. Additional faculty participants were selected through a more organic process of asking students about faculty members, "who were particularly supportive of their academic career." Student participants cited supportive faculty members as those who provided mentoring and support, provided opportunities to research experiences, and/or recommended internships. Although students cited faculty members who were already identified by the MEP director there were several cases of faculty members who were identified through the student-nomination process.

Porter State University

Porter State is a public university in the Southeastern region of the United States. Porter State has over 30,000 students and is characterized as a research university by the Carnegie Classification. This southeastern university has considerable research activity with expenditures just over 100 million dollars. Porter State's undergraduate student population consists of roughly 10% African Americans. It is important to note Porter State is in a former slave state and for a good portion of its history excluded African Americans from enrolling at this institution.

I contacted a total of seven schools of engineering for participation in this study. Porter State was the first to respond to my request, so I set up an appointment via telephone with the Dean and the Director of MEP. I went into the phone conversation not sure what to expect, but I was pleasantly surprised when Porter State gave me approval. Moreover, I was struck by how excited the Dean and the MEP director, Dr. Nichols, were to have me conduct my case study at their school of engineering. The Dean talked with me for about 15 minutes and he stated how important this research topic was and how he believes Porter State is absolutely committed to supporting African American engineers. The MEP director spoke with me for an additional 45 minutes chronicling the ways his office supports African American engineers and computer scientists. He asked me how many students I was looking to interview and I told him 8-12. My "jaw dropped to the floor" when he replied, "that won't be a problem. We have well over 50 students that meet your criteria."

After I received all the necessary approvals, I traveled to Porter State University to conduct this case study. My first appointment was with Dr. Nichols, MEP director, whose office was located in the main engineering administrative building. When I entered the building, I could not help but notice several walls were used to highlight distinguished alumni award recipients. There were 72 pictures on the walls of alumni who were honored for one of the following reasons:

1. Planning and direction of engineering work
2. Fostering professional development of young engineers
3. Contributing to knowledge in the field of engineering

4. Bringing in other ways, distinction to the university through engineering achievement.

The prestigious alums consisted of 66 White men, 3 White women, 2 African American men, and 1 African American woman. I saw this as a historical relic of past discriminatory practices because Porter State is in a former slave state and at one point in its history excluded African Americans and other minorities to its school of engineering and university. I could not help but think back to Amy Slaton's *Race, Rigor, and Selectivity in U.S. Engineering* and the University of Maryland's former President Curly Byrd and the intentional ways he sabotaged and excluded African Americans from engineering. I could not help but think of all the past injustices occurring in the halls of Porter State before opening the doors to African Americans and other racial minorities.

I asked Dr. Nichols about this alumni wall with very few representations of racial minorities and women and he informed me that he currently sits on the board selecting the alumni for this wall. He insisted there was nothing anyone could do about past selections, but moving forward the committee was committed to honoring a diverse constituency. In fact, the one African American woman was a recent addition.

The Porter State School of Engineering has a fairly new set of buildings, which are located on a separate campus, housing state of the art STEM buildings about a mile from the main campus. I went back and forth between the main campus and the STEM campus to conduct my interviews. Walking the halls of the various engineering buildings it was evident there were mostly White men engineering majors. I was fortunate to receive a walking tour from one of my student participants Ian. He showed me where his

classes and labs were located; he also showed me his senior design lab. Ian explained some of the different prototypes on display, which were created by past senior design projects. Additionally, Dr. Nichols took me on a driving tour of the campus and the surrounding city. I took any opportunities available to walk the halls of the engineering buildings and campus to pay attention to group dynamics in order to get a sense for the campus environment.

The Dean and Dr. Nichols gave me a "key to the city" because nothing was off limits. I was given the opportunity to interview anyone. After my campus visit ended, the only thing I was worried about was gaining the same level of access to another university's school of engineering.

Baldwin University

Baldwin University is a public university in the Midwestern region of the United States. With over 40,000 students, Baldwin is characterized as a research university by the Carnegie Classifications. This Midwestern university has a considerably larger research expenditure (over 150 million dollars), is more selective, and has a more highly nationally ranked school of engineering than Porter State. However, Baldwin's undergraduate African American student population is approximately 6%, which is appreciably smaller than Porter State's (10%).

Luckily, Baldwin University granted me the same level of access as Porter State. Like Porter State, Baldwin's School of Engineering has a relatively new set of buildings, which are located on a separate campus, housing state of the art STEM buildings about three miles from the main campus. Almost all of my interviews were conducted on the

STEM campus with the exception of two interviews with university-wide administrators. I interviewed students in a small office in the Engineering Learning Center and all other interviews were conducted in the respective faculty or administrator's office. The center consisted of two administrative offices, about 12 computer workstations, white boards, a few tables with chairs and two small couches. I was fortunate enough to have a study participant, Vera, a junior civil engineer with a 3.35 GPA, show me one of the computer workstations and all of the various engineering based software packages it contained, which included Geo Studio, Tecplot 360, Risa 3D, and an additional 20 applications used by engineers. She explained to me students could obtain remote access to all of these assorted applications via the Internet. As a result, students did not have to purchase individual licenses for the costly software to complete their homework assignments and projects.

During the week I spent interviewing students in the Learning Center, it appeared African American students seemed to utilize the space consistently for long periods of time. Other students would come in and out, but it seemed as though they would stay for shorter periods of time to execute specific tasks like printing something out or emailing someone.

Similar to my time at Porter State, I observed the halls of the various engineering buildings, which were much more spread out at Baldwin compared to Porter State. I took any opportunities available to walk the halls of the engineering buildings and campus to pay attention to group dynamics in order to get a sense for the campus environment. While walking around it was evident there were mostly White men engineering majors,

but I noticed slightly more racial diversity. In one of the main buildings, I was surprised to find a 20" by 20" group photo of around 14 African Americans prominently displayed in a high traffic area. Mr. Taylor, MEP Director, explained the School of Engineering is in the process of putting up more photos of students and has the goal of showcasing their diverse student body.

Data Collection

Student participants completed a short demographic questionnaire before the start of the interview. This brief questionnaire gathered information on a range of relevant background characteristics (e.g., SES background, high school attended, and racial demographic of the neighborhood the participant grew up in). I asked students to participate in either an individual or focus group interview. The individual interviews lasted approximately sixty minutes and focused on the student's path to and through the engineering pipeline. I focused on what sparked their initial interest in engineering and what support mechanisms they found particularly helpful in their experience. Of the 37 current undergraduate and alumni participants, 28 participated through an individual interview and 9 participated through a focus group. The focus group interviews, which were all conducted at Porter State, lasted approximately 75 minutes and focused on the students' collective and individual experiences at their respective university. I conducted two focus groups of 4-5 current undergraduate students at Porter State and no focus group interviews were conducted at Baldwin. The administrators and faculty interviews were individual and either face-to-face or via telephone lasting between 30 to 60 minutes. I conducted a total of three interviews with faculty and administrators over the telephone.

Qualitative Study Participants

The 45 students and alumni participants came from a variety of different majors. Table 5.1 lists all of the participants for Porter State and Table 5.2 lists all of the participants for Baldwin. These tables include the pseudonym name each participant selected for his or herself, participant's sex, academic standing, major, and undergraduate GPA. Students from Porter State collectively maintained a mean 3.27 GPA and students from Baldwin achieved a mean 3.4 GPA. Approximately 42% of the participants were women. Table 5.3 is a cross tabulation of participants sex and engineering major. Over 50% of the women in this portion of the study were either a chemical or industrial engineer. The men were more evenly distributed over the various engineering subfields. In terms of SES, about 38% of the students' parents earned less than $60,000 per year, 33% earned between $60,000 and $99,999, and about 11% earned $100,000 or more (Table 5.4). Over 70% of the students' were raised within 100 miles of their respective campuses (Table 5.5).

Table 5.1 – Student Participants from Porter State University (n=31)

Pseudonym Name	Sex	Academic Standing	Major	College GPA*
Alexandria	Female	Alum	Industrial	3.11
Anthony#	Male	Junior	Computer Science	3.19
Audrey#	Female	Senior	Mechanical	3.03
Avery	Female	Junior	Industrial	3.01
Bella	Female	Senior	Computer Science	3.66
Caden	Male	Alum	Computer Engineering	3.08
Carter	Male	Alum	Electrical	3.76
Charlotte	Female	Junior	Computer Engineering	3.14
Chloe	Female	Senior	Chemical	3.3
Cooper#	Male	Junior	Mechanical	3.24
Damien	Male	Senior	Computer Science	3.12
Elizabeth	Female	Junior	Computer Science	3.7
Emily#	Female	Senior	Chemical	3.17
Ethan	Male	Junior	Computer Science	3.28
Gabriel	Male	Senior	Electrical	3.38
Grace	Female	Senior	Electrical	3.85
Ian	Male	Senior	Biomedical	3.37
Isabella#	Female	Junior	Computer Engineering	3.23
Jayden#	Male	Senior	Chemical	3.13
Kaleb	Male	Alum	Civil	3.3
Layla	Female	Junior	Biomedical	3.25
Liam#	Male	Junior	Material Sci & Eng	3.45
Lillian#	Female	Junior	Mechanical	3.3
Logan#	Male	Senior	Mechanical	3.17
Mikayla	Female	Alum	Industrial	3.13
Nathan	Male	Senior	Electrical	3.3
Olivia	Female	Alum	Chemical	3.24
Owen	Male	Junior	Industrial	3.1
Peyton	Male	Junior	Computer Science	3.14
Ruby	Female	Senior	Industrial	3.2
Xavier	Male	Senior	Mechanical	3.15

* Mean College GPA of 3.27 with a Std. Dev. of .21

Participated via focus group

Table 5.2 – Student Participants from Baldwin University (n=14)

Pseudonym Name	Sex	Academic Standing	Major	College GPA*
Andrew	Male	Alum	Mechanical	3.5
Bernard	Male	Senior	Industrial	3.77
Eli	Male	Senior	Civil	3.6
Faith	Female	Senior	Industrial	3.19
Jack	Male	Senior	Aerospace	3.23
Jackson	Male	Junior	Industrial	3.22
John	Male	Junior	Chemical	3.46
Karson	Male	Senior	Biomedical	3.37
Kaydence	Female	Senior	Chemical	3.06
Levy	Male	Alum	Electrical	3.0
Luke	Male	Senior	Aerospace	3.92
Michael	Male	Junior	Electrical	3.8
Sofie	Female	Junior	Chemical	3.1
Vera	Female	Junior	Civil	3.35

* Mean College GPA of 3.4 with a Std. Dev. of .29

Table 5.3 – Cross Tabulation of Participants' Gender and Major for Baldwin and Porter State

	Sex			
Major/Degree	Male	Female	Total	Percent
Aerospace	2	0	2	4.4
Biomedical	2	1	3	6.7
Chemical	2	5	7	15.5
Civil	2	1	3	6.7
Comp Eng	1	2	3	6.7
Comp Sci	4	2	6	13.3
Electrical	5	1	6	13.3
Industrial	3	5	8	17.8
Material Sci & Eng	0	1	1	2.2
Total	26	19	45	100

Table 5.4 – Participants' Parental Income for Baldwin and Porter State

Income	Number	Percent
<40K	6	13.3
40-59K	11	24.4
60-99K	15	33.3
100-149K	6	13.3
150-180	2	4.4
>180K	3	6.7

Table 5.5 – Participants' Miles from Home for Baldwin and Porter State

Miles from Home	Number	Percent
50 or less	17	40.5
51-100	13	30.9
101-1000	12	28.6

Table 5.6 – Participants' Plans Immediately after completing undergraduate education for Baldwin and Porter State

Plans	Number	Percent
Graduate School	23	51.1
Work	15	33.3
Other/Undecided	7	15.6

Minority Engineer Programs

MEP at Porter State

Porter State's Minority Engineering Programs office is the anchor binding the experiences of African American engineers and computer scientists at this university. The MEP director is an African American man, Dr. Ulysses Nichols, with an assistant director, Ms. Sharon Ellis, who the students affectionately refer to as Ms. Sherry. Both

Dr. Nichols and Ms. Ellis have backgrounds in engineering. Porter State's MEP office sponsors a number of programs including an overnight recruitment weekend where prospective students stay with current students and attend a number of programs and events; a summer bridge program where entering freshman live in campus housing for 6 weeks before the start of the school year and take a mathematics, a chemistry, and an engineering course. Students also attend college survival workshops and have weekly visits to corporate industry sites. The Porter State Summer bridge program also has social and recreational activities as well, which promote community. This office also offers a formal mentoring program where entering students are paired with upperclassmen, who are paid a small stipend in exchange for their mentoring assignment.

Lastly, the MEP office organizes introductory engineering courses where students learn about various engineering disciplines and are given college survival skill tools like time management, social adjustment, and advice on how to approach faculty members. Also, students engage in small group projects, receive feedback on their resumes, and participate in mock interviews with corporate representatives.

Although the MEP staff salaries are funded by the school of engineering, the programmatic funding is based completely on soft money. As a result, the MEP office must rely on corporate sponsorships, federal grants, and other contributions. A pertinent example is the summer bridge program. I interviewed a number of students at Porter State, who did not participate in the summer bridge program because it was not offered the year they entered. Dr. Nichols points out the previous challenges of funding for programs like the summer bridge, but he insisted the budget difficulties have been

addressed. To participate in the summer bridge program participants are asked to pay a costly $350 fee, which helps to offset the cost of the program and ensure the program can take place every year.

An overwhelming majority of the Porter State students had only positive comments about the MEP office. Some of the useful functions participants cited include initial recruitment to the university, personal support, resources and information, advising, and a safe space on campus. At the onset, the MEP staff create a welcoming environment not only for the students, but also for students' parents and guardians. Carter explains how his parents initially met the Porter State MEP staff at a recruitment event:

> Ms. Sharon Ellis, and Dr. Nichols actually I didn't meet them initially, it was like in the house and we were pretty busy playing football and all that kind of stuff, and I believe they were having a recruitment event down in the [City] which is like 45 minutes from where I'm from, and my parents went down there on my behalf and they ended up speaking to Dr. Nichols and Ms. Sherry and they felt like they were some good people to get in contact with, and after that I contacted Ms. Sherry and I know a little bit more about the school and I was going to say that was one of the catalysts that ended up bringing me here to Porter State.

A number of students described similar experiences with meeting the MEP staff at a recruiting event and immediately having a connection with Dr. Nichols and/or Ms. Sherry.

Dr. Nichols' handled the bigger picture operations of the MEP program, which encompasses providing an overall vision for the program, soliciting funding from

corporate sponsors, writing grants to governmental funding agencies, seeking faculty involvement, and representing the MEP office at both university wide and school of engineering meetings. Ms. Ellis dealt more with the day-to-day operations of running the MEP office and being the first line of contact for MEP students. The MEP students I interviewed had a strong connection to Ms. Ellis. In one of several examples referring specifically to Ms. Ellis, Elizabeth described how easy it is to get in touch with Ms. Ellis:

> Yes, I can always talk to Ms. Sherry, Ms. Sherry has always been supportive. She's always there, all I have to do is send her a text message. She is always available anytime I need help with something or I have a question.

Over the course of my visit, I witnessed first-hand how she would communicate directly with students via text messaging. Students would send her a question or they would have a problem and they would send Ms. Ellis a message and the next thing you know, Ms. Ellis would be asking Dr. Nichols or other staff members for help with solving whatever problem the student had. Ian referred to her as a nurturing mother figure as he stated:

> I mean it starts with the way she treats you. She treats you like you are her children I guess, she has a motherly type personality. So she will be very nice to you, but she'll get stern with you if she needs to. I remember in Summer Bridge, I think like half these students didn't do well on their first comp test. So she took away all the computers, the TV's and video game systems, from us. That is the same thing a mother would do, be nice to you and give you everything you want, but if you start messing up she is the one to get strict with you and tell you this is how it needs to be, and this is what you guys need to do to be successful.

I asked Ms. Ellis about her relationship with her MEP students and she said she treats them like they were her own children. She gives them her cell phone number, so there can be no excuse for not contacting her. She went on to say sometimes she gets messages from students at all hours of the evening and there have been occasions where a message came through after 11 pm.

Lastly, the MEP office takes a proactive role in checking in on students. Grace explains, "They always do checkups on me to see you know how am I doing, am I like definitely keeping up with my grades, which is nice receiving an email from Dr. Nichols or Ms. Ellis saying, 'how is school are you keeping up, keep working hard.' And I'm like Okay thanks!" By taking a proactive approach, the MEP office made it easier for students to seek guidance and help if they had questions or if they were in trouble in a particular class. Many students described getting connected with tutors or getting help with working out issues with professors.

MEP at Baldwin University

Like Porter State, Baldwin's Minority Engineering Programs office is the focal point for African American engineers and computer scientists at this university. The MEP director is an African American man, Mr. Edward Taylor. While Porter State's MEP office operated with a certain level of autonomy, Baldwin's MEP office is housed under a larger umbrella office, which I will refer to as the Diversity Center. The Diversity Center focuses more generally on diversity in engineering including MEP, a women in engineering program, and an outreach programs office. This joint venture blurs the lines between what is a MEP sponsored program and what is a Diversity Center program, but it

gives the MEP program more financial backing because it is incorporated with other more mainstream offices.

The Baldwin University MEP office sponsors a number of programs, which are integrated into one large program, which I will refer to as Baldwin Success. The main program within Baldwin Success is a summer bridge program where entering freshman live in campus housing for 6 weeks before the start of the school year and take mathematics, science, and engineering courses. Students also attend high school to college workshops and take field trips to corporate industry sites. This program also has social and recreational activities as well, which builds a family like atmosphere. One thing setting Baldwin's summer bridge program apart from Porter State's is instead of paying to attend the program ($350 in the case of Porter State), Baldwin pays participants $1,500 for successfully completing the program. I asked the director of the Diversity Center, Mr. Stuart Tucker, for a rationale on doing this and he said, "...because they've given up the summer that they could be out working right, making money or doing something, so we incent them to be here getting themselves ready by paying them $1,500."

In addition, Baldwin Success pays students an additional $750 after each semester they successfully complete the program within the first year. In essence, students receive $3,000 of funding in their first year for successfully participating in the Baldwin Success program. The program also strongly encourages participants to secure a corporate internship or an undergraduate research experience during the summer between their freshman and sophomore years to remain in "good standing" with the program.

Additionally, the Baldwin Success program offers peer mentoring, academic advising, tutoring, and career guidance. The program continues in students second year with additional tutoring and coaching from program staff. Mr. Tucker and Mr. Taylor make no secret the Baldwin Success program is patterned after the University of Maryland, Baltimore County's Meyerhoff Scholars Program.

However, when asked about the funding sources for programs like Baldwin Success, Mr. Tucker, similar to Porter State, described mostly soft funding streams from corporate sponsorships and grant funding. As a result, programs do not always have guaranteed funding sources. Mr. Tucker referred to having "hand to hand combat" to fight for funding for the various programs his offices sponsor.

All fourteen Baldwin participants had only positive comments about the MEP program. They all seemed to find something positive about their experiences within the programs offered by MEP. Some of the positives participants cited include personal support, resources and information, advising, and having a safe space on campus. An illustration of the power of the MEP office at Baldwin comes from Vera, who expresses:

> Well, I will say that we definitely have a lot of resources and a supporting staff. The MEP office, Edward Taylor and all of them, they are all very supportive and if we have any issues like there is somebody to talk to because if I ever felt like I don't know how to pay for my next textbook or I think I may need to drop this course before the drop/add deadline I know who to go talk to and get some consultation, before I make that decision on my own.

The MEP office has been an invaluable resource for the students who may feel isolated on a large predominantly White campus like Baldwin's. The MEP staff has created an open and welcoming environment and students rely on them for advising and information about other resources. Eli captures the spirit of the MEP office by stating:

> I think MEP is an awesome program and the people are real personable and you can talk to them, kind of feel like you have like a safe haven, you know on campus. I think that's very, very, very important because you know it's some type of feeling being you know the only Black person in your classroom, the only Black person in the computer lab, the only Black person on the project team.

While students like Vera and Eli received an overall feeling of support from the MEP office, other students like Sofie cited specific examples of how the MEP program helped them personally. Sofie explains:

> I applied to a lot of scholarships my freshman year, and then like people from Baldwin Success I think they applied for a scholarship for me too because I ended up getting a $5,000 scholarship from [Company] and I didn't apply for it, and they just handed it to me.

Examples like Sofie's demonstrates how the MEP office at Baldwin was not merely a passive office waiting for students to come in and ask for help. The MEP staff actively sought out ways to help students achieve success. Sofie had to take out student loans to fund her education and the various scholarships and grants she received, with the help of the MEP office, really made a difference in her feeling like she could manage the financial aspects of seeking an engineering degree.

Summer Bridge

Some students from both Porter State and Baldwin passed on the opportunity to participate in the summer bridge programs because they wanted to cherish their last summer before college with their high school and neighborhood friends. However, the ones who did attend reported a number of program benefits, which include being prepared academically for freshman classes, building a social network, and becoming familiar with the campus and its resources.

Like many participants, Bernard believed it prepared him academically. He described the programmatic benefits by stating:

> It made the first semester of classes actually really easy just because you had already gone over and already seen a lot of the material and there is a different learning structure here than there is in high school, so you get used to that learning structure and so you know what they are looking for out of you. So you can actually sort of understand how they give tests or quizzes, you know what sort of to expect, and it made the first semester a lot easier.

There were a number of students at Baldwin like Bernard, who found the summer bridge program helped them be successful in their first semester. Students from Porter State had equally high praise about the Summer Bridge program. Ethan describes how the program at Porter State was not just a social summer camp, but he describe the benefits of such a rigorous program by stating:

> So going to [Summer Bridge] immediately after graduation really prepared me because we had long days, like 7 [am] to 7 [pm], basically no breaks, they made

> us go to bed at 12 [midnight], they would do room checks. We took college level calculus; we were introduced to college level English as well as chemistry, so we're constantly going, and you're doing it in a short period of time. It's not like a semester's work, it's a summer course, so that really got me going.

This summer program was the wakeup call that some students needed to jump-start them to life at a university and not just a continuation of high school study habits.

Students described the importance of not only the academic preparation, but also the social aspects as well. Students like Charlotte believed Porter State's summer bridge program really helped her adjust to a large research university. Charlotte captured this feeling by stating:

> It helped not just academically, but socially. You know, coming into college at a big university like Porter State, there are a lot of people, you don't really know too many people, [Summer Bridge] gave me the opportunity to meet African American students who had the same common goals as myself. Which made the transition a whole lot easier because when I was studying, they were studying. When we were having fun, we were all having fun together because we all had the same pathway we were trying to follow, so that made things a whole lot easier.

Building a social network was very important to students at both Porter State and Baldwin and many students who participated in the MEP sponsored Summer Bridge programs described how important social networks were in the first year of college. Michael believes his first year at Baldwin would have been a much more isolating experience if it were not for the MEP summer program. He explains:

> I think the benefit for me for participating was just, you go through the program with 50 other people and most of us were minorities, and the bonding and the social networks that I created with those people. So that freshman year when you get here you know people in your dorm, and some of your classes, and you don't feel as isolated, because sometimes I feel a bit isolated here, you know.

The social benefits transferred over to academic benefits because students who participated in the summer bridge programs tended to express having an easier time finding other students to study with and felt like part of the campus community.

Importance of Outreach and Pre-College Programs

Universities often purport having very little control over students' academic preparation prior to entering the ivory towers. Administrators and researchers alike point to the lack of prior academic preparation and other negative circumstances as being out of the jurisdiction of a higher education institution. Often, these challenges are seen as a K-12 problem. However, both Baldwin's and Porter State's school of engineering whole heartedly reject these philosophies and embrace a mission of outreach and partnerships to communities in their locale. I was very surprised at how much focus Porter State and Baldwin placed on outreach and pre-college programs. The importance of outreach as a tool for diversifying engineering and computer science programs seemed to permeate all levels of the school of engineering and often the university as well. A large portion of the undergraduate, graduate student, faculty member, and administrator participants expressed the significance of sparking an interest in engineering and computer science to the local community prior to college and as early as elementary school.

Most telling was the response of an administrator from Porter State, who also teaches an introduction to Engineering class, when I asked her what program she would initiate to strengthen the Engineering and computer science pipeline at Porter State with $10 million dollars of unrestricted funds. She said she would allocate a vast majority of the funds to outreach, precollege programs, and K-12 partnerships. She explained how so many African Americans are dissuaded from or never engaged in engineering or computer science and the formative years is where the true battles need to be waged.

There are several additional examples to draw from for each university. At Porter State a number of students described serving as a mentor in an outreach program through a student organization like the National Society of Black Engineers or through other specific engineering-based student organizations. For example, Ethan, described his involvement in a computer science-based student organization and the type of work they do with middle school students from a neighboring city:

> So basically the goal of that organization is to broaden computing among youth. So they have different outreaches, so for one we had kids come from a school out of [Local City], they come about 15-20 kids every other week and we just teach them all this programming, just to kind of get them started, like drag and drop programming. We teach them, we do LEGO mindstorm robots. We just really want to get them generally interested if not computer science at least engineering or a technical field. It's interesting because not just any high schools, I mean it's a private middle school for underrepresented minorities, so to get them interested in

> something they just view as incredibly hard or out of their grasp, you know a university, it just gets them pumped!

This type of outreach was surprising to me because it was not affiliated with a race-based organization. In fact, Ethan said there are only 2 or 3 African Americans out of the 20 organization members.

Similarly, Kaleb worked with a program where he taught mathematics in a local school. He described the value this added to his time at Porter State by stating:

> Those kind of experiences they help the whole overall college experience to me, so Porter State has a lot of programs like that um, where you can go in and use your skills and, you know, do things outside of just coming here to get a degree.

Like Ethan, Kaleb explained how although the program targeted racial minorities, it was run by a White woman and a number of the teachers were also White. The diversity of the organizations and programs committing to this type of work emphasizes how outreach efforts are not placed solely in the hands of racial minorities, but White Americans, Indian Americans, and Chinese Americans all see this as an important mission. Based on the interviews I conducted with various constituents at Porter State, I believe the school of engineering emphasizes the importance of diversity and reaching out to underrepresented communities, which creates an environment where diverse actors will come together to undertake this mission.

Baldwin University's school of engineering showed a similar commitment to outreach and diversity and perhaps an even longer track record of doing so. Baldwin University received immense returns on their investment in outreach, which appeared to

be to a lesser extent at Porter State. A number of the students I interviewed from Baldwin participated in an outreach program, which they attributed to their interest in STEM fields and/or choosing to attend Baldwin. For instance, Karson attended Baldwin University from out of state and he participated in a summer program before his senior year of high school. He describes how this pre-college summer program helped him decide to choose Baldwin:

> One of the things about the summer program is when they always promoted diversity and so we had a bunch of different people from a bunch of different backgrounds there. I got to interact with faculty so I took like a two-week course on surface chemistry, and you know I just liked the atmosphere here. I just you know enjoyed interacting with a lot of people who were also interested in coming to the university, and I thought you know this seems like a place I'd fit in pretty well.

Vera participated in a pre-college summer program leading into her senior year and she describes how it helped her choose Baldwin:

> It was a competitive program in which out of the 40 participants only 3 people will be selected to get a full tuition scholarship to come to the college of engineering here, and I was one of the 3 people in our group that summer, and so that was a strong incentive.

Vera was accepted to a number of other highly selective universities, but decided to attend Baldwin in part because of the scholarship she received from this program. Eli

participated in the same program between 10th and 11th grade and he describes the impact this had on his college going decisions by stating:

> I had the opportunity to get a full ride scholarship, and at that point college became like feasible, like wow I can really go to college, I can really pay for it, so you know I need to do everything in my power to be able to get that scholarship, so that was kind of the turning point right there.

Vera and Eli's experiences are two examples of how Baldwin's outreach programs supported African American students to not only pursue engineering, but to do so at Baldwin University with financial incentives. However, Bernard explains how the outreach programs impact students regardless of the incitement of a scholarship offer. Bernard shared with me colloquial nomenclature for the positive outcomes of these outreach programs:

> They call them MEP babies, because that is who runs all these programs, for all these students. [Students] participated year after year after year. Every summer they come to Baldwin and learn about engineering. Sometimes the students will just come back and just keep coming back, so for young students to get involved in that, they see Baldwin helping these young Black students, with engineering. So they'll be like, "I want to go there, because there has been this support for so long."

National Society of Black Engineers (NSBE)

The National Society of Black Engineers (NSBE) is a national student-governed organization and was founded in 1975. A number of student participants cited verbatim

and from memory NSBE's mission which is "to increase the number of culturally responsible Black engineers who excel academically, succeed professionally and positively impact the community." Among student participants, 29 of the 45 (64.4%), including alums, were active members of NSBE. For both campuses NSBE is closely aligned with the MEP office with one of the staff members serving as the organization's advisor. The undergraduate and graduate students I interviewed touted the positive benefits of NSBE for its outreach and community service components, as well as the social and career networking opportunities.

The community service portions of NSBE were front and center in many participants' descriptions of the reasons why they joined NSBE. Ian, a Porter State NSBE Executive Board Member, exemplified a typical response for students with altruistic desires to expand opportunities for engineering to racial minority communities by stating, "we were able to go out into the community and help influence kids like us to pursue science and engineering type majors and things like that." NSBE members at Baldwin also cited community service as a top priority at both the chapter and national level. Vera stated:

> One thing that NSBE did this year, NSBE National, they reached out to St. Lucia and awarded I think about 25 scholarships to some students in St. Lucia to come to I want to say the University of Illinois to study engineering, and that was really big on our part to be able to fund those type of full scholarships for students, and it was really a moving moment when they showed the video and things like that and the students were there, they were hungry, they wanted to come here and

> study engineering and things like that, and so I felt like that was one of the greatest moments being [at the National Conference]

Students often cited being energized by the community service and outreach they were engaged in as being a member of NSBE. It grounded their collegiate experience to know they can help to improve minority communities while pursuing engineering.

Additionally, students feel NSBE helped create a sense of community among African American engineers and computer scientists. The successful African American students I interviewed have demanding schedules and devote hours on end to studying and completing projects. Some students even went so far as to state their academic course load is more challenging than a non-STEM student. For example, participants had to often turn down invitations to go to parties with some of their non-engineering friends. NSBE gave students comfort in seeing they were not alone and there were others who had to deal with similar endeavors. Faith explains:

> You definitely get to meet more people, and just not more people, but more people like yourself, who are going through the same struggles and to let you know that you're not alone out there, and then they really try to help you academically and to provide different resources for you.

The feelings of isolation come not only from being one of few African Americans in the engineering and computer science courses, but also some students felt isolated from other African Americans because their academic course load reduced their opportunities to engage in campus wide African American social functions. NSBE plays a critical role in counterbalancing these feelings of isolation.

Bernard was one of only a few participants to take it one step further than students like Faith. A small number of students cited NSBE serving as a positive role model as compared to their home neighborhoods. Bernard captured this sentiment as he states:

> I mean you see all the Black engineers at school, but then when you go home and see the opposite end of the spectrum a lot of young Black kids dealing drugs and getting in trouble. People I grew up with, just went to jail for murder and then when you go to NSBE stuff you can see people who are actually trying to sort of excel and be successful with their lives and engineering.

NSBE provides a platform for students like Bernard to remain focused on the task at hand, which is completing his Industrial engineering degree. Bernard and others can surround themselves in a supportive peer group with like-minded individuals who also strive to be successful engineers and computer scientists.

The more widely cited benefits of being a member of and participating in NSBE were the expansion of social networks and job placement. Elizabeth encapsulates both benefits as she describes her experience in Porter State's NSBE chapter by saying:

> I really enjoyed all the friendships that I made and all the people I met, and we have a lot of companies come to interview and they talked about useful things like interviewing, resumes, or just connecting with companies, and getting possible opportunities for internships.

Elizabeth goes on to say NSBE gives her an opportunity to branch out beyond computer science and meet other African American engineers. Other students like Charlotte, who have had the opportunity to attend one or more national NSBE conferences believe

NSBE enables them to expand their social networks beyond their respective campus. Charlotte states:

> It makes your network large, very large, because I've met people from I can't even count how many schools. But I have contact information from all over the country, so if I ever needed a job, call somebody up and be like "do you have a job in New York?" and they'd be like "oh yeah, we got this position," and I could apply for it, and I wouldn't know that if I didn't know them. But it also gives me a lot of company representatives, CEO's come to NSBE conferences, I mean you never know who you are going to run into at a NSBE event, so that makes your network a whole lot bigger than just being an engineer. The exposure is great!

A number of participants cited NSBE as the venue through which they found out about a summer internship or met a corporate representative, who helped them obtain full-time employment upon degree completion.

While NSBE helped foster community, expand social networks, provide professional development, and played an instrumental role in career placement, I did not receive any data to suggest NSBE pushed students towards graduate school. I asked an African American professor at Baldwin about encouraging students to go to graduate school and he cited some challenges associated with the differential recruiting practices at NSBE's national conferences. Professor Hall explained:

> What will happen is those students will go to NSBE conferences and so forth and Baldwin has figured out how to do this, but most schools haven't, which is go to NSBE you go up to university they have like a little booth with you know nothing

> very exciting. There is a table with cloth on it, a few brochures, a couple people saying, "why don't you stay in poverty for five more years, get a Ph.D., or you pay us some more for two more years, get more in debt for an advanced degree?" We won't tell you why that is beneficial. And yet across the aisle there is Apple. They got a cafeteria like display, you go there and drink a latte and have a computer there as well. You've got GM, Ford, and Northrop Grumman, the Air Force research laboratory has like a hologram display. So I'd tell you if you're a 20-year old kid and you're going to decide where your future is going to be, who are you going to place your bet with?

While many students cited meeting with corporate recruiters through NSBE, very few described meeting with graduate school representatives or hearing about graduate school opportunities through NSBE. Obviously, Professor Hall is not saying the graduate recruiters are actually saying the above statements, but he is suggesting this may be what prospective students take away from the conversations they have with graduate recruiters.

Summary

In this chapter, I demonstrated the number of ways students were able to find the support structures they needed to be successful. The MEP offices at Porter State and Baldwin both sponsored a Summer Bridge. Student participants felt this program helped them feel prepared academically for freshman classes, build a social network, and become familiar with the campus and its resources. Secondly, the importance of outreach as a tool for diversifying engineering and computer science programs seemed to permeate

all levels of the school of engineering and often the university as well. A large portion of the undergraduate, graduate student, faculty member, and administrator participants expressed the significance of sparking an interest in engineering and computer science to the local community prior to college and as early as elementary school. Lastly, participants praised their participation in NSBE for its outreach and community service components, as well as the social and career networking opportunities.

Chapter Six – Qualitative Findings: Race, Gender, and Interpersonal Relationships

In this chapter, I offer findings from two qualitative case studies conducted at Porter State and Baldwin Universities, which are both characterized as Top 50 producers of African Americans with baccalaureate degrees in engineering. I examine the role of race and gender and how it influences interpersonal relationships with same race faculty members, different race faculty members, fellow students, and professional colleagues.

Same Race versus Different Race Faculty Interactions

In general, Baldwin had more African American faculty than Porter State, but in some instances the African American faculty were not always affiliated with the departments with higher concentrations of African American undergraduates. Porter State had more structured opportunities to interact with faculty on an ongoing basis by assigning all engineering undergraduates a faculty advisor. Porter State has the faculty advisor practice across all of the engineering departments. Although study participants from Baldwin did not necessarily cite any specific negative faculty interactions, Baldwin participants tended to cite far fewer faculty interactions in general. On the other hand, Participants at Porter State tended to cite many more faculty interactions, which were across the spectrum of positive to negative experiences. However, most the faculty interactions at Porter State were positive or neutral.

African American Faculty in Engineering and Computer Science

Students at both Porter State and Baldwin expressed desires to see more African American professors leading their classrooms and walking the hallways of their technically-advanced engineering buildings. When asked about the racial backgrounds of their engineering instructors, most students I interviewed never took a course from an African American professor in engineering or computer science. I took this opportunity to get students' feelings on whether or not a faculty member's race makes a difference. The sentiment ranged from same race faculty could help build confidence in success to the need for having a personal connection and role a role model. Vera, who is a junior civil engineering major at Baldwin, describes the difference an African American professor would make as she states:

> It would increase my confidence to see a professor in my field, who was African American, and I'm not really expecting them to do anything different than what my other professors are doing, but just representation, that is all I need, representation of us being, you know, equal.

While Vera felt the only difference was psychological for her personally, students like Bernard, an industrial engineering at Baldwin, speculated there would probably be a more tangible difference as he expresses:

> What I hear from other students who are in aerospace or chemical engineering, they have black professors, and yes, they understand some things about people that other professors may not. Like they wouldn't be ones to judge you just by the way you dress or act and stuff, because I'm sure [African American professors]

had a bunch of friends growing up that were just like that who may not necessarily acted the way you perceive them to be, but I guess they never affected me personally just because I never had one.

Students at Porter State shared similar feeling as Vera and Bernard. Charlotte, who is a computer engineer major at Porter State, believes African American faculty would better understand her experiences. Charlotte asserts:

> I've only ever had one minority professor and he is from like India. So it, as an African American student it's somewhat not discouraging, but it's kind of like man, we have all these Caucasian professors, and I mean no one to relate to us, no one that I can go to and be like you got through it, I can get through it too. Just seeing that face would mean a lot to me.

Drawing from a specific experience Nathan, who is an electrical engineer at Porter State, contends:

> [African American faculty] are able to put things in a certain perspective. For example, the peer mentor program that is mostly for minorities, so the faculty for that were able to help us transition. They were there outside their [normal] jobs and are there for concerns. We had personal relationships, you know, with some of the faculty. They are motivators because in all actuality, and this is the truth, I guess you are more to a certain degree, even though like seeing that you love people of all races definitely, but you're probably more likely to model yourself after someone of your own race. Or you are more likely to look up to, or see that person as a mentor.

Charlotte and Nathan's feelings were representative of a strong desire to have what Porter State's Dean of the School of Engineering referred to as "existence proof." Dean Gutierrez explains, "everybody needs existence proof, right, it's more than a role model, it's an existence proof that you can look and say "hmm, this is somebody like me and look where they are, I can be there."

Even though African American engineering and computer science faculty are small in number, there were only a few examples of study participants who developed meaningful relationships with African American faculty members. A key example from Baldwin are from the experiences of Eli and Vera, both cited Dr. Eaton. Eli is a senior civil engineering major and is a participant in a program allowing him to receive a master's degree with some additional course work. Eli describes how he developed his relationship with Dr. Eaton:

> [Dr. Eaton] was a really good professor, kind of one of those professors that go, you know, above and beyond. You know, this professor, you can stop by her office outside of office hours times to get help with stuff, and just talk. So, [Dr. Eaton] is one of those really good professors; seemed like she really cares and I think after a course I took with her our relationship kind of, you know, sparked and that is when we were, you know, talking more and more.

After developing a positive relationship, Eli explains how Dr. Eaton approached him about the opportunity to complete a Master's degree in civil engineering:

> [Dr. Eaton] actually, at one of our award ceremonies for grades and things like that, [Dr. Eaton] pulled me aside and was like "hey what are you planning on for

> grad school?" and things like that, and that was the first time somebody ever talked to me about that or about me doing grad school, so yeah from then I said yeah ok sure I'll apply and check it out and see how it goes.

I followed up this statement by asking Eli whether or not he previously planned to apply to graduate school and he said, "No, I honestly think I would have got a job." Professor Eaton's recognition of Eli's talent and encouragement of graduate studies provides a solid example of how African American faculty may be able to push African Americans to expand their horizons and to prompt these students to achieve even more than they think may be possible for themselves.

Fortunately, I had a chance to talk with Dr. Eaton and ask about relationships with African American undergraduates in engineering. A significant portion of Professor Eaton's career has been to expanding the pipeline for students of color and women. Dr. Eaton has considerable contact with undergraduates through a faculty advisor role and instructor for required engineering courses. In our conversation, we discussed some of the challenges facing underrepresented students and Professor Eaton drew on her own experiences. Dr. Eaton knows what it feels like to be one of few African Americans in an engineering course. I asked Professor Eaton how this experience influences interactions with African Americans. Dr. Eaton replies:

> It depends, I've got one woman in my class right now, [Vera], who wrote an article that was in the last issue of NSBE [magazine] and you know I told her, "I know you are doing an awful lot. You have cut out a lot for yourself to do, so if you need an extension on a homework, you know, let me know because I know

> you are working, it's not like you're blowing me off." So, you know, sometimes I will do something like that. I also have another student who did not do well in [my class]...I called her in, and I said you need to pick it up because I know you are a senior and you need to graduate. You can't afford to get a D in this class, so you need to pick it up, and instead of picking it up, it went this way [Dr. Eaton did a downward motion with her hand]. So at the end of the semester, I called her in again, and I said I'm giving you an incomplete and you need to repeat the second half of the course.

Professor Eaton took the initiative and called students in to her office when they were in trouble or offered guidance on time management and stress reduction. Furthermore, Dr. Eaton encouraged an African American male to obtain a Master's degree in engineering, who, from his own admission, would probably have not otherwise pursued graduate education. Although these are only a few recent and specific examples, it is clear, Professor Eaton's career has been spent positively influencing the academic trajectories of countless African American, other racial minority populations, and women engineers.

Unfortunately, Dr. Eaton does not feel these efforts have necessarily been rewarded by Baldwin University. Although fully tenured, Professor Eaton denied promotion due to not having "enough publications and research funding." Dr. Eaton counters this claim by mentioning the number of ways the service provided to the university and the School of Engineering has improved the diversity, espoused to be important, at Baldwin. Dr. Eaton exclaims:

> I mean it's become you know abundantly clear yet again, because I mean as part of my casebook, I pointed out that because of the work I've done the enrollment of women has gone from, in our Ph.D. program, 20% to 60%, this coming year because of what I was doing. We will have doubled the URM enrollment in our Ph.D. program. I can go on! When I was the undergraduate program advisor our graduation rate went from 80% to 92%, you know. I can go on! But it's just kind of like, "ok, and how much money did you bring in last year, and how many publications did you write last year?" We really need to look at what the college mission is and the college mission does not say "we are a research institution out to maximize our profit" but that is the feeling that you get some days on campus.

Dr. Eaton does not believe the school of engineering values service activities suggesting there is a shift in the mission of the school towards increasing university prestige through the research enterprise and not on serving undergraduates.

Porter State has far fewer African American faculty members than Baldwin and there were only few instances of African American students who were able to develop meaningful relationships with African American faculty members. One example is Ruby, a senior industrial engineering major, who developed a relationship with Dr. Kristin Jackson. Ruby described Dr. Jackson by stating:

> She is really passionate about what she does. So yeah, I really like her. She is the only African American woman in our department. Most of the time with her, like, when I have a course I would go in and get help with the coursework, but we'd also just, you know, talk. I can't really say it was any kind of advice or, I don't

know, it was just talk about random things I guess. But it was good that we could have conversations as well as get help, so…I can't speak for everybody, but I always like to see successful people that look like me.

Drs. Eaton's and Jackson's racial identities seemed to garner a certain level of approachability with the students they work with. The simple things like connecting with a faculty on topics outside of engineering (in the case of Ruby and Dr. Jackson) or getting the extra push to get through difficult material (in the case of Dr. Eaton) all seemed to demonstrate the value of African American professors in engineering and computer science.

Positive Interactions with Faculty from a Different Racial Background

Although the desire for, and benefits of, African American faculty members in engineering and computer science are compelling, the reality is there are currently very few African American engineering faculty and small numbers of African Americans receiving Ph.D.'s in engineering and computer science. There is a strong need to expand the pipeline of African Americans who pursue the Ph.D. in engineering fields. The current engineering faculty, who are not necessarily African American, will ultimately help to drive this expansion.

A majority of the students reported generally neutral to positive interactions with faculty members in engineering or computer science, but they did not necessarily develop a personal relationship with particular professors. However, I did find considerably more examples of mentorship and encouragement derived from faculty members with different

racial backgrounds as compared to the same race faculty theme[7]. The first example is Dr. Yang an Asian professor at Porter State, who was cited by Gabriel, Damien, and Ethan as being very supportive of their respective academic careers. Even more interesting was Dr. Yang reached out to these students, who did not even take one of his courses. Gabriel explains, "Yeah he actually reaches out to a lot of the minority engineers and asks them to come do research for him. I see him as a mentor for minority engineers, and he's helped me out a lot." When probed about specifics of Dr. Yang's support Gabriel states:

> I've gone to, like a workshop at the [Food Drug Administration] with him, there was a workshop on medical devices and he just asked me if I wanted to go, so I went there with him. He helped me write my statement of purpose for grad school, he's written recommendations for research programs and for grad school.

Ethan had similarly high praise of Dr. Yang, who helped him get a summer internship. Ethan describes his relationship with Dr. Yang:

> He just wants everybody to succeed, and he really acts on it. When I first got here he took me out to eat and asked me about my background, my experiences, where I saw myself in the near future and distant future. Then he mentally writes everything down, and is like "ok he said he wanted to do this as a freshman, so how close is he to his goal?" Then we'll just go back and forth he provides undergraduate research for different students. He is willing to, he is just accessible, I have his house number and his mobile number.

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[7] There are often only a couple of African American faculty members in any given engineering department out of 20-40 faculty members.

Similar to the African American faculty members Dr. Jackson and Dr. Eaton, Dr. Yang went out of his way to ensure the success of these three African American men.

I had a chance to ask Dr. Yang about why he reaches out to African American engineers and he explained the importance of racial diversity. He believes diverse perspectives help him to produce better research. He understands the challenges African American students face and looks for ways to expand their opportunities and network. Surprisingly, Dr. Yang believes Porter State gives him tremendous support to continue to mentor racial minority students. Unlike, Dr. Eaton, he cited favorable feedback on his tenure case and financial support to hire undergraduate research assistants.

There was another faculty member at Porter State, Dr. Mary Conway, who had multiple students cite her as being very supportive of their academic success. Chloe, Jayden, and Olivia all described how Dr. Conway, a White woman, knew them by name and often gave them words of encouragement. Olivia is a recent alum of Porter State and is currently working for an engineering consulting firm. Olivia described her relationship with Professor Conway by stating:

> I mean the one person that I just definitely think is an amazing faculty member is Dr. Mary Conway. She wasn't my advisor, but I told her I wanted her to be my advisor and so she worked that out so that she would be my advisor. She would, you know, email you anytime there was a new job opening, and she would really be there. She really wanted what was best for the students and she would just go out of her way to just really try and like, "oh there is this interview on campus." That is how I got my job now. I got a random email from her saying "[An

> Engineering Consulting Firm] has an interview tomorrow, sign up by [blank]" and I was like "oh it's [near Porter State] oh that'd be great!" I had never heard of it, went to look it up, ok sounds good, let me go to the interview, and I mean I know there is a lot of different colleges that don't have someone like that, and you're missing out, I mean she was a great resource.

Chloe and Jayden both shared similar stories about Professor Conway helping them to find internships, how they felt a personal connection to her, and Chloe and Jayden were impressed by Dr. Conway for learning their names and taking an interest in their success.

I took the opportunity to talk with Dr. Conway about her experiences working with African American engineers. I was curious to know why she took the time to learn her students name. First she described her technique:

> The first class that I taught last semester, I had 120 people, so I took pictures of each person holding their name on a name card, and I studied those pictures, and the next day I tried to call each person by name, and usually I'd get them all, but I might miss one or two, out of 120.

Then she stressed the importance of learning names in her education philosophy:

> It sends a clear message, "I hope, you know I want to get to know you, I'm going to make an effort to learn your name, it's important that you be here." If I see that someone has missed, I don't take attendance, but I can usually tell someone doesn't pick up their homework, or if they miss a day or two I'll email them and say "hey, I've been missing you in class just wanted to check in and make sure things are going ok." I think if students know that you know, there is an

individual accountability, and I don't want anyone to disappear, and have no one even ask about them or even notice they weren't there.

Professor Conway goes on to express how she approaches her faculty advisor responsibilities by stating:

> Our curriculum is very prescriptive, I mean they take thermo 1, thermo 2, but the value that the advisor adds is just being that human connection point of someone actually has an interest in you. Some students really latch on to that offer to develop a relationship, and other students are like "no, I'm good" you know, don't really need that, and you know that's ok, I'm not going to force anyone to you know but, I think if you put it out there they know they have the option.

Clearly, a number of African American women have taken her up on her offer to develop a relationship.

As I was sitting in Dr. Conway's office, I could not help but notice the pictures on her wall. She had a picture frame, which held roughly eight to ten 4x6 photographs. Professor Conway had a frame for each year she has been at Porter State (10 total). As our interview concluded, I asked her about the racially diverse array of students photographed in their graduation regalia. She described the photos to me and she pointed out all the African American students; she told me their names, where they were in graduate school, or where they were currently working. She explained that she stays in contact with as many people as possible through social networking tools like Facebook. I was blown away by this presentation of photographs because I could sense her genuine sincerity.

The final example from Porter State comes from Kaleb, who described receiving support from two male faculty members one was Asian and another was White. Kaleb is a recent alum of Porter State and received a bachelor's degree in civil engineering. He is a Ph.D. student in civil engineering at Porter State and he partially attributes the motivation to pursue a doctoral degree from inspirational speeches of an older White faculty member. Kaleb described his interaction by stating:

> I would go to ask him a question about a problem and he would always end up giving me these speeches about my potential, you know you have potential to do this. He found out eventually I was interested in graduate school and he was like "well there are not a lot of minority professors" and it's true there aren't, and he would always give me these speeches about the impact that [I] can have if [I] were to go into this. I respected him because I know his heart was in the right place. That was something that I hadn't thought about. It wasn't something that coming into college I said "you know I'm going to get a Ph.D." I was like, "I'm going to get my 4 year degree and I'm going to go get a job" kind of going the path everybody always takes.

As a true testament to this White male professor's determination to get Kaleb on the faculty tenure track path, the professor continued to motivate Kaleb once he began his doctoral studies. Kaleb describes the professor's continued motivation by stating:

> I saw him two or three weeks ago, and he told me about this program Bridge to the Professoriate, or something of that nature, and he was just the same in the hallway. He stopped me in the hallway and asked me "well are you in the

> preparing for the professoriate program yet?' and I was like "no, I don't know about that" and he was like, "Well let me get your information" and you know I think in his case, it's one thing to give someone a message, but he's good about following up, and over the course of the years he has kind of shown that interest. Over time, I started to understand the intent of it, and he is a pretty cool guy and he is good at that, not just the kind of guy that I thought would ever mentor me.

Although not sharing a similar racial background as Kaleb, this White male professor took the time to encourage Kaleb to not only go to graduate school, but to obtain the highest degree awarded in engineering. In addition, the White male professor recognized the unique contribution Kaleb could make in aspiring other African American students to pursue engineering and an academic career path. Kaleb's experience gives a deeper insight in the lasting impact faculty from different races may have on African Americans in engineering.

Negative Interactions with Faculty from a Different Racial Background

Regrettably, not all study participants had neutral or positive relationships with some of the professors they encountered. A few students like Ian, a senior biomedical engineering major at Porter State, presented more discrepant data through citing negative experiences and their feelings of being treated differently. Ian captures this sentiment when he states the following:

> I think the biggest challenge is sometimes I don't feel like the help from the professors is the same. When I was younger I thought it probably is because of my race, but I was more I guess more upset about it. But then as I got older and

> started thinking, I think sometimes they just probably like to help people who are more like themselves, and that's probably why they help white kids and things like that. [long pause] But that was the major thing like going to office hours I didn't feel like I got the same quality of help sometimes from those professors. so I had to seek different avenues to figure out how to understand the work to get my work done, so it wasn't as easy for me to excel in those classes.

The students who mentioned feelings like this tended to generalize this experience to all faculty members and seemed to express hesitancy with approaching faculty for assistance in the future. This example shows the negative impact a few bad experiences may have for a highly successful African American engineering student like Ian, who has maintained nearly a 3.4 college GPA. Also, these negative episodes may cause students to retreat and close themselves off from faculty who would like to be supportive like Dr. Mary Conway.

Although a few students like Ian only cited generally negative experience with faculty, other students cited very specific examples of mistreatment by faculty from a different racial background. There was one faculty member in particular at Porter State, who was cited by Nathan, Isabella, and Charlotte as an example of a non-supportive faculty member. I have come to think of this professor as an anti-Dr. Conway. Charlotte, a junior computer engineering major with a 3.1 GPA, described how there was a shared belief among racial minorities about their mistreatment:

> I don't know, because I don't think everyone in the undergrad department gets the same treatment. I don't really hear too many Caucasians complaining about

> [Professor's] advising, or just how [this professor] treats them and talks to them. Like I've had peers, not even just African American peers, but from the Middle East to say that [Professor] has talked down to them, or said they can't do it. And everyone believes an advisor should be encouraging. I've had a couple of students that ["you can't do it"] has been said to them, and as an advisor I feel like if anything you should be encouraging students to stick to it.

Charlotte brings up a great point because as scholars and practitioners we assume, to a certain extent, faculty interactions are positive and encouraging.

Isabella, who is also a junior computer engineering major, described a much more personal account of the blatant mistreatment of this White faculty member. Isabella had a double dose of this professor as a faculty advisor and course instructor. Isabella describes her encounter by stating:

> I was taking her course and I ended up getting a D+, I've never got a D in my life, but I did and I went to the talk to her about it. She never told me how many points away I was, she wouldn't tell me the details, she wouldn't let me see my test or anything. I was really upset, and she knows I was on scholarship and it was like she wanted my scholarship to be taken from me. So I was talking to her about it, and she was like, "well you're going to lose your scholarship anyways because you don't have a 3.5." I explained to her that me and my father have talked to the scholarship representatives and they told me as long as I keep a 3.0 I'm fine, but she was automatically like nixing it, like, "you're not going to get your scholarship anyway so it doesn't really matter." and she was like, "you can afford

it it's only $20,000 a year." Like blatant stuff like that she has said to me. So I was just like wow, this is really knocking me down!

Unlike, Dr. Mary Conway, the White professor described by Isabella does not appear to be very interested in the success of African American students. This professor's actions are alarming because she was discouraging of students with GPAs well over a 3.0.

African American Women in Engineering and Computer Science

In the quantitative phase of this study, I found the gendered effects of being a woman does not statistically predict whether an African American student who entered college with the intention of majoring in an engineering or computer science completed a degree in this field. In light of this finding appearing to contradict previously published research, I made sure to inquire about the specific experiences of being an African American woman in engineering with the 19 current and alumni women I interviewed.

I initially asked participants to recall their own college pathways to think of pitfalls for women interested in engineering. A majority of the participants described some of the early educational experiences dissuading women from pursuing highly technical fields like engineering and computer science and others described a lack of familiarity with the engineering field. Avery, who has maintained a 3.0 GPA at Porter State, captures this sentiment by stating:

> I feel like there are a lot of things in engineering that deter women away. It's a lot of do it yourself type of work, a lot of to yourself type of thinking. Then I think it can be intimidating too. I think people talk about it like it's really bad, it's really hard, and a lot of women probably do probably get intimidated and they know

there isn't a lot of women in it, so that again discourages it, almost like it's a cycle. Because if I didn't find industrial engineering in high school, and if I didn't particularly seek that out, I don't know that I would have pursued any other type of engineering, because when I look at the other types of engineering I don't want to do any of them.

Avery points out how a precollege introduction to industrial engineering opened her outlook on the engineering field. Unfortunately, more women are not able to participate in these inspiring precollege programs. Another example comes from Elizabeth, who is a computer science major at Porter State and has maintained a 3.7 GPA. Elizabeth elaborates a little further on some of the specific images presented about engineering by stating:

> When I think of engineering before I actually knew everything that it entailed I thought about bridges and building bridges or working with machines, or and I mean that is just how I thought of engineering before I got to Porter State and realized all the different types of engineering that there are. I think a lot of women look at that and you know they kind of think building bridges or working with machines that's more of a guy's job. So, if you don't really know everything that engineering entails then I mean you will look at it that way, and you'll probably go for something else.

Although considerable progress has been made in terms of equal rights and opportunities for women, Elizabeth's notions of gender occupational roles are still being projected towards highly capable girls and women. Although these generalized notions and

gendered roles permeate our society, many women in the study described ways these views were repudiated through familial support and the support from meaningful others like high school teachers and counselors.

In focusing specifically on the undergraduate experiences, there were clear intersections of race and gender with some attributing differential treatment to them being African American, others attributed it to being a woman, and some attributing it to both. The first example comes from Faith, who provided an account of a group project, which she presented in class the day before our interview. Faith voiced her concern about her role in the group presentation:

> I am on a senior design team where we have 6 people. We have the biggest group and I'm the only girl on the team. Four of us put in a lot of effort into the project and the other two not so much. We had our final presentations to the class yesterday and the way that we divided up the parts I ended up with the very last section, which ultimately happened to be the smallest section. The first section was one of the longer sections and they gave it to one individual who is not the best public speaker on the team, but long story short, the presentation ran over, and so by the time it got to my part I had to rush it, and basically summarize it in 2 minutes. Afterwards, I just felt I really wish that didn't happen because even though the presentation as a whole went well, I feel like I made myself look like the typical girl role, having the least amount of work giving the smallest part of the presentation at the end. It really hurt me that I didn't stand up for myself earlier and say no, give me more to do.

I could tell this situation really bothered Faith because she wanted to demonstrate not only her mastery of the course concepts, but she wanted to show she belongs in this field. Faith has maintained a 3.19 GPA as an industrial engineer at Baldwin and is as fully capable as the men in her group project. Faith's narrative when taken as an isolated incident may to some seem trivial, but her story speaks to the cumulative impact of these types of incidents occurring again and again.

Other participants had different experiences in working in predominantly male groups. For example, women like Sofie, a chemical engineering major at Baldwin, took charge in group settings. When asked if her male peers treated her differently, she exclaims:

> Definitely not, no! For some reason, I always seem like I end up taking more charge because the guys are so laid back, so I'm the one like we're going to do this or something like that. I don't know if it's to make sure they don't treat me like just a girl, I don't know, but yeah I have never had a problem.

More often than not, Sofie's response was more typical for the women undergraduates because a number of participants did not feel they were treated differently because they were women. Although these two examples are seemingly contradictory, the experiences of Faith and Sofie both demonstrate how women engineers have to be aware of the dynamics in the classroom setting and in working with their male peers. One could argue Sofie was, in fact, being mistreated because the men in her group enticed her to take on a considerable load and yet they reaped the benefit of the group's success. In essence, the men exploited Sofie's talent by playing into her fear of being labeled in a gendered way.

Additionally, men in engineering never have to question whether they are being treated differently because of their gender.

Although, for the most part, women felt as though they were treated fairly, insights from women who have moved beyond the undergraduate experience have different perspectives. As undergraduates, the women participants work with men on group projects and in labs, but the men are in the same age group as the women. Additionally, these men may have been socialized a bit more progressively regarding gendered roles than their previous generation counterparts. Olivia is a recent alum who received a bachelor's degree in Chemical Engineering with a 3.24 GPA and she is one of two women engineers, and one of two African American engineers at her engineering consulting firm. She contrasts the differences between collegiate and professional life as a women engineer:

> I don't think there were that many prejudices as much in school that I can think of, I mean it's noticeable now, but no, I don't think so, especially because you kind of go with the same group of people throughout your four years, so you know they've worked with you before. The hardest challenge is now I mean I'm in an engineering consulting company, our median age is 55 in my company and they are mostly men.

Olivia believes the differences she has experienced are attributed to her being a women and not her being African American. She states:

> People are not saying "oh she's black [*gagging sound effect*]" they say "oh she is a women she might not know her stuff" especially "she is young" and in this

> industry she doesn't really know anything. So you can't let them see you weak, and if you don't know anything you have to ask in a knowledgeable fashion, you know you cannot come off as not knowing what you're doing because they'll judge you because they are already judging you. So, you just have to hold your head up, you have to hold yourself to a higher standard, you have to be more careful, be careful of what you say, careful of what you do.

Not only does Olivia have to worry about her perception when working with her professional colleagues, but she also has to deal with blatantly sexist issues working with the clients for whom her company consults. Olivia gives an example of being assumed to be a secretary as she explains:

> In my job if we have lunch with a client or the vendor will come in and since we buy all of our equipment from the vendor's for the clients they are obviously coming in a lot, and they automatically think that you're an administrator, or administrative assistant, and you're like "no I'm a process engineer, I'm in the process department" and they're a little shocked. I go to the mill and they see me and "oh what does she do, what is she here for?" and they'll dismiss my abilities.

Olivia has been very frustrated that she has to deal with these types of issues on an ongoing basis. I asked Olivia how this has impacted her and she described her discontent by stating:

> You have to stand out, and you have to, I think it's definitely possible, but I think you're going to have to work harder than anyone else is, because you have to first become an equal, let's be honest, in their eyes, you have to work to become an

equal and then you have to work to succeed, so I think you are going to have to work harder.

Olivia's story gives insight into some of the unforeseen challenges facing the current women undergraduates. Although some female participants are not currently having challenges with being a woman in engineering, they may be extremely shocked when they enter the workforce and have to deal with predominantly older White male colleagues.

Summary

Students at both Porter State and Baldwin expressed desires to see more African American professors. When asked about the racial backgrounds of their engineering instructors, most students never took a course from an African American professor in engineering or computer science. Participants believed same race faculty could help build confidence in success to the need for having a personal connection and role a role model. The simple things like connecting with a faculty on topics outside of engineering or getting the extra push to get through difficult material all seemed to demonstrate the value of African American professors in engineering and computer science.

Conversely, I found considerably more examples of mentorship and encouragement derived from faculty members with different racial backgrounds as compared to the same race faculty. The faculty from different races served in a proxy role for students by providing similar mentoring and support as a same race faculty member.

Lastly, for the most part, women felt as though they were treated fairly by male professors and male students in group settings. However, the undergraduate women may not be aware of how picking up the slack for "laid back" men is actually a mistreatment. I gained key insights from women who have moved beyond the undergraduate experience. Although some female participants are not currently having challenges with being a woman in engineering, they may be extremely shocked when they enter the workforce and have to deal with predominantly older White male colleagues.

Chapter Seven – Qualitative Findings: Engineering Successful Outcomes

In this chapter, I offer findings from two qualitative case studies conducted at Porter State and Baldwin Universities, which are both characterized as Top 50 producers of African Americans with baccalaureate degrees in engineering. I focus on how students overcame their challenges and strategies utilized for success. I conclude this chapter with an examination of participants' immediate plans after completing an undergraduate degree in engineering, which include pursuing an advanced degree or beginning a professional career in industry.

Challenges and Successes

Even Successful Students Have Challenges

Although the Porter State student participants collectively maintained a 3.27 GPA and the Baldwin student participants combined to sustain a 3.4 GPA they still had to overcome many challenges. Although there were a number of unique challenges, there were two main themes, which emerged as the most salient challenges for the African American engineers, and computer scientists, which are academic and psychosocial challenges.

First, a number of students discussed the differences between their high school and university level work. A majority of the student participants were one of the top graduates from their high school and a number of them cited having very little trouble

making A's in high school. However, the same work ethic and study habits did not necessarily garner the same success it did in high school. Layla characterizes this experience succinctly as she states:

> I never really struggled in high school. I graduated like 3rd in my class. Studying was optional to some extent. I took all these AP classes and things. I was like, "I aced calculus all through high school, I'll just jump right into Calc 3 and it'll be a breeze." And that was like when I hit the wall and I got like a D on my first calculus test, and I was like, "this isn't supposed to happen? I studied for 2 or 3 hours, what in the world?" So to get that A- on a test, I put in like 9 hours, you know, so that was I think the biggest thing, just like getting adjusted to how I was supposed to study.

While some students would have folded when they received a D on a mid-term, students like Layla regrouped and reevaluated their commitments and efforts.

Other students had challenges adjusting to thinking like an engineer; Students had to problem solve and think critically. In high school and perhaps in non-engineering college courses, students found success in rote memorization or just figuring out what the right answer was based on a formulaic response pattern. Charlotte explains:

> I think that engineering the biggest challenge I had to overcome was the context within the classes I guess. Because you know typically you can adjust to English class or math class, no matter the difficulty you can eventually adjust. The thinking process you have to have in engineering classes are completely different than math, because a lot of engineering classes are conceptual, whereas math is

> just hard facts, x plus y equals whatever. There is always a right or wrong answer. Then engineering, there really isn't, so to speak. There are so many different ways to do things, and you know one person may be thinking differently than the other, but both your answers can be correct.

Students like Charlotte had to retrain their brain to tackle the challenges presented to engineers and develop their problem solving and critical thinking skills.

For the most part, student participants who were engineering majors described fairly collaborative environments with a number of group projects. However, this was not the case for computer scientists, who often had to contend with very competitive environments where you have to "beat" your classmates. Ethan explains:

> One of my main struggles I've had in computer science is competitive, but it's not like a friendly competitiveness, so a lot of people are not pushing you to do better they're pushing you so that they can beat you and then if you don't do well it's like, ok yes I beat him or my program ran faster. So me that was a problem I wasn't used to that. I played sports in high school and I wanted you to do good, and I want this person to do good, kind of like a team sport, but to get to college and be in a major where everything is just hey you know, beat your opponent or you know run a better internship than your opponent it was just definitely a change for me, so I wasn't actually used to that.

When asked how he was able to overcome this challenge Ethan said he received tremendous support from his mentor Dr. Yang. Ethan was fortunate to have someone to support him through this immensely competitive environment.

Secondly, feelings of isolation seemed to pervade quite a few student participants. Students often cited the psychological toll of being one of few African Americans in their engineering and computer science courses. Students who came from predominantly African American neighborhoods and high schools seemed to have a far more difficult time adjusting to the predominantly White environments of Porter State and Baldwin Universities. Grace captures this tribulation by stating:

> Well, I would have to say one of the biggest challenges would be to come to class and be like ok, there is definitely like two other Black people in this like 120 people class. And so it used to be like you were very, it's very obvious to you at that moment that you're a minority, so it might be a little discouraging, especially if like, for predominantly most of your life you've only associated with people who are African American, to like talk to or having to relate to other people because you cannot pass classes unless you talk to other people and figure out how to do homework together or get things done together.

A compelling example of how the feelings of isolation impacts students comes from Ian who shares his feelings about the difficulty he had in overcoming family challenges back home.

> Also, I guess, a good example is when I started having trouble at home, my grades started slipping and things like that, and in biomedical engineering there is only I think 50 students in a class, my class. Two Black, one is a Black girl and then myself. And, no one including the teachers there like sought me out to say, "hey

Ian what's going on? Are there any problems going on, anything at home?" They just, I guess took me as a slacker and someone who didn't want to do his work.

Ian felt isolated and had trouble finding the support he needed from someone who might show interest in his well being.

I asked Kaleb, "How have you been able to overcome the challenges that arise?" He replied:

> The word "can't" is what separates, you know it's a mentality, with engineering everybody runs into a course that is going to crush them, I like to think I don't know anybody who hasn't run into a course or two that absolutely demolished them. I think that is what somewhat separates, if you let it break your confidence it will crush you.

I believe Kaleb's response rings true for practically all of the participants. The African American engineers and computer scientists I interviewed never let the word "can't" permeate their thought processes. They never quit no matter how grave the circumstances.

How Students Succeed

Despite the many challenges these extraordinary young African Americans faced, they found a way to overcome adversity and achieve the goals they set for themselves. Although researchers have found the numerous ways students fail in STEM fields (e.g., Seymour and Hewitt, 1997), the students who participated in this study found a number of ways to succeed despite all that we know to be stacked against them. Clearly, students were successful in part because of a number of the programs provided by the respective

MEP offices, but this section focuses specifically on things outside the MEP office. The most commonly cited success strategies include developing mental toughness and confidence, finding ways to self-motivate, and relying on support structures.

The African American participants at both Baldwin and Porter State had to develop both a mental toughness and confidence to overcome both academic and social challenges. From the academic side, Charlotte, who has maintained a 3.14 GPA in computer engineering at Porter State, personifies the participants who had to develop a mental toughness to sacrifice in order to ensure she put enough time into studying. Charlotte explains:

> I just learned how to manage my time a little bit better and I understood that I would have to sacrifice some things that I didn't have to in the past. Whether it be sleep, or eating, or not hanging out on the weekends, I just had to come to grips with those were the kind of things I'd have to sacrifice to do the things I wanted to do. To still stay active and still do well in my coursework.

Charlotte goes on to expound upon how she rationalized these personal sacrifices by saying:

> I always found that I don't know, something in my mind is always like, well, this will pass, and if you overcome it then all the benefits you will receive will be greater than the stress that you are going through now. It's just that peace in my mind like, you can get through it. I find that some people don't have the patience to find that within themselves.

A number of student participants found this strength from spiritual forces and/or their faith in God and Jesus Christ. The students who cited faith-based support often cited being involved in campus ministries and other religious-based student organizations.

While a number of students found success through mental toughness related to academic challenges, other participants used this cognitive durability to overcome social challenges. Layla, a biomedical engineering major with a 3.25 GPA at Porter State, epitomizes other participants' feelings toward overcoming any social stigmas placed on them by their White counterparts. Layla describes this process by stating:

> I mean, I've heard it all from, having a full ride scholarships, "oh it's because you're Black. You know you're a Black female so you're a double minority and you want to go into engineering or medicine which are male predominant fields," So you know just as I progress it's just become one of those things that you just kind of take with a grain of salt and you have to know that you're qualified to be where you are. And that just because you might have had a little extra help on the other side of things, you still had to put in the just as much work in the classroom if not more by being involved in these extra programs.

Through legal action, neither Porter State nor Baldwin enacted Affirmative Action admissions policies. All the African American students, who were admitted to either university, got there based on their individual academic merits. However, participants still had to overcome racist remarks by maintaining confidence in their own abilities.

Another success strategy, which emerged among the African American male participants, was a self-motivation to not go back to the poverty-stricken neighborhoods

they grew up in. The African American men cited this fear of failure and being forced to return to their old neighborhoods as a self-motivator. Eli, a civil engineering major with a 3.6 GPA at Baldwin, captures this sentiment by stating:

> My biggest motivation is you know if this doesn't work, then I really don't have any other you know options, like if I go back, if I fail here at Baldwin, and I go back to [the neighborhood], and I feel like you know it's not really much I can do, so that kind of helps me when I say you know if I'm going to stay home tonight, or am I going to go out, you know, it's like a no brainer when you think about it like that, like I'd rather not go back to nothing, so I think that is one of my motivations right here.

While most of the men responded with a more general notion of not wanting to return back home, Kaleb, a Ph.D. student in civil engineering, cited specific experiences, which gives him such conviction in his unwillingness to go back to his old neighborhood. Kaleb asserted:

> I can't go back home. I can't be that guy, you know. When I would go home for Christmas break and I would see my friends and they would be back home, you know, went here, now they're back at home and I couldn't be that guy. My motivation was more so that, and I just couldn't let anybody, I had friends that you know we all had fun, and we go out and some of our friends chose not to study and if they were going somewhere and I had to study, you know, sometimes I would go, but it was never when I had to study, I knew when I had to set off the limits.

Kaleb went on to say:

> I'm not going to fail out and go back to [the neighborhood], because there is nothing for me in [the neighborhood] but drugs and disappointment, so it's not going to happen, so you know. I think you need to be scared of going home, and for me I didn't want to go back to [the neighborhood], still don't want to go back to [the neighborhood]!

This type of self-motivation seemed to work well for the men who employed it. Street violence, drug abuse, and all around poverty were many male participants motivations to see the bigger picture and to continue to strive for success although it may not be the easy choice.

Lastly, students found success through the support they received via their social networks. These support structures help students fight feelings of isolation and depression to know others are right there to support them. Michael, an electrical engineering major with a 3.8 GPA at Baldwin, explains what the personal support means to him by stating:

> The support network where a couple of my friends and the people in my classes, there are like four or five other people in my classes every semester, that I classes with and it, you know, we help each other out and we study together. If there is like a problem, I might ask them a question they can come to me too. I never really feel like I'm going through this alone, so I think that is something that has really helped me.

On the other hand, Vera, a civil engineer with a 3.35 GPA at Baldwin, tried to go at it alone and although she found academic success, she also found personal anguish. Vera explains:

> The support system, I know I can't do it all on my own, I tried my freshman year and although I got a 3.7 I was depressed, so I was like you know I'm going to shift my focus and not try to study all the time, and just focus on what I'm learning the material, and things of that nature, and not worry so much about the GPA, but the GPA still came with that, so which worked out really well because at first I was just focusing on the GPA and I got to the GPA but nothing else came along with that, so I shifted my focus and it worked out.

Some students cited similar experiences as Vera where they started out thinking they could do it all on their own and then they realized it was virtually impossible to do so. These participants turned to their social networks for support.

Post Baccalaureate Decisions: Graduate School versus Industry

Internships in Industry

Engaging in an internship with a corporate industry organization was a key component in the experiences of many of the students I interviewed. The Baldwin Success program practically guarantees participants an internship or research experience after their first year. Typically these experiences are not available until after the second year because students have not quite delved into major specific courses by the end of their first year. Both Porter State and Baldwin maintained mutually beneficial

relationships with their corporate sponsors. Corporate sponsors support a number of the MEP programs and the sponsors were seemingly first in line to offer internships to highly successful MEP students. The students I interviewed cited a number of positive outcomes associated with their respective corporate internship. Study participants were introduced to corporate life, were given opportunities to move across the country and in a few cases across the world, and students were able to ascertain a clearer view of their academic and/or career interests.

First, a number of students described the difference in being an undergraduate and being a professional. Students relished the fact they had their own desk or they were the lead on a project. Bernard describes how his internship helped him realize the difference between the corporate world and his collegiate experience. Bernard explains:

> I never been in an actual real sort of corporate environment, all the jobs that I've had were working with people my own age, so working with people sixty years old, who are thinking about retirement, and then working with me 19 years old, it is just sort of interesting.

The thing surprising me most about these internships were they were typically 12 week experiences, the company paid for them to relocate (in almost every case with the exception of Faith), paid for their housing expenses, and paid them a healthy salary. Many students described their ability to put money into a savings account because their only expenses were food and entertainment. Additionally, students were not just put in an office and asked to make photocopies or answer the phone. The interns conducted

engineering duties like process improvements, making calculations, doing software verification, project management, and other highly involved activities.

As a result of engaging in the work of engineering professionals, many students' internships influenced their decisions to stick with a particular major or to switch to a different engineering major or even add a minor. Student participants like Avery were highly engaged in their internships and they were able to apply concepts they were learning in their engineering or computer science courses. Avery gives a clear explanation as to why this was important by stating:

> Actually I think it was the most influential factor in really knowing what I'm getting myself into. You know because when I took this internship I hadn't really been doing that many [Industrial Engineering] classes yet because I'm just coming off my sophomore year and so you know, I'm not exactly sure what I'm getting myself into, so it kind of was just like "this is what it's like in real life." Then it's funny when I got done and I really got into my core [Industrial Engineering] classes, all this stuff that I did and I saw the industrial engineer there do. I see it again in my schoolwork, so I'm like "oh they really use this stuff."

The types of connections Avery made play an important role in students recognizing the utility in their course concepts. Other students' internships influenced both their academic and career interests. For example, Ethan explains his change of heart regarding computer science and programming:

> After meeting different professionals, and actually my last internship which was information technology, I really started to understand that it may be a better route

> for me. The computer science at least at Porter State we don't really get a really good understanding of how to work with people. Everything is so competitive you're always programming against your neighbor, or who has to pass this or, the most efficient program. But at the end of the day you have to understand how to translate that to the business side of it. So currently I am sort of debating whether to just minor in computer programming and then go for more of an IT degree. In that regard both of my internships had shaped me throughout the summers.

The opportunity to gain first hand insights from professionals and through experience played a crucial role in Ethan deciding he would rather work with people instead of being a programmer for the rest of his life. On the other hand, students like Elizabeth were involved in internships, which strengthened their resolve for a particular field of study and career. Elizabeth, a Porter State Computer Scientists, captures this sentiment by stating:

> Well I always knew that I wanted to take on the programming aspect, and work with application, and since I was working with the application that they used within [company] I think that just confirmed what I already knew that I wanted to do.

Other students like Ruby, a Porter State industrial engineer, found internships enabling them to engage in different aspects of the company, so they may deduce the type of work they find most enjoyable. Ruby states:

> I don't really know still what I want to do. I'm looking for a position that will allow me to be pretty flexible and use kind of some of this [Industrial

> Engineering] stuff, so like I said that [company] has a leadership development program. It's a program where you kind of use a lot of different aspects. You can do supply chain; you can do logistics; they just have a lot of different experiences so that at the end of the program you can kind of know which path, and go to the path that you kind of fit in the most.

The internships are invaluable tools for students like Ruby, who are unsure of the career path interesting them most. They have the unique opportunity to test the waters of different positions while the stakes are a bit lower and before they have to make a full commitment like they will have to do once they receive full-time employment.

Lastly, Eli had one of the more interesting internships because it led to him receiving an opportunity to move to London for three months to complete an internship. He completed a successful summer internship with a company and they liked him so much they asked him to come back for a second summer, but this time in London. Eli explains the circumstances of his international internship as he states, "In order to do this opportunity where I go to London and they pay for it and all this. I have to commit that I will work for them for two years after graduation." Some people go their entire life without having an opportunity to travel internationally and Eli has the opportunity to do it at the age of 21.

Undergraduate Research

Far fewer students who participated in this study took part in an undergraduate research experience. Participants were involved in research at either their respective universities, other universities in the surrounding area, or during the summer some took

part in research at universities across the country through special programs. Similar to the internship duties, students who participated in undergraduate research were not stuck cleaning beakers and filing paperwork. Nearly all participants were engaged in the research process. Many students reported favorable undergraduate research experiences and found positive benefits.

Students like Michael, an Electrical engineer at Baldwin, were involved in key aspects of the research process and utilized technology to develop new innovations. Michael describes one of the projects he worked on by explaining:

> [The research labs I worked for were] working on coming up with systems to do kind of artificial intelligence type things, so the first project I worked on was doing image processing, with some cameras that we mounted on the ceiling. Basically, what it boiled down to was I wrote software that would do vision processing on pictures, to try and pick up features and image so my job was to like locate like a little LED in the image, so like basically I had to kind of learn about some vision processing techniques where you look at the images.

After students like Michael witness how he could utilize his talents in a research environment, there is no surprise he is interested in pursuing a Ph.D. in Electrical Engineering.

Other students like Sofie learned a valuable lesson about the trials and errors of conducting research. Unlike in a laboratory section of a class, experiments do not always work when individuals are conducting cutting edge research. Sofie, a chemical engineer

at Baldwin, worked at a university near Baldwin, she explains her project and what she learned in the process by stating:

> My freshman year I worked in [University's] National Fuel Energy Laboratory, and I worked using algae as a sort of bio-diesel, so we had a 52 gallon tank of salt water that we were growing algae in for a couple of days, it didn't work, the salt water ate through the lights, but this is something we had to learn.

Some of these challenges associated with engaging in research help students realize the joy in an experiment finally working after a number of failed tests. Students relied on their academic training and creativity to find the break through needed to create a successful experiment. Andrew, who is a Ph.D. student in Mechanical Engineering at Baldwin, explains how his undergraduate research experience at Baldwin got him interested in graduate school as he stated:

> I worked in his lab doing some research and it really got me like, at that point I was like yeah, I like research. I at least want to go get my master's and do research while I'm getting my masters. I don't want it to be a course based masters. I want to do some research, and so that was the original change, prior to that I had you know the summer before I got here the research program that I did, I did it doing some automotive related research, and that is when I realized that I didn't want to do automotive engineering, it's more of a personal project than it is like a career.

Conducting research is an unknown for students because although they have lab sections in the science courses from high school through college it is not quite the same as

conducting original research. The formulaic nature of some lab sections may actually turn some students off to research. When student participants were exposed to conducting original research a number of them described this feeling like a light bulb was lit over their head. A prime example is Gabriel, an Electrical Engineer at Porter State, describes this sentiment by stating:

> The thing I've realized about research, is that when you go in they expect you not to know everything. You can figure out what track you need to go on to learn things, and then you go and find books and you find articles and you find other research papers, and you read, and you teach yourself, that's a lot of self-motivation and self-teaching, so that you learn what you need to do. Instead of having a professor that tells you a formula, and take this step, and you get this answer, because that is the exact opposite, it's more of like a self-learning type thing.

Instead of getting a step-by-step guide and always ending up with the correct experiment. Students like Gabriel fell in love with investigating a topic, looking at how other researchers may have tackled a similar problem, and then make the appropriate modifications to find success.

Lastly, a few students had the opportunity to participate in research programs at other universities across the country during the summer. These programs were a little more comprehensive in nature because they often had not only a research experience, but they also provided professional development in terms of providing insights into graduate

school and the application process. For instance, Michael completed a research program at an elite northeastern university.

> I think it was the program I did last summer at [university], so that program was part of, so there is the research component and then there was also a component where they talk where you learned about graduate school and particular doctoral studies and like what faculty and people who do the industry research what they do. We learned about that environment and also the aspects of the application process, you know, we had like advisors that were current grad students there, so we got kind of their experience, learned from them.

The programs like the one Michael attended made clear connections to the research experience and participants future career plans. Applying for undergraduate admissions is very stressful and confusing and applying to graduate school can be equally if not more stressful for students. Especially, students, who are not familiar with the graduate admissions process or are not receiving the types of guidance they might have received in high school to complete college applications. Programs like the one Michael attended help demystify the process and give students the knowledge they need to be successful.

Immediate Plans after Undergraduate: Graduate School versus Industry

It is obvious student participants, who were exposed to undergraduate research, were more likely to strive for an advance degree in engineering, computer science, or a related STEM field. Conversely, students who participated in corporate internships were more likely to want to work immediately after completing their baccalaureate degree. Although, some did express plans to obtain a Masters in Business Administration.

Among participants who were interested in working immediately after their undergraduate experience there were a range of responses from students who found their calling in life to students who were more apathetic and were just tired of school. Nathan, from Porter State, was a student who was a bit undecided, but he gives an interesting take on all the different options and his rationale for them by stating:

> I've considered a lot, I've talked to a lot of different people and I guess, my perspective in regards to that was at first, graduate, and get a job if I could, but if not then just go back to school and go ahead and get your masters, and maybe in engineering, I also considered getting my master's in business, because I've talked to an electrical engineer who told me that it may actually be more beneficial to me for me to do it like that.

Nathan's response was typical among students who were undecided about graduate school or not.

Corporate industry is very alluring to underrepresented students who come from lower socioeconomic backgrounds. Students like Carter, who is currently working towards a master's degree in electrical engineering fielded multiple offers from companies ranging from $60,000 to $80,000 a year with only a bachelor's degree. Furthermore, when Carter was an undergraduate he made so much money during the summers he graduated with $25,000 in a savings account. As Dr. Brent Hall, an African American faculty member at Baldwin, mentioned in a previous section, it is preposterous to think a 21 year old college graduate would forgo making $75,000 a year to become a

graduate student with limited income and possibly continued poverty for themselves and their family. Dr. Hall believes:

> Collectively in academia we do a terrible job of even explaining to students why getting an advanced degree is important, even for industry it's important because who are they going to retain when times get tough? We just don't explain that, what comes across often is faculty complain, we like to complain like anybody else, faculty here do not often don't pay attention to the vibes they're giving out, their appearance, just sort of how people view them, and so many students of color probably look at most faculty and say "why would I want to be like them? I want to be like the person who is out in industry" you know and so we just don't explain that to them and don't give them the right vibes, so the only way they see a different world is if we actively pluck them in and bring them into the lab and thankfully most of the faculty who do that are good role models and are not the stereotypical walking around with the holes in their soles of their shoes and things like that and dowdy clothes, so they get a good exposure, these people are normal, they have families, they are regular human beings like the rest of us and turns out love what they do.

Dr. Brent Hall definitely walked the walk because when I interviewed him he had on a dress shirt and slacks, nice Italian loafers, and I noticed a pristine Rolex wristwatch. More importantly, students like Andrew and Jack cited how Professor Hall encouraged them to attend graduate school. As a result, Jack was accepted to and will be attending a Ph.D. program in Mechanical Engineering at an elite university in the Midwest. While,

Andrew, a Ph.D. student in Mechanical Engineering at Baldwin, explained to me his apprehension to pursue the Ph.D. degree by saying:

> I knew I wanted to go to grad school; I knew I wanted to do research. I didn't know I wanted to do the Ph.D. with that whole time commitment process to the Ph.D. I was like, you know I don't know, you know, because I didn't know if I really wanted to be a faculty member, and you know at that point in time I was like if you get a Ph.D. your only option is to go and teach you know or if you're lucky enough you can become research and development at some company.

Dr. Hall talked him through his options and demystified the Ph.D. degree and explained to him the pros and cons for his various options.

The Dean of Porter State's School of Engineering provided an additional insight for trying to push more underrepresented racial minorities into graduate school and the professoriate from the perspective of needing more underrepresented racial minority and women faculty members. Dean Gutierrez states:

> So having a faculty population, having a more diverse faculty is very, very critical to that, not only because they see somebody, but because that person is more than likely to be able to talk to them and relate to them. Put it in the case of women faculty, or women, you know not underrepresented, just women, if you have a department that does not have any women faculty, so who does that young women student talk to? Not about the technical issues of the field, but about the idea that you know, why would I even think about doing graduate work and being faculty, I don't see anybody like me that does that, you have one in the mix and it

changes already because now there is somebody that can talk to how do you bring a family up, how do you do these things.

Dean Gutierrez emphasized the need for Schools of Engineering to make the diversification of both the faculty and student body a priority.

Summary

Two main themes emerged as the most salient challenges for the African American engineers and computer scientists, which are academic and psychosocial. A number of students discussed the differences between their high school and university level work; while other students described having to adjust to "thinking like an engineer" or the competitive environment of computer science. Students also reported having to cope with feelings of isolation. Despite the many challenges these extraordinary young African Americans faced, they found a way to overcome adversity and achieve the goals they set for themselves. The most commonly cited success strategies include developing mental toughness and confidence, finding ways to self-motivate, and relying on support structures.

Engaging in an internship with a corporate industry organization was a key component in the experiences of many of the students I interviewed. Study participants were introduced to corporate life, were given opportunities to move across country and in a few cases across the world, and students were able to ascertain a clearer view of their academic and/or career interests. Far fewer students who participated in this study took part in an undergraduate research experience. Participants were involved in research at either their respective universities, other universities in the surrounding area, or during

the summer some took part in research at universities across the country through special programs. Many students reported favorable undergraduate research experiences. Participants, who were exposed to undergraduate research, were more likely to strive for an advance degree in engineering, computer science, or a related STEM field. Conversely, students who participated in corporate internships were more likely to want to work immediately after completing their baccalaureate degree.

Chapter Eight – Discussion and Implications

In this chapter, I utilize the quantitative results and the qualitative findings to answer the three research questions guiding this study. Then, I make connections with the findings and previous literature. I conclude this chapter with important implications for policy, practice, and future research.

Research Questions Revisited

In this study, I have focused on successful African American engineers and computer scientists through a mixed methodological approach. First, I examined the experiences of 657 African American students who entered college with the intentions of majoring in engineering or computer science. I analyzed data from the 2004 Freshman Survey (TFS) administered by UCLA's Higher Education Research Institute (HERI), which was matched with 5-year degree attainment data from the National Student Clearinghouse. I utilized a multinomial logistic regression to answer the following research question:

> How do individual and institutional factors differentially affect Engineering and Computer Science baccalaureate degree attainment for African American students, who entered college with the intention of majoring in Engineering or Computer Science?

The results indicated survey respondents (as compared to respondents who graduated with a degree in a non-STEM field) were more likely to complete a degree in engineering

or computer science if they attended a private high school (13.6% more likely) or attended a Top 50 producer of African Americans with baccalaureate degrees in engineering (19.8% more likely). Additionally, a one grade category increase (i.e., from a B+ to an A-) in average high school grade garnered 7% increased likelihood of completing a degree in engineering or computer science.

Among students who completed a degree in science or mathematics, respondents were less likely to switch to a non-STEM field if they attended an HBCU (7.5% less likely) or if they took four years of mathematics (as compared to those who took only three years) (5.9% less likely). Also, a one-grade category increase (i.e., from a B+ to an A-) in average high school grade garnered a modest 1% increased likelihood of completing a degree in science or mathematics.

Building on the quantitative results, I conducted case studies of two predominantly White public research universities characterized as Top 50 producers of African American baccalaureate degrees in engineering. I interviewed 70 individuals: 37 African American engineers/computer scientists, 9 engineering or computer science faculty members, 16 administrators, and 8 recent baccalaureate recipients. Through qualitative data analyses of the case studies, seven themes emerged as important factors in the academic careers of the successful African American participants, which include:

1. The role of Minority Engineering Programs (MEP)
2. The importance of outreach and pre-college programs
3. The role of the National Society of Black Engineers (NSBE)
4. Successful students have challenges too and strategies for success

5. The role of same race versus different race faculty interactions
6. African American women's experiences in engineering and computer science
7. Post baccalaureate decisions: graduate school or industry

These seven themes contribute to answering the following research questions:

1. How do schools of engineering, characterized as top producers of African Americans with Baccalaureate degrees in Engineering, encourage or impede the support of African American engineering and computer science students?
2. How do institutional agents, programmatic interventions, co-curricular involvement, and engagement opportunities support or discourage participants' persistence through the engineering pipeline?

To answer the first question, I found institutions encourage the support of African American engineers and computer science by offering outreach and precollege programs as well as through the support of the MEP offices. The outreach and precollege programs served two roles: a.) Increase interest and awareness of Engineering at the respective university among African American youth, and b.) Provide an outlet for African American engineering and computer science students to engage in mentoring and community service. About half the students at Baldwin participated in an outreach and/or precollege program prior to enrolling as an undergraduate, which speaks to the power of these programs. Moreover, some study participants found meaningful experiences in serving as a mentor to outreach programs.

Additionally, the universities provide support by funding the staff salaries and some overhead costs for the Minority Engineering Programs. The MEP offices play an

instrumental role in supporting its participants. The student participants speak to the number of ways the MEP program has made a positive impact on their experiences. The two schools of engineering unequivocally support their respective MEP programs. Both Deans gave their respective MEP program warranted praise. Unfortunately, the soft funding of these programs seems to provide an uncertain future for the continued existence of meaningful programmatic interventions like the summer bridge programs. The directors of MEP have to continually seek funding from corporate sponsors and funding agencies. These programs may not exist if funding needs are not met, which was the case for a few years at Porter State where some students reported not having the opportunity to attend the summer bridge program because it was not offered the year they entered.

In addition to the soft funding challenge, Baldwin, a university with hundreds of millions of dollars of research expenditures, may indirectly impede the support of African American Engineers through a lack of advocacy for the faculty members who mentor and nurture these students. The case of Professor Eaton, who was denied promotion because it was deemed this professor's record did not contain enough grant funded research projects and publications, was presented as a clear example of how potential impediments may come about. For example, Dr. Eaton may renounce service activities if it were decided being promoted was the most important thing, which would thereby leave an important population of African American students and women underserved. The case of Dr. Eaton shows the potential moral hazard of encouraging faculty members, even those with tenure, to engage in mentoring and supporting undergraduate students. As Allen et

al. (2002) suggested, service activities take time away from the pursuits bestowing not only tenure, but promotion as well. Furthermore, pre-tenure and post-tenure faculty may observe the results of Dr. Eaton's denied promotion and limit their own service activities as a result.

To answer the second question, I found multiple ways institutional agents, programmatic interventions, co-curricular involvement, and engagement opportunities served to support participants' persistence through the engineering pipeline. There were a number of institutional agents from both MEP directors, Dr. Nichols and Mr. Taylor, to Ms. Ellis (MEP Assistant Director), who served as a mother figure to a number of participants. Also, there were a whole host of faculty members at both Porter State and Baldwin University, which includes individuals like Drs. Yang, Conway, Eaton, and Hall to name a few. These individuals provided support, encouragement, and opportunities for the student participants. The African American faculty members served as role models often serving as "existence proof" to students who may see themselves in these same race faculty mentors. Moreover, the faculty members of different races like Professors Yang and Conway provided similar encouragement and support to African American participants demonstrating how mentorship has the ability to transcend ones racial background.

Furthermore, students' co-curricular involvement in student organizations like NSBE and other major based student organizations help sustain the study participants. Students cited the numerous ways NSBE provided peer support, professional development opportunities, job placement and internship opportunities, and engagement

with the local community through service activities. Students who participate in NSBE reported expanded social networks with students at other campuses.

Likewise, participants' were encouraged to persist through the engineering pipeline through engagement opportunities, which in this study were found through corporate internships and undergraduate research experiences. Participants who were involved in industry internships and/or undergraduate research were able to make connections to their academic course work through practically apply course concepts. Some students were also able to modify their academic interests, which provided greater satisfaction in their course of study. Also, through internships, students were able to narrow their career interests because they were exposed to multiple engineering positions. While, a majority of student participants, who were engaged in undergraduate research, reported an increased interests in obtaining a master's degree or Ph.D. in a STEM field.

On the other hand, I found a few cases of institutional agents, which in this instance were faculty members, who were discouraging of study participants. The clearest example was found at Porter State where a faculty member, who I characterized as the Anti-Dr. Conway, seemed to actively engage in demoralizing successful African American engineers. Multiple students independently brought up this White woman faculty member and they all cited the multiple ways the professor discouraged them to succeed in an engineering course or treated them differently because of their race.

Collectively, these findings shed light on the quantitative results, which indicated students who attended a Top 50 producer of African American baccalaureate degrees in Engineering were nearly 20% more likely to complete a degree in engineering. Both

Porter State and Baldwin Universities, who are Top 50 producers, demonstrated multiple ways they are committed to institutional diversity and to the success of African Americans in engineering and computer science. Porter State and Baldwin are not Top 50 producers because of chance; they are top producers because of intentional actions. Both institutions actively engage in activities to promote racial diversity in engineering and computer science. Outreach and precollege programs are the core activities used to expand the engineering pipeline among African Americans and other racial minorities.

Connections to Historical Context

Through examining the history of African Americans in engineering, I have documented the many ways African Americans were excluded from participating in the technology and engineering enterprise. Early tinkerers and inventors were prohibited from obtaining patents and/or profiting from their inventions. In the postbellum era, although African Americans were permitted to acquire patents, they were met with racism, sabotage, and unwarranted litigation. Moreover, African Americans were excluded from a number of public flagship universities and forced to attend underfunded HBCUs.

Universities, who initially denied access to African Americans have since granted admission to their ivory towers. Universities like Porter State have spent decades trying to reverse the past wrongs and have demonstrated a commitment to supporting institutional diversity. The next generation of African American tinkerers and inventors are finding success at these two universities, but not by chance. Porter State and Baldwin

universities have enacted intentional policies and practices promoting the success of their African American engineering and computer science students. This study on engineering success provides some support for Brown, Morning, and Watkins (2005) study as they found a statistically significant relationship with higher graduation rates, lower perceptions of racism and discrimination, and perceptions of institutional commitment to diversity.

Connections to Previous Literature

Faculty Mentorship

Faculty interactions and mentorship has received considerable attention from higher education scholars because of the meaningful impact faculty have on students' experiences. Researchers have found faculty's influence can either be positive (Cole & Espinoza, 2008; Espinosa, 2008; Newman, in press) or negative (Newman, in press; Seymour & Hewitt, 1997). Faculty support and encouragement (Cole & Espinoza, 2008) and opportunities to engage in research with faculty members (Espinosa, 2008) were found to increase students of color's GPAs and their academic self-concept. Although study participants all had above a 3.0 GPA, per the study inclusion criteria, students cited multiple ways supportive faculty aided in achieving high academic marks. Furthermore, a vast majority of students who were involved in research with faculty members exhibited increased academic self-concept in terms of confidence in the ability to begin graduate level work.

Both Cole and Espinoza's (2008) and Espinosa's (2008) studies provided statistically significant results with regard to the relationship between faculty and students. However, these studies aggregated students of color and all STEM disciplines. This current engineering success study sheds light on the outcomes (increased GPA and academic self-concept) by documenting specific ways faculty members contribute to African American students' successes.

From a qualitative perspective, Newman (in press) found supportive faculty members in engineering at two large research universities on the west coast tended to operate as "lone wolves." These lone wolves' support for students was counter to the departmental culture. However, findings from the current study indicate the faculty members at Porter State and Baldwin Universities were aligned with a departmental culture focusing on supporting undergraduates and African American engineers and computer scientists. In fact, the lone wolves at Porter State were the non-supportive faculty members who actively discouraged the persistence of some study participants. Whereas the lone wolves in Newman (in press) study were the beacons of hope, the lone wolves in the current study attempted to dissuade the persistence of the African American engineers.

Lastly, scholars like Leggon (2010) and Slaughter (2009) have stressed the importance of same race role models for African American students in STEM fields. This current inquiry supports the work of Leggon (2010) and Slaughter (2009). Study participants have cited the ways African American faculty members serve as roles models in both theory and practice. Students cited desires to see more African American

professors leading their classrooms and often had to surmise the positive outcomes, which may ensue. Students hypothesized African American faculty members would better understand students' background and the struggles they go through. Students, who did have the opportunity to interact with same race faculty members, cited how these faculty members encouraged them to achieve.

However, partially due to the small number of African American faculty members, study participants cited more extensively the ways faculty members of different races provide mentorship, encouragement, and support. White and Asian faculty members served as surrogate mentors and role models. Students cited the many ways these White and Asian faculty members served in capacities similar to a same race faculty member. Racial background was not a barrier for the faculty of different races. This finding contributes to the literature because it rejects the widely held belief African American faculty are the only individuals to support African American students. This study has demonstrated the ways a caring and compassionate person may fill the void and serve in a role similar to an African American faculty member. This is not to say African American faculty members are not needed; faculty of different races should not relinquish their advising and mentoring duties for African American students just because African American professors are not on the respective campus' engineering faculty. There is a strong possibility African American engineering and computer science majors will be receptive to faculty members of different races who show an interest in supporting all students.

Women in STEM

Although women are the new majority on college campuses, they are still underrepresented among engineering majors. Correll (2004) and Mannon and Schreduers (2007) have found women tend to be concentrated in biological, biomedical, and chemical engineering. More than half (52.6%) of participants in the current study majored in chemical engineering or industrial engineering (Please see table 3.7). While these figures do not have statistical significance, a number of women participants explained how gendered roles were socialized in young girls and women. For example, some women may think building bridges is all an engineer does and this line of work may be characterized as a man's job. Therefore, women may be disinterested in pursuing engineering if these misconceptions go unchallenged. Female study participants were thankful to find out about other opportunities under the realm of engineering like industrial and chemical engineering at an early stage of their education.

Other studies have pointed to women in STEM majors reporting high ratings of their own self-confidence, which is on par with men (Han, Sax, & Kim, 2007). However, women respondents tended to doubt themselves within group settings (Han, Sax, & Kim, 2007) or when having to present in STEM courses (Mannon & Schreuders, 2007). The current study provides divergent views on these previous research studies. Some women in the study document the ways male group members may have mistreated them by only allowing for a minor role in a final presentation. While other participants scoffed at the idea of men mistreating them within group settings. These women reported taking charge of the groups for which they were members. These women may have been unaware of the

male group members letting them do all of the work without giving these women proper credit. While alumnae participants cited ways they were blatantly mistreated by older White men in their post-undergraduate workplace environment.

As suggested by Carlone and Johnson (2007), the highly successful African American women engineers and computer science majors in this study appear to have developed strong engineering identities as a result of performance, recognition, and competence. The women participants performed well in their engineering duties in internships, class projects and presentations, and through undergraduate research opportunities. Also, these women are recognized for their talents by faculty members, who include them in their research projects; corporate recruiters, who extend job offers based on interviews; and their supervisors in their internships, who request for them to return for the following summer and/or to extend permanent employment. Lastly, the African American women have exhibited their competence in the engineering material by collectively maintaining well over a 3.0 GPA. Carlone and Johnson also posit an intersection between ones science identity, and their racial and gender identities. This theory holds true for a vast majority of the participants in this study. The African American women participants were very conscious of their status as an African American and a woman in a predominantly White and male engineering discipline.

Sense of Belonging through MEP Offices

Good, Halpin, and Halpin (2002) found students who participated in Minority Engineering Programs had an increased self-report of sense of belonging to the university. Findings from the current study provide support for the positive relationship

between MEP and participants' sense of belonging. Study participants believed the MEP office gave them a safe haven on campus; a place they can call their own. As a result, a number of students who participated in MEP reported feeling like members of the campus community. The MEP staff created a near family-like atmosphere where students could belong to a close-knit community. MEP programs give participants the opportunity to expand their social networks across engineering majors and in some instances across racial boundaries. This study provides deeper insights into the value MEP offices add to the success of African American engineers and computer scientists.

Self-Motivation

Moore, Madison-Colmore, and Smith (2003) coined the phrase "to prove-them-wrong syndrome" as a self-motivating tool for African American engineering majors in their study. Moore and his colleagues found students used this motivating tool to prove the people who have doubted their abilities wrong. In the current study, African American male participants used a different motivating tool whereby they reminded themselves of the negative environments of their old neighborhood. Male study participants cited some of the negative circumstances of the neighborhoods they grew up in, which include drugs, street violence, and economic hardship. These participants were motivated by the fear of failure and being forced to return to their former neighborhoods.

The fear of failure, as several men in this study characterize it, speaks to the intense pressure some African American men face in pursuit of a baccalaureate degree. They overcame all of the challenges, which have been documented by a voluminous body

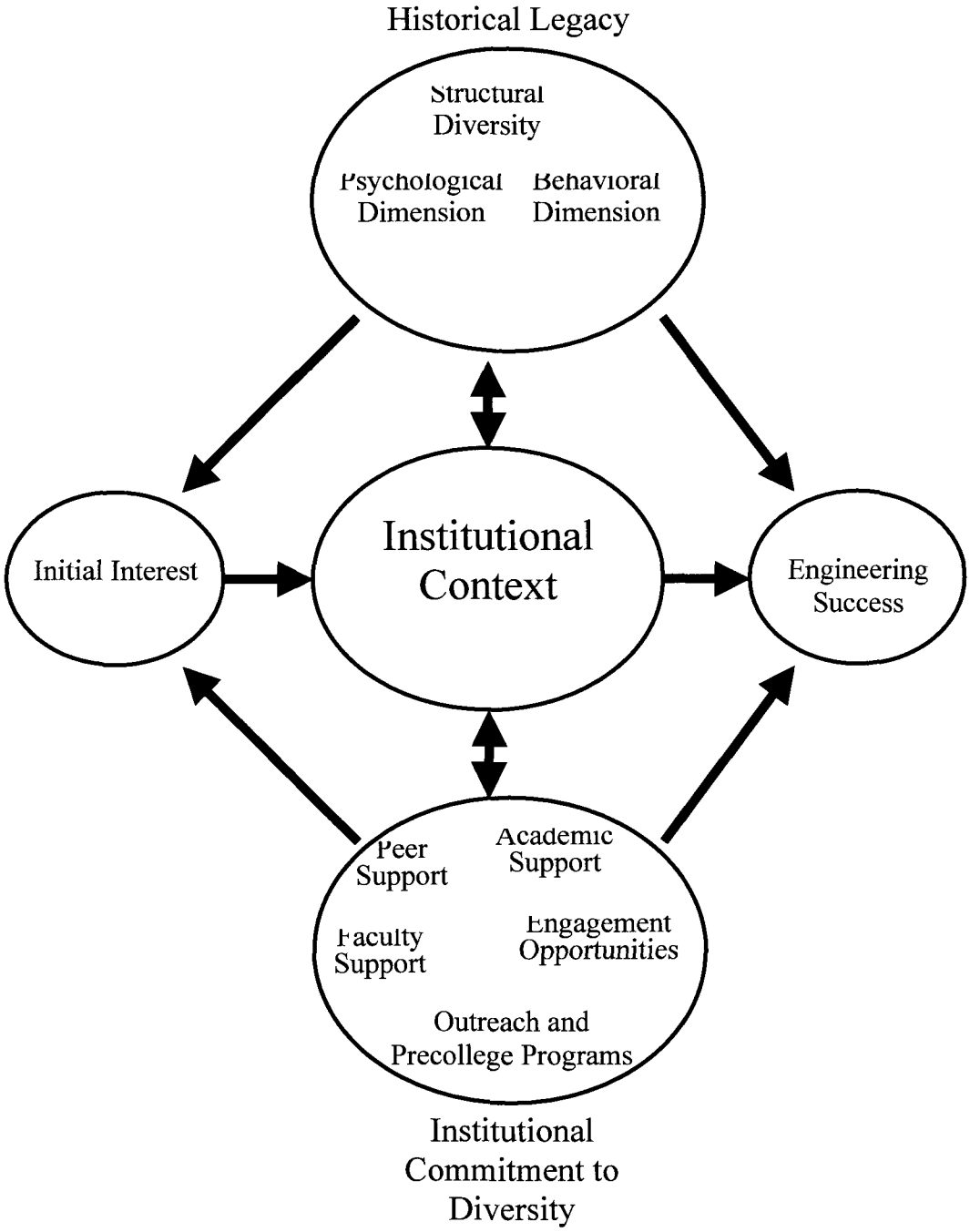
of literature. Yet, it has remained in the back of these male participants minds; if they do not succeed they will become the very person they have strove not to be their entire lives.

Conceptual Framework

The African American participants in this study were able to transform their initial interest into becoming an engineer or computer scientists. They navigated Porter State or Baldwin Universities to achieve their academic and career goals. The institutional context played an important role in the success of these study participants. Please see the revised model in Figure 8.1. I found the institutional context shaped the setting for student experiences and provided the environment for which the experiences were more fully understood and assessed. Like Bensimon (2005), I did not place the onus for success solely on the shoulders of students. Porter State and Baldwin's respective Schools of Engineering recognize the important contribution they make in providing opportunities for positive student outcomes.

With regard to the four dimensions of the campus racial climate (Hurtado et al., 1998), which influences students' perception of the institutional context, I have made connections to the historical legacy at these two predominantly White public research universities. The two case studies have demonstrated the ways these universities took countermeasures through outreach and pre-college programs to undo social injustices of previous generations. These programs expand the opportunity to becoming an engineer or computer scientists to a diverse citizenry in each university's surrounding locale and beyond.

Figure 8.1 – Revised Conceptual Framework for Engineering Success for African American undergraduates at Universities



The structural diversity element was presented through each university's commitment to recruiting and retaining a diverse student body, as well as, recruiting diverse faculty mentors. Porter State and Baldwin both provided considerable support for their respective MEP office, which also contributes to the structural diversity of the institution. In terms of the behavioral and psychological dimensions, the African American students' perception suggested a generally welcoming environment with few instances of perceived discrimination or blatant racism. Participants very often found students of different races to study with or work with on group projects.

Porter State and Baldwin University demonstrate an institutional commitment to diversity. Students found peer support through MEP programs and through participating in student organizations like NSBE. Additionally, study participants were engaged in opportunities like undergraduate research experiences, corporate internships, and serving as mentors in outreach programs. Porter State and Baldwin demonstrate the tangible ways institutional actions may support espoused mission statements. Outreach and Precollege Programs and Faculty support/recognition were particularly helpful and have been added to the revised conceptual framework.

From the anti-deficit perspective, I defined the outcome for the conceptual framework as success: a.) Completing a baccalaureate degree in engineering with a competitive grade point average (3.0 or higher), and b.) Participating in undergraduate research or industry internships. These two benchmarks enable a student to acquire a career in engineering or prepare him or her for graduate school in engineering or beyond. The African American participants in this study are well on their way to completing their

baccalaureate degree in engineering with a 3.0 GPA or higher and nearly everyone was engaged in either a corporate internship or undergraduate research experience. This study has provided key insights into these successful students' collegiate experience.

Unique Contribution to Literature

The results and findings presented in this study contribute to the literature on African American engineers and computer scientists. First, the exploration of the significance of attending a university characterized as a Top 50 producer of African Americans with a baccalaureate degree in engineering has not previously been attempted. Furthermore, finding Top 50 producers increased the likelihood of an African American student completing a degree in engineering or computer science by nearly 20% is remarkable. Prior to presenting the results of these multivariate analyses, scholars may have assumed institutions on this Top 50 list were merely beneficiaries of large African American and/or STEM undergraduate student bodies. In this study, I found, even after controlling for the percentage of STEM students and whether an institution is an HBCU or not, Top 50 producers still significantly predict baccalaureate degree completion in engineering or computer science. While the qualitative phase of the study explores this finding at two predominantly White public research universities, there is a need to explore further Top 50 producers at different institutional contexts (i.e., private research universities, HBCUs, and Tech universities).

In addition, the qualitative findings provide clear insights into the utility of schools of engineering engaging in highly integrated pre-college outreach programs and K-12 partnerships. The outreach enterprises at both Baldwin and Porter State were not

isolated in one small minority services office. Outreach efforts were integrated into several levels of the university, which included K-12 partnerships and precollege programs administered by the School of Engineering, minority engineering programs office, and various student organizations. This integrated approach to outreach has exhibited tremendous success at Baldwin University by expanding the pipeline of African American engineers and computer scientists. African American engineers, who were participants in Baldwin's pre-college outreach programs, were labeled "MEP babies." Some participants estimated about half of the African American engineers at Baldwin were "MEP babies," which indicate a considerable return on the investment Baldwin has made in outreach programs. While Porter State has begun outreach efforts similar to Baldwin, they have not yet received the types of returns on the investment Baldwin has received. However, Baldwin's success does bode well for a continued effort in pre-college outreach activities at Porter State.

Implications for Policy

Federal Policy

Much attention has been given to the United States being in jeopardy of losing its competitive advantage. Science, Technology, Engineering, and Mathematics have been highlighted as one such venue for maintaining the U.S.' prosperity. This is why it is shocking to read the 2009 "Rising Above the Gathering Storm Revisited" report and learning a majority of the recommendations from the 2005 report went unfunded. The U.S. must make sizeable investments in its infrastructure and human capital if it is to remain a leading nation in STEM innovation and production.

The U.S. Department of Education should create a federal grant program specifically for lower income and underrepresented racial minorities, who are interested in pursuing STEM fields. Countries like China are investing billions of dollars in scholarships for higher education especially in STEM fields. The system of scholarships breaks down financial barriers to lower income and rural students in China. If the U.S. is truly interested in maintaining prosperity a serious investment is needed to match those of countries with intense economic growth. The increasing costs of higher education and the inequitable quality of primary and secondary education makes pursuing STEM field a challenge for many underrepresented racial minorities. Portable financial support like this will help students attend colleges and universities across the county by making this a financially feasible goal.

The U.S. Department of Education has a student loan forgiveness program for individuals who commit to teaching for five consecutive years in schools serving lower income families. The total forgiveness package can be combined to provide up to a $17,500 benefit. The Department of Education should amend the current loan forgiveness program to include an additional pool of funding for individuals who teach STEM related courses in schools serving racial minority or lower income communities.

Federal funding agencies (e.g., the National Science Foundation) need to continue funding quantitative, qualitative, and mixed methodological studies focusing on underrepresented racial minorities who pursue STEM fields. Quantitative studies can provide excellent data for bigger picture trends and relationships between experiences, interventions, and outcomes. Qualitative inquiries may give researchers an opportunity to

take an in depth look at a phenomenon to determine not just what interventions work, but why experiences or interventions garner desired outcomes. More specifically, funding agencies should give priority to funding proposals with the ability to disaggregate data not only by race and gender, but also by academic discipline. Engineering is far different from Biology, which is far different than Physics. Moreover, the experiences of African Americans, Latinos, Native Americans, and Southeast Asians are not all the same. More powerful conclusions may be drawn from disaggregating data to better understand which interventions may work for specific racial groups within distinct academic disciplines. Aggregating data may lead to faulty conclusions about the benefits of interventions on specific populations within distinct disciplines.

University/School of Engineering Policy

There are particularly meaningful insights gleaned from this study regarding the role of corporate sponsorship of Minority Engineering Programs and NSBE conferences. The MEP offices in this study are provided funding by the university for staffing, but few funds were allocated for programmatic efforts. As a result, programs, which have clear patterns of success, have gone unfunded for some years. MEP offices have been forced to solicit funds from corporate sponsors and funding agencies. Corporate sponsors may serve as wonderful partners with MEP offices by providing needed funding and employment opportunities for MEP participants. While the motives for corporate sponsorships may seem completely philanthropic, these corporations main goal is to increase profitability. Therefore, I express caution in relying too heavily on corporate sponsors because some may utilize their partnerships to exploit the MEP offices for their

vital resources, which are highly successful racial minority engineers and computer scientists. These corporations may not always have the MEP participants' best interest in mind. MEP offices with corporate sponsorships need to ensure students are exposed to other avenues like graduate school. MEP offices should provide a balance between corporate sponsorship involvement and graduate school opportunities. For example, if there is an event to meet with corporate recruiters, there should also be an event to meet with graduate school recruiters or graduate students. This balance will give students an opportunity to fully explore all of their options and make an informed decision regarding their career.

Lastly, research universities and schools of engineering need to reevaluate faculty mentoring rewards and the positive and/or negative impact it may have on promotion and tenure. At Porter State, a professor reported receiving considerable reward for engaging in mentoring activities with undergraduates. On the other hand, a professor at Baldwin reported quite the opposite. From my experience, individuals who choose to engage in mentoring undergraduates either fully commit to it or they steer clear of these types of duties all together. Mentoring may take time away from activities such as writing research grants and/or publishing papers. Universities and schools of engineering need to be more transparent in advising faculty on what activities are rewarded in the tenure and promotion process. Most importantly, tenure and promotion rewards should be aligned with stated missions. The promotion and tenure review committees should be reminded of the university's and/or the School of Engineering's mission. Otherwise, statements on

"valuing diversity" are just empty rhetoric if you do not provide the necessary opportunities for those who undertake "diversity work."

Extreme care should be taken in selecting the promotion and tenure committees with individuals who are in support of the university's stated mission. Faculty peer reviewers who are "on board" with valuing diversity may better understand the achievements made by individuals who document gains in enrollment and graduation as a result of taking the helm of a department or through mentoring. Therefore, these faculty and peer reviewers may recognize the commitment and dedication of individuals who take on mentoring and supporting students.

Implications for Practice

Schools of Engineering

The Top 50 producers of African Americans with baccalaureate degrees in engineering have quantitatively been shown to increase the likelihood of an African American student to graduate with a bachelor's degree in engineering. Two of these top universities have been investigated qualitatively; I have documented the ways they have supported African American students' success. There are a number of large public research universities, who did not make the Top 50 list even though it only took graduating 18 African Americans with a degree in engineering. Therefore, any university can become a Top-50 producer if supporting this student population is an institutional priority. However, a transformational change is required. The proven support structures must be put in place to achieve success in this endeavor; this task cannot be left solely to

a small an underfunded MEP office. The School of Engineering has to have integrated support mechanisms.

Secondly, Porter State's system of assigning faculty advisors has been proven to have positive outcomes. Students reported more interaction with faculty members. With this being said, the system is not perfect and it requires some oversight to ensure faculty members are properly trained in student advising. Department Chairs should set up clear guidelines on how faculty members should advise and interact with students, who are succeeding as well as those who are struggling. While the students who had positive relationships with their faculty advisors flourished, students who had an unsupportive advisor had to overcome yet another challenge. Therefore, if a School of Engineering does not embrace faculty-mentoring undergraduates then assigning faculty advisors may end up causing more harm than good. However, if implemented with care and oversight faculty advisors may positively change the experiences of African American engineers and computer scientists.

Finally, outreach programs have also proven to amass considerable positive outcomes to the student and the university. Schools of Engineering interested in promoting diversity and inclusion should start their efforts with outreach and precollege programs. The return on investment is not necessarily immediately guaranteed and may come a number of years down the road, but it is vital to achieving success. Outreach programs and precollege programs serve a key role in increasing the talent pool, which ultimately will lead to more racially diverse and academically prepared pool of applicants.

MEP Programs

Both MEP offices offer comparable programs for entering freshman. During the summer bridge programs and beyond both campuses offer contact with industry representatives and students reported the benefits resulting from this connection. However, some students I talked to expressed interest in talking with recent professional and graduate student alums about life and opportunities after undergraduate education. While some students gained insights about professional life and graduate school as a result of participating in internships or undergraduate research, I believe an even earlier exposure to this information will help students decide on what opportunities to pursue. Furthermore, these young alums may also serve as role models especially in the absence of African American faculty members. All eight of the alums I interviewed are willing to talk with undergraduate engineers and computer scientists about their experience.

Also, MEP programs should systematize support whenever possible. For example, students often talked about the ease with which they were able to find tutors for lower division courses, but found it extremely difficult to find academic support in upper division courses. To find tutors, study participants would personally contact MEP administrators for help, who would then ask around on the students' behalf. While this system seems to have garnered some success, a more proactive and systematic approach may be better suited. MEP offices may find success in giving students a formal process of requesting tutors for upper division courses. This process could be through an online request form and should be prominently located on relevant web pages. The formal process will serve two purposes:

1.) Students will become aware of the ability to acquire a tutor for upper division courses.

2.) MEP administrators may find clustering for students requesting support in the same course(s), which will give the MEP program the opportunity to coordinate a group tutor in a more efficient manner.

In the informal system, a student may have been a bit apprehensive to ask for help or assume MEP may not be able to help them with finding a tutor. A systematized approach may make it easier for students to ask for help. This is just one example of the clear benefits of systematizing support and not solely relying on interpersonal relationships and local knowledge.

Lastly, Porter State's MEP office had formal programs for students in their first year, which included the summer bridge and mentorship programs. Porter State participants remained involved as mentors in the program and also as tutors, but there was little additional programs after the first year. While Baldwin's MEP office had formal programs for students through the first two years, there was also a loss of contact after the second year. MEP programs need to think of ways to maintain formal connections with students beyond the first two years. The two MEP offices offer programs to support students in transitioning into the university. However, students in their third, fourth, and fifth years are faced with a number of challenges like the engineering comprehensive exam, finding full time employment, and/or navigating the graduate school admissions process. MEP may play a key role in helping students'

transition to the next phase as they seek "engineering success" (i.e., employment in related fields or graduate school).

Implications for Future Research

This study provides insights specifically on two predominantly White public research universities. Perspectives are needed from additional institutional contexts. There are other types of institutions characterized as Top 50 producers of African American baccalaureate degree recipients in Engineering. Future research should investigate the similarities and differences between the two institutions in this study and those categorized as HBCUs (e.g., Morgan State, Praire View A&M), private research universities (e.g., Vanderbilt, Drexel), and "Tech" focused universities (e.g., Georgia Tech, Rensselaer Polytechnic).

Next, future research should focus on disaggregating STEM disciplines as well as racial and gender backgrounds. More powerful conclusions may be drawn from disaggregating data to better understand which interventions may work for specific racial groups within distinct academic disciplines. Aggregating data may lead to faulty conclusions about the benefits of interventions on specific populations within distinct disciplines.

Also, future research should focus not only on student experiences, but also on the institution's role in providing the context for those experiences. Far to many research studies focus solely on students and do not ascribe adequate responsibility to institutions. As a result, the institution never changes and the status quo remains intact. A lack of

focus on the institution enables inequities to go unchecked and thousands of students to fall through the cracks of an already porous engineering and computer science pipeline.

Closing

Through the two campus case studies, I am certain I have met the next great African American engineers and computer scientists. This group of highly successful individuals is carrying on the torch for Ned, Granville Woods, Garrett Morgan, and the many nameless pioneers in engineering. I have met future engineering firm executives, CEOs, engineering or computer science faculty members, entrepreneurs, or businesspersons. These remarkable young people will go on to serve as "existence proof" to the thousands of African Americans, who will follow in their foot steps.

While self-motivation and intrinsic desires to achieve greatness are important, African American students will have a far more difficult time succeeding without an institutional commitment to diversity. Universities who espouse the importance of racial diversity must make serving African American engineering and computer science students a priority.

Appendices

PLEASE PRINT NAME AND PERMANENT/HOME ADDRESS (one letter or number per box)

000001

NAME: FIRST MI LAST

When were you born? Month (01-12) Day (01-31) Year

ADDRESS:

CITY: STATE: ZIP: PHONE: – –

2004 STUDENT INFORMATION FORM

MARKING DIRECTIONS

Your responses will be read by an optical mark reader. Please,

- Use a pencil or black or blue pen
- Fill in the oval completely
- Erase cleanly any marks you wish to change or "X" out mark if in pen

CORRECT MARK ● INCORRECT MARKS ✓ X

PLEASE PROVIDE YOUR ID NUMBER (as instructed)	Mark here if directed	
	GROUP CODE A	GROUP CODE B
0 0 0 0 0 0 0 0 0 0	○	○
1 1 1 1 1 1 1 1 1 1	○	○
2 2 2 2 2 2 2 2 2 2	○	○
3 3 3 3 3 3 3 3 3 3	○	○
4 4 4 4 4 4 4 4 4 4	○	○
5 5 5 5 5 5 5 5 5 5	○	○
6 6 6 6 6 6 6 6 6 6	○	○
7 7 7 7 7 7 7 7 7 7	○	○
8 8 8 8 8 8 8 8 8 8	○	○
9 9 9 9 9 9 9 9 9 9	○	○

1. Your sex: ○ Male ○ Female

2. How old will you be on December 31 of this year? (Mark one)

16 or younger	○	21-24	○
17	○	25-29	○
18	○	30-39	○
19	○	40-54	○
20	○	55 or older	○

3. Is English your native language?

○ Yes ○ No

4. In what year did you graduate from high school? (Mark one)

2004	○	Did not graduate but passed G E D test	○
2003	○		
2002	○	Never completed high school	○
2001 or earlier	○		

5. Are you enrolled (or enrolling) as a: (Mark one)

Full-time student? ○

Part-time student? ○

6. How many miles is this college from your permanent home? (Mark one)

5 or less ○	11-50 ○	101-500 ○
6-10 ○	51-100 ○	Over 500 ○

7. What was your average grade in high school? (Mark one)

A or A+ ○	B ○	C ○
A– ○	B– ○	D ○
B+ ○	C+ ○	

8. From what kind of secondary school did you graduate? (Mark one)

- ○ Public school (not charter or magnet)
- ○ Public charter school
- ○ Public magnet school
- ○ Private religious/parochial school
- ○ Private independent college-prep school
- ○ Home school

9. What were your scores on the SAT I and/or ACT?

SAT VERBAL

SAT MATH

ACT Composite

10. Citizenship status:

- ○ U S citizen
- ○ Permanent resident (green card)
- ○ Neither

11. Prior to this term, have you ever taken courses for credit at this institution?

○ Yes ○ No

12. Since leaving high school, have you ever taken courses at any other institution? (Mark all that apply in each column)

	For Credit	Not for Credit
Yes, at a community/junior college	○	○
Yes at a 4-yr college or university	○	○
Yes, at some other postsecondary school (For example technical vocational business)	○	○

13. During your last year of high school what proportion of the time did you live with: (Mark one in each row)

	All	Most	Some	None
Mother	Ⓐ	Ⓜ	Ⓢ	Ⓝ
Father	Ⓐ	Ⓜ	Ⓢ	Ⓝ
Stepmother	Ⓐ	Ⓜ	Ⓢ	Ⓝ
Stepfather	Ⓐ	Ⓜ	Ⓢ	Ⓝ
Grandparent	Ⓐ	Ⓜ	Ⓢ	Ⓝ
Legal guardian	Ⓐ	Ⓜ	Ⓢ	Ⓝ
Other adult(s)	Ⓐ	Ⓜ	Ⓢ	Ⓝ

14. Where do you plan to live during the fall term? (Mark one)

With my family or other relatives	○
Other private home apartment or room	○
College residence hall	○
Fraternity or sorority house	○
Other campus student housing	○
Other	○

15. Is this college your: (Mark one)

First choice?	○	Less than third choice?	○
Second choice?	○		
Third choice?	○		

16. To how many colleges other than this one did you apply for admission this year?

None ○	1 ○	4 ○	7-10 ○
	2 ○	5 ○	11 or more ○
	3 ○	6 ○	

17. During high school (grades 9-12) how many years did you study each of the following subjects? (Mark one for each item)

	None	1/2	1	2	3	4	5 or more
English	○	○	○	○	○	○	○
Mathematics	○	○	○	○	○	○	○
Foreign Language	○	○	○	○	○	○	○
Physical Science	○	○	○	○	○	○	○
Biological Science	○	○	○	○	○	○	○
History/Am Govt	○	○	○	○	○	○	○
Computer Science	○	○	○	○	○	○	○
Arts and/or Music	○	○	○	○	○	○	○

18 Do you have a disability? (Mark all that apply)

None	○
Hearing	○
Speech	○
Orthopedic	○
Learning disability	○
Health-related	○
Partially sighted or blind	○
Other	○

19. What is the highest academic degree that you intend to obtain? (Mark one in each column)

	Highest Planned	Highest Planned At This College
None	○	○
Vocational certificate	○	○
Associate (A A or equivalent)	○	○
Bachelor's degree (B A B S, etc)	○	○
Master's degree (M A M S etc)	○	○
Ph D or Ed D	○	○
M D D O D D S or D V M	○	○
J D (Law)	○	○
B D or M DIV (Divinity)	○	○
Other	○	○

20. Are your parents: (Mark one)

Both alive and living with each other?	○
Both alive, divorced or living apart?	○
One or both deceased?	○

21. How much of your first year's educational expenses (room, board, tuition, and fees) do you expect to cover from each of the sources listed below? (Mark one answer for each possible source)

	None	Less than $1,000	$1,000-2,999	$3,000-5,999	$6,000-9,999	$10,000+
Family resources (parents relatives spouse etc)	○	○	○	○	○	○
My own resources (savings from work work-study, other income)	○	○	○	○	○	○
Aid which need not be repaid (grants scholarships, military funding etc)	○	○	○	○	○	○
Aid which must be repaid (loans etc)	○	○	○	○	○	○
Other than above	○	○	○	○	○	○

22. What is your best estimate of your parents' total income last year? Consider income from all sources before taxes. (Mark one)

- ○ Less than $10,000
- ○ $10,000-14,999
- ○ $15,000-19,999
- ○ $20,000-24,999
- ○ $25,000-29,999
- ○ $30,000-39,999
- ○ $40,000-49,999
- ○ $50,000-59,999
- ○ $60,000-74,999
- ○ $75,000-99,999
- ○ $100,000-149,999
- ○ $150,000-199,999
- ○ $200,000-249,999
- ○ $250,000 or more

23. Current religious preference: (Mark one in each column)

	Yours	Father's	Mother's
Baptist	Ⓨ	Ⓕ	Ⓜ
Buddhist	Ⓨ	Ⓕ	Ⓜ
Church of Christ	Ⓨ	Ⓕ	Ⓜ
Eastern Orthodox	Ⓨ	Ⓕ	Ⓜ
Episcopalian	Ⓨ	Ⓕ	Ⓜ
Hindu	Ⓨ	Ⓕ	Ⓜ
Islamic	Ⓨ	Ⓕ	Ⓜ
Jewish	Ⓨ	Ⓕ	Ⓜ
LDS (Mormon)	Ⓨ	Ⓕ	Ⓜ
Lutheran	Ⓨ	Ⓕ	Ⓜ
Methodist	Ⓨ	Ⓕ	Ⓜ
Presbyterian	Ⓨ	Ⓕ	Ⓜ
Quaker	Ⓨ	Ⓕ	Ⓜ
Roman Catholic	Ⓨ	Ⓕ	Ⓜ
Seventh Day Adventist	Ⓨ	Ⓕ	Ⓜ
Unitarian/Universalist	Ⓨ	Ⓕ	Ⓜ
United Church of Christ/Congregational	Ⓨ	Ⓕ	Ⓜ
Other Christian	Ⓨ	Ⓕ	Ⓜ
Other Religion	Ⓨ	Ⓕ	Ⓜ
None	Ⓨ	Ⓕ	Ⓜ

24. Do you consider yourself a Born-Again Christian?

○ Yes ○ No

25. Please indicate your ethnic background. (Mark all that apply)

- ○ White/Caucasian
- ○ African American/Black
- ○ American Indian/Alaska Native
- ○ Asian American/Asian
- ○ Native Hawaiian/Pacific Islander
- ○ Mexican American/Chicano
- ○ Puerto Rican
- ○ Other Latino
- ○ Other

26. For the activities below, indicate which ones you did during the past year. If you engaged in an activity frequently, mark F. If you engaged in an activity one or more times, but not frequently, mark O (Occasionally). Mark N (Not at all) if you have not performed the activity during the past year. (Mark one for each item)

	Frequently	Occasionally	Not at all
Attended a religious service	Ⓕ	Ⓞ	Ⓝ
Was bored in class	Ⓕ	Ⓞ	Ⓝ
Participated in organized demonstrations	Ⓕ	Ⓞ	Ⓝ
Tutored another student	Ⓕ	Ⓞ	Ⓝ
Studied with other students	Ⓕ	Ⓞ	Ⓝ
Was a guest in a teacher's home	Ⓕ	Ⓞ	Ⓝ
Smoked cigarettes	Ⓕ	Ⓞ	Ⓝ
Drank beer	Ⓕ	Ⓞ	Ⓝ
Drank wine or liquor	Ⓕ	Ⓞ	Ⓝ
Felt overwhelmed by all I had to do	Ⓕ	Ⓞ	Ⓝ
Felt depressed	Ⓕ	Ⓞ	Ⓝ
Performed volunteer work	Ⓕ	Ⓞ	Ⓝ
Played a musical instrument	Ⓕ	Ⓞ	Ⓝ
Asked a teacher for advice after class	Ⓕ	Ⓞ	Ⓝ
Discussed politics	Ⓕ	Ⓞ	Ⓝ
Voted in a student election	Ⓕ	Ⓞ	Ⓝ
Socialized with someone of another racial/ethnic group	Ⓕ	Ⓞ	Ⓝ
Came late to class	Ⓕ	Ⓞ	Ⓝ
Used the Internet for research or homework	Ⓕ	Ⓞ	Ⓝ
Performed community service as part of a class	Ⓕ	Ⓞ	Ⓝ
Used a personal computer	Ⓕ	Ⓞ	Ⓝ
Discussed religion/spirituality In class	Ⓕ	Ⓞ	Ⓝ
With friends	Ⓕ	Ⓞ	Ⓝ
With family	Ⓕ	Ⓞ	Ⓝ
Worked on a local, state or national political campaign	Ⓕ	Ⓞ	Ⓝ
Maintained a healthy diet	Ⓕ	Ⓞ	Ⓝ
Stayed up all night	Ⓕ	Ⓞ	Ⓝ
Missed school because of illness	Ⓕ	Ⓞ	Ⓝ

27. For each item, please mark Yes or No:

	Yes	No
Did your high school require community service for graduation?	Ⓨ	Ⓝ
Have you participated in		
A summer research program?	Ⓨ	Ⓝ
A health science research program sponsored by a university?	Ⓨ	Ⓝ

28. What is the highest level of formal education obtained by your parents? (Mark one in each column)

	Father	Mother
Grammar school or less	○	○
Some high school	○	○
High school graduate	○	○
Postsecondary school other than college	○	○
Some college	○	○
College degree	○	○
Some graduate school	○	○
Graduate degree	○	○

29. In deciding to go to college, how important to you was each of the following reasons? (Mark one answer for each possible reason)

	Very Important	Somewhat Important	Not Important
My parents wanted me to go	Ⓥ	Ⓢ	Ⓝ
I could not find a job	Ⓥ	Ⓢ	Ⓝ
Wanted to get away from home	Ⓥ	Ⓢ	Ⓝ
To be able to get a better job	Ⓥ	Ⓢ	Ⓝ
To gain a general education and appreciation of ideas	Ⓥ	Ⓢ	Ⓝ
There was nothing better to do	Ⓥ	Ⓢ	Ⓝ
To make me a more cultured person	Ⓥ	Ⓢ	Ⓝ
To be able to make more money	Ⓥ	Ⓢ	Ⓝ
To learn more about things that interest me	Ⓥ	Ⓢ	Ⓝ
To prepare myself for graduate or professional school	Ⓥ	Ⓢ	Ⓝ
To get training for a specific career	Ⓥ	Ⓢ	Ⓝ
To find my purpose in life	Ⓥ	Ⓢ	Ⓝ

30. How would you characterize your political views? (Mark one)

- ○ Far left
- ○ Liberal
- ○ Middle-of-the-road
- ○ Conservative
- ○ Far right

31. Rate yourself on each of the following traits as compared with the average person your age. We want the most accurate estimate of how you see yourself. (Mark one in each row)

	Highest 10%	Above Average	Average	Below Average	Lowest 10%
Academic ability	○	○	○	○	○
Artistic ability	○	○	○	○	○
Compassion	○	○	○	○	○
Computer skills	○	○	○	○	○
Cooperativeness	○	○	○	○	○
Courage	○	○	○	○	○
Creativity	○	○	○	○	○
Drive to achieve	○	○	○	○	○
Emotional health	○	○	○	○	○
Forgiveness	○	○	○	○	○
Generosity	○	○	○	○	○
Kindness	○	○	○	○	○
Leadership ability	○	○	○	○	○
Mathematical ability	○	○	○	○	○
Physical health	○	○	○	○	○
Public speaking ability	○	○	○	○	○
Religiousness	○	○	○	○	○
Self-confidence (intellectual)	○	○	○	○	○
Self-confidence (social)	○	○	○	○	○
Self-understanding	○	○	○	○	○
Spirituality	○	○	○	○	○
Time management	○	○	○	○	○
Understanding of others	○	○	○	○	○
Writing ability	○	○	○	○	○

32. Mark only three responses, one in each column.

M Your mother's occupation
F Your father's occupation
Y Your probable career occupation

NOTE: If your father or mother is deceased, please indicate his or her last occupation.

	Y	F	M
Accountant or actuary	Y	F	M
Actor or entertainer	Y	F	M
Architect or urban planner	Y	F	M
Artist	Y	F	M
Business (clerical)	Y	F	M
Business executive (management administrator)	Y	F	M
Business owner or proprietor	Y	F	M
Business salesperson or buyer	Y	F	M
Clergy (minister, priest)	Y	F	M
Clergy (other religious)	Y	F	M
Clinical psychologist	Y	F	M
College administrator/staff	Y	F	M
College teacher	Y	F	M
Computer programmer or analyst	Y	F	M
Conservationist or forester	Y	F	M
Dentist (including orthodontist)	Y	F	M
Dietitian or nutritionist	Y	F	M
Engineer	Y	F	M
Farmer or rancher	Y	F	M
Foreign service worker (including diplomat)	Y	F	M
Homemaker (full-time)	Y	F	M
Interior decorator (including designer)	Y	F	M
Lab technician or hygienist	Y	F	M
Law enforcement officer	Y	F	M
Lawyer (attorney) or judge	Y	F	M
Military service (career)	Y	F	M
Musician (performer composer)	Y	F	M
Nurse	Y	F	M
Optometrist	Y	F	M
Pharmacist	Y	F	M
Physician	Y	F	M
Policymaker/Government	Y	F	M
School counselor	Y	F	M
School principal or superintendent	Y	F	M
Scientific researcher	Y	F	M
Social, welfare or recreation worker	Y	F	M
Therapist (physical, occupational, speech)	Y	F	M
Teacher or administrator (elementary)	Y	F	M
Teacher or administrator (secondary)	Y	F	M
Veterinarian	Y	F	M
Writer or journalist	Y	F	M
Skilled trades	Y	F	M
Laborer (unskilled)	Y	F	M
Semi-skilled worker	Y	F	M
Unemployed	Y	F	M
Other	Y	F	M
Undecided	Y		

33. Mark one in each row:

1 Disagree Strongly
2 Disagree Somewhat
3 Agree Somewhat
4 Agree Strongly

	4	3	2	1
There is too much concern in the courts for the rights of criminals	4	3	2	1
Abortion should be legal	4	3	2	1
The death penalty should be abolished	4	3	2	1
Marijuana should be legalized	4	3	2	1
It is important to have laws prohibiting homosexual relationships	4	3	2	1
Racial discrimination is no longer a major problem in America	4	3	2	1
Realistically, an individual can do little to bring about changes in our society	4	3	2	1
Wealthy people should pay a larger share of taxes than they do now	4	3	2	1
Colleges should prohibit racist/sexist speech on campus	4	3	2	1
Same-sex couples should have the right to legal marital status	4	3	2	1
Affirmative action in college admissions should be abolished	4	3	2	1
The activities of married women are best confined to the home and family	4	3	2	1
Federal military spending should be increased	4	3	2	1
Colleges have the right to ban extreme speakers	4	3	2	1
If two people really like each other, it's all right for them to have sex even if they've known each other for only a very short time	4	3	2	1
The federal government should do more to control the sale of handguns	4	3	2	1

34. Below is a list of community service/volunteer activities. Indicate which of these you participated in during high school. (Mark all that apply)

None	○	Elder care	○	Community improvement/ construction	○
Tutoring/teaching	○	Hospital work	○	Conflict mediation	○
Counseling/mentoring	○	Substance abuse education	○	Service to my religious community	○
Environmental activities	○	Other health education	○		
Child care	○	Services to the homeless	○	Other community service	○

35. During your last year in high school, how much time did you spend during a typical week doing the following activities?

Hours per week:	None	Less than 1 hour	1-2	3-5	6-10	11-15	16-20	Over 20
Studying/homework	○	○	○	○	○	○	○	○
Socializing with friends	○	○	○	○	○	○	○	○
Talking with teachers outside of class	○	○	○	○	○	○	○	○
Exercise or sports	○	○	○	○	○	○	○	○
Partying	○	○	○	○	○	○	○	○
Working (for pay)	○	○	○	○	○	○	○	○
Volunteer work	○	○	○	○	○	○	○	○
Student clubs/groups	○	○	○	○	○	○	○	○
Watching TV	○	○	○	○	○	○	○	○
Household/childcare duties	○	○	○	○	○	○	○	○
Reading for pleasure	○	○	○	○	○	○	○	○
Playing video/ computer games	○	○	○	○	○	○	○	○
Prayer/meditation	○	○	○	○	○	○	○	○

36. Do you have any concern about your ability to finance your college education? (Mark one)

- None (I am confident that I will have sufficient funds) ○
- Some (but I probably will have enough funds) ○
- Major (not sure I will have enough funds to complete college) ○

37. Below are some reasons that might have influenced your decision to attend this particular college. How important was each reason in your decision to come here? (Mark one answer for each possible reason)

	Very important	Somewhat important	Not important
My relatives wanted me to come here	V	S	N
My teacher advised me	V	S	N
This college has a very good academic reputation	V	S	N
This college has a good reputation for its social activities	V	S	N
I was offered financial assistance	V	S	N
The cost of attending this college	V	S	N
High school counselor advised me	V	S	N
Private college counselor advised me	V	S	N
I wanted to live near home	V	S	N
Not offered aid by first choice	V	S	N
This college's graduates gain admission to top graduate/ professional schools	V	S	N
This college's graduates get good jobs	V	S	N
I was attracted by the religious affiliation/orientation of the college	V	S	N
I wanted to go to a school about the size of this college	V	S	N
Rankings in national magazines	V	S	N
Information from a website	V	S	N
I was admitted through an Early Action or Early Decision program	V	S	N
A visit to the campus	V	S	N

38. Below is a list of different undergraduate major fields grouped into general categories. Mark only one oval to indicate your probable field of study.

ARTS AND HUMANITIES
- Art, fine and applied ①
- English (language and literature) ②
- History ③
- Journalism ④
- Language and Literature (except English) ⑤
- Music ⑥
- Philosophy ⑦
- Speech ⑧
- Theater or Drama ⑨
- Theology or Religion ⑩
- Other Arts and Humanities ⑪

BIOLOGICAL SCIENCE
- Biology (general) ⑫
- Biochemistry or Biophysics ⑬
- Botany ⑭
- Environmental Science ⑮
- Marine (Life) Science ⑯
- Microbiology or Bacteriology ⑰
- Zoology ⑱
- Other Biological Science ⑲

BUSINESS
- Accounting ⑳
- Business Admin (general) ㉑
- Finance ㉒
- International Business ㉓
- Marketing ㉔
- Management ㉕
- Secretarial Studies ㉖
- Other Business ㉗

EDUCATION
- Business Education ㉘
- Elementary Education ㉙
- Music or Art Education ㉚
- Physical Education or Recreation ㉛
- Secondary Education ㉜
- Special Education ㉝
- Other Education ㉞

ENGINEERING
- Aeronautical or Astronautical Eng ㉟
- Civil Engineering ㊱
- Chemical Engineering ㊲
- Computer Engineering ㊳
- Electrical or Electronic Engineering ㊴
- Industrial Engineering ㊵
- Mechanical Engineering ㊶
- Other Engineering ㊷

PHYSICAL SCIENCE
- Astronomy ㊸
- Atmospheric Science (incl Meteorology) ㊹
- Chemistry ㊺
- Earth Science ㊻
- Marine Science (incl Oceanography) ㊼
- Mathematics ㊽
- Physics ㊾
- Statistics ㊿
- Other Physical Science (51)

PROFESSIONAL
- Architecture or Urban Planning (52)
- Home Economics (53)
- Health Technology (medical dental laboratory) (54)
- Library or Archival Science (55)
- Medicine Dentistry, Veterinary Medicine (56)
- Nursing (57)
- Pharmacy (58)
- Therapy (occupational physical speech) (59)
- Other Professional (60)

SOCIAL SCIENCE
- Anthropology (61)
- Economics (62)
- Ethnic Studies (63)
- Geography (64)
- Political Science (gov't international relations) (65)
- Psychology (66)
- Social Work (67)
- Sociology (68)
- Women's Studies (69)
- Other Social Science (70)

TECHNICAL
- Building Trades (71)
- Data Processing or Computer Programming (72)
- Drafting or Design (73)
- Electronics (74)
- Mechanics (75)
- Other Technical (76)

OTHER FIELDS
- Agriculture (77)
- Communications (78)
- Computer Science (79)
- Forestry (80)
- Kinesiology (81)
- Law Enforcement (82)
- Military Science (83)
- Other Field (84)
- Undecided (85)

DO NOT WRITE IN THIS AREA

39. Please indicate the importance to you personally of each of the following: (Mark one for each item)

E Essential · V Very Important · S Somewhat Important · N Not Important

- Becoming accomplished in one of the performing arts (acting, dancing etc) E V S N
- Becoming an authority in my field E V S N
- Obtaining recognition from my colleagues for contributions to my special field E V S N
- Influencing the political structure E V S N
- Influencing social values E V S N
- Raising a family E V S N
- Having administrative responsibility for the work of others E V S N
- Being very well off financially E V S N
- Helping others who are in difficulty E V S N
- Making a theoretical contribution to science E V S N
- Writing original works (poems novels short stories etc) E V S N
- Creating artistic work (painting, sculpture decorating etc) E V S N
- Becoming successful in a business of my own E V S N
- Becoming involved in programs to clean up the environment E V S N
- Developing a meaningful philosophy of life E V S N
- Participating in a community action program E V S N
- Helping to promote racial understanding E V S N
- Keeping up to date with political affairs E V S N
- Becoming a community leader E V S N
- Integrating spirituality into my life E V S N
- Improving my understanding of other countries and cultures E V S N
- Working to find a cure to a health problem E V S N

40. What is your best guess as to the chances that you will: (Mark one for each item)

V Very Good Chance · S Some Chance · L Very Little Chance · N No Chance

- Change major field? V S L N
- Change career choice? V S L N
- Participate in student government? V S L N
- Get a job to help pay for college expenses? V S L N
- Work full-time while attending college? V S L N
- Join a social fraternity or sorority? V S L N
- Play varsity/intercollegiate athletics? V S L N
- Make at least a "B" average? V S L N
- Participate in student protests or demonstrations? V S L N
- Transfer to another college before graduating? V S L N
- Be satisfied with your college? V S L N
- Participate in volunteer or community service work? V S L N
- Seek personal counseling? V S L N
- Communicate regularly with your professors? V S L N
- Socialize with someone of another racial/ethnic group? V S L N
- Participate in student clubs/groups? V S L N
- Strengthen your religious beliefs/convictions? V S L N
- Participate in a study abroad program? V S L N

41. Do you give the Higher Education Research Institute (HERI) permission to include your ID number should your college request the data for additional research analyses? ○ Yes ○ No

The remaining ovals are provided for questions specifically designed by your college rather than the Higher Education Research Institute. If your college has chosen to use the ovals, please observe carefully the supplemental directions given to you.

42. A B C D E
43. A B C D E
44. A B C D E
45. A B C D E
46. A B C D E
47. A B C D E
48. A B C D E
49. A B C D E
50. A B C D E
51. A B C D E
52. A B C D E
53. A B C D E
54. A B C D E
55. A B C D E
56. A B C D E
57. A B C D E
58. A B C D E
59. A B C D E
60. A B C D E
61. A B C D E
62. A B C D E

THANK YOU!

Appendix B – Variable Definitions and Coding Schema

Items	Scale and Range
Background Characteristics	
Gender	0 - Male; 1- Female
Parent(s)' highest level of education	1 - Grammar school or less; 2 - Some high school; 3 - High school graduate; 4 - Postsecondary school other than college; 5 - Some college; 6 - College degree; 7 - Some graduate school; 8 - Graduate degree
Parent is an engineer or computer analyst/programmer	0 - No; 1 - Yes
High School Context and Performance	
Attended a private high school	0 - No; 1 - Yes
Average high school grade	1 - D; 2 - C; 3 - C+; 4 - B-; 5 - B; 6 - B+; 7 - A-; 8 - A or A+
Years of HS mathematics	0 - Less than 4 years of mathematics; 1 - 4 or more years of mathematics
College Contexts	
Reported any financial concerns	0 - No; 1 - Yes
Attended a top 50 producer of African American engineers (B.S.)	0 - No; 1 - Yes
Attended a historically Black college or university	0 - No; 1 - Yes
Attended a private college or university	0 - No; 1 - Yes
Percent of student population with STEM major	.13% to 32.54% range
College or university's average SAT score (100 point scale)	7.55 to 14.67 range
Revenue per full time equivalent student	continuous varialbe in dollars divided by number of full time equivalent students
Dependent Variable	
National Clearinghouse degree attainment information	0 - non-STEM field; 1 – Science or mathematics; 2 - Engineering or computer science

Appendix C – Recruitment Email

Dear engineering or computer science student,

You are invited to participate in a UCLA Education research study lasting approximately 60 minutes. The purpose of the study is to better understand the experiences of successful African American/Black engineering undergraduates at public research universities. It is designed to explore your overall college experience with particular attention to your experiences as an engineering student. I will also ask you to recall some of your pre-college experiences such as factors that contributed to your decision to pursue the engineering field. Your participation in this research study (or decision not to participate) will not affect your relationship with UCLA or your current Institution.

This research is being conducted by Christopher B. Newman of the UCLA Graduate School of Education & Information Studies. The criteria to participate are as follows:

- You must be an engineering major (All engineering majors including computer science) with Junior or Senior class standing.
- You must have at least a 3.0 grade point average.
- You must identify as Black or African American.

You can choose to participate in one of two ways: 1) A 45-60 minute one-on-one and face-to-face interview with Christopher Newman (Primary Investigator) or 2) A 60-75 minute face-to-face focus group session with 4-5 of your peers and Christopher Newman. There is a brief questionnaire to complete (about 5 minutes) before both the individual interview and focus group. Please let me know if you have any questions at christopher.newman@ucla.edu.

Thank you for your time,
Christopher

Christopher B. Newman, M.A.
Ph.D. Candidate
UCLA Graduate School of Education & Information Studies

Appendix D – Background Questionnaire

Student Information Sheet

Please complete the following survey by marking your most appropriate responses on each question.

Name: _____

Email: _____

Date of Birth: _____

1. Sex: O Female O Male

2. Please tell us how you racially/ethnically identify_____

3. What year are you at your college or university?
O Freshman O Sophomore O Junior O Senior O 5+ O Alumni

4. Did you transfer to your current institutions from another college? O Yes O No
If yes, please specify the institution: _____

5. What is your area of study?
Major_____**Minor**_____

6. Generation/Citizen Status (Please select one)

- O Your grandparents, parents, and you were born in the U.S.
- O Either or both your parents and you were born in the U S.
- O You were born in the U.S., but neither of your parents were
- O You are a foreign born, naturalized citizen
- O You are a foreign born, resident alien/permanent resident
- O None of the above applies to you

7. What was the approximate combined income of your parents/guardian before taxes last year? Include taxable and nontaxable income from all sources. *Mark one.*

Less than $39,999	O	$100,000 to $149,999	O
$40,000 to $59,999	O	$150,000 to $180,000	O
$60,000 to $99,999	O	$180,001 or more	O

8. Indicate the highest level of education completed by your mother/guardian and father/guardian. *Mark one in each column.*

	Mother/Guardian	Father/Guardian
Grammar school or less	O	O
Some high school	O	O
High school diploma	O	O
Some college or postsecondary education	O	O
Associate's degree	O	O
Bachelor's degree	O	O
Some graduate or professional	O	O
Graduate or professional degree (e.g., MA, PhD, MD, JD)	O	O
Other: Please specify _____	O	O
Unknown	O	O

9. Are you the first in your family to attend college? O Yes O No

10. How would you describe the neighborhood where you grew up?

a. O Racially Diverse O Predominantly White O Predominantly Black

11. Approximately how many miles is this university from where your parent(s)/guardian live? _____

12. How would you describe your high School?

a. O Public O Private non-religious affiliated O Private Religious affiliated OCharter School O Boarding School

b. O 1-199 students O 200-699 students O 700-1,199 students O1200-1,999 students O2,000-2,999 students O3,000 or more students

c. O Racially Diverse O Predominantly White O Predominantly Black O Other: _____

13. What organizations have you been a part of since entering college and what year where you in school when you became a member?

_____
_____
_____

14. What was your high school grade point average (unweighted)? _____

15. What was your SAT score?

Verbal: _____

Math: _____

Writing: _____

16. How many honors and Advanced Placement (AP) courses did you take in high school?

_____

17. What is your college grade point average? _____

a. What is your GPA in your major: _____

18. What are your plans immediately after you complete your undergraduate degree?

O Begin graduate education (i.e. Masters or Ph D)
O Begin professional work in my field of study
O *I am not sure that I will complete my undergraduate degree*
O Other. Please Explain _____

Thank you for your time.

Appendix E – Individual Interview Protocol

Early Experiences

1. How did you become initially interested in the field of Engineering?
    a. What motivates you to pursue Engineering as a major?

2. Was there anyone (e.g., family, teacher, counselor, or mentor) who encouraged you to strive for a career in Engineering?
    a. How did they encourage you?

Transitions and Interventions

3. When you entered (Institution) did you feel adequately prepared academically?
    a. What was the most important factor that helped you transition to college?

4. At any point in your undergraduate experience have you had any financial concerns?

5. What are the biggest challenges or obstacles you faced as a Black Engineering major?
    a. How did you overcome these challenges?

Co-curricular Involvement

6. Did you participate in any internship programs in high school or college?
    a. If yes, please tell me a little bit about your experience. What were the types of activities you were involved in?
    b. Have you been involved in any projects with faculty in engineering outside of class?

7. Are you involved in any student organizations?
    a. If yes, please tell me a little bit about the organization (e.g., purpose, sponsored activities) and why you joined? Would you consider yourself and active member?
    b. If no, why not?

Academic and Career Goals

8. What are your immediate and long term academic and career goals?
    a. Are there any experiences in college that has impacted your decision to pursue a certain career?
    b. How did you find out about the academic and career opportunities that you may have after undergrad?
    c. What does your family think of your career goals?

Appendix F – Focus Group Protocol

Institutional Context

1. How would you describe the academic and social environment for successful Black engineering students at this university and within the school of engineering?
    a. Do you feel like you are part of the campus community? Why or why not?
2. (UNIVERSITY) has been selected for this research study because it is consistently one of the top producers of bachelor's degrees in engineering among Black students. What is it about (UNIVERSITY) that has led to this success?

Peers

3. Would you describe the academic environment amongst your peers in engineering as competitive or collaborative?
    a. Could you give me an example of an experience that has led you to this conclusion?
4. Have you had any negative experiences with students in engineering or the broader campus community? If so, please give an example.

Faculty

5. Do you think the faculty in engineering at (UNIVERSITY) are concerned with your academic success?
    a. Have any faculty members played a part in your successes in Engineering?
    - If so, what have these faculty members done to contribute to your success?
    b. Have you been involved in any projects with faculty in engineering outside of class?
6. Have you had any negative experiences with faculty members in engineering or in other STEM courses?

Expanding the Pipeline

7. What advice would you give a first year student that is interested in pursuing engineering at (UNIVERSITY)?

Appendix G – Administrator Interview Protocol

1. (UNIVERSITY) has been selected for this research study because it is consistently one of the top producers of bachelor's degrees in engineering among Black students. What is it about (UNIVERSITY) that has led to this success?

2. What do you think are the biggest challenges schools of engineering face in trying to support Black engineering students?
    a. How has (UNIVERSITY) tried to address these challenges?

3. What types of policies or funding streams can help you achieve your mission?

Appendix H – Faculty Interview Protocol

1. (UNIVERSITY) has been selected for this research study because it is consistently one of the top producers of bachelor's degrees in engineering among Black students. What is it about (UNIVERSITY) that has led to this success?

2. You were selected for participation in this study because (a number) of Black engineering students told me that you played an important role in their academic achievement. Do you have a particular strategy or philosophy when dealing with undergraduates in engineering?

3. Do you feel supported by the university, the school of engineering, or your department in your support of Black engineering undergraduates?

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