



## **Leaving engineering: An examination of the reasons that influence Black Women to depart (Work in Progress)**

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# **Leaving Engineering: An Examination of the Reasons that Influence Black Women to Depart**

## **Abstract**

Black women continue to be underrepresented in engineering education programs and this disproportionate representation continues into the engineering workforce. Research indicates that once entering an engineering career, 25% of women leave the field within five years and experience discrimination not endured by White men. These studies, however, frequently lack detailed examination of Black women who are significantly underrepresented in engineering when compared to all women. In order to continue to diversify the engineering workforce and create work environments that are inclusive and that encourage the persistence of Black women, it is essential for the engineering education community to be knowledgeable of the experiences of this group in engineering. Using critical race theory and intersectionality frameworks, this study utilizes quantitative and qualitative data to examine the reasons that influenced Black women to leave their engineering positions. Engineering graduates of a large public Midwestern university were surveyed. Ten of the 3,807 graduates identified as a woman and Black or African American. Participants provided information on their career trajectories, including information on their position(s) held and the reasons that influenced them to leave. Reasons that influenced Black Women engineers to leave their engineering positions are presented. Preliminary analyses and findings will be used for further examination in a larger population. This study can begin to capture reasons that influence Black women to leave the engineering workforce. Results of this work can provide ideas to improve efforts to support Black women in the workforce.

## **Introduction and Literature Review**

In the past few decades the participation of women and racial-ethnic minorities in science and engineering has increased; however, there are still gender and racial disparities that exist [1, p. 389]. When examining Black women post-graduation, they are considerably underrepresented in academia and engineering industry. Black women make up 4% of all women engineering professors [2] and comprise only 0.72% of engineers in engineering industry [3][4]. Fouad and Singh [5] also discovered that once women join the engineering workforce, 25% of women leave the field within five years. In order to resolve the issues surrounding the underrepresentation and retention of Black women in engineering, it is important to understand the experiences of Black women in the academy and industry.

Women in engineering academic institutions and engineering industry have varying experiences but there are many commonalities. Women in both the academy and industry have indicated that these environments have “chilly” climates [6][7]. In the engineering workplace, both academia and industry, women have experienced discrimination and harassment [8][9][10]; gender and racial bias [8][10][11]; and challenges in hiring, salary, promotions, or tenure [5][11][12][13]. Fouad et al. [6] stated, “Some have argued that women leave engineering or STEM careers because they lack confidence, others cite women's lack of interests in technical areas” [6, p. 80].

When it comes to Black women, there is limited scholarly literature describing the challenges they encounter in the engineering profession. However, one can presume from the small amount

of literature that is available that Black women face some of the same challenges as described above. A dissertation described some of the barriers to success for Black women in the engineering workforce [14]. Those barriers included “the lack of diversity within engineering organizations and the impact of the participants’ age, race, and gender on their career experiences” [14, p. 148]. There are challenges and experiences that Black women face that are influenced by race [15] that White women do not encounter. For example, there is a shortage of quality mentoring opportunities for women of color [16]. There are no systematic studies that examine why Black women leave engineering industry positions. However, Ross [4] examined the experiences of Black women in engineering industry in her dissertation and found several reasons why they stay in engineering despite the challenges faced. Black women indicated that they stayed in engineering due to mentors, personal relationships with colleagues, and because of obligations or commitments to their priorities [4].

Unfortunately, many studies that examine women study the group as a whole without consideration of the different experiences within the group, such as different experiences by race. Most studies do not consider the intersections exemplified by women and men of color and typically focus on gender or race/ethnicity separately [17]. Rice and Alfred [18] wrote, “there is a dearth of research and literature examining the career experiences of African American female engineers” [18, p. 40]. Similarly, Ong, Wright, Espinosa, and Orfield [19] examined almost forty years of empirical data on the educational experiences of postsecondary women of color in STEM. The authors acknowledge the gaps in the literature and the progress made in studying minority populations. They stated:

While it is promising that researchers are taking greater notice of the need to address the intersection of gender and race/ ethnicity in STEM education and careers, there is a long way to go before we can truly understand the environments and experiences that promote or hinder the advancement of women of color in scientific and technical fields

The authors further suggested that research on women of color be made a priority so that improved data collection and analysis will be excited and in turn promote progression towards understanding and transformation. We believe that understanding the experiences of Black women engineers can help with the recruitment and retention efforts of this group.

## **Purpose of Study**

### ***Scope***

The purpose of this study is to examine Black women and the reasons that influence them to leave their engineering positions. This study investigated Black women with an engineering degree from an accredited engineering program from a single institution. It also included women in both the academic and non-academic engineering workforce. Differences have been cited when it comes to engineers serving in faculty positions and those working in industry. For example, DeCuir-Gunby, Grant, & Gregory [15] found that Black women engineering professors who had professional experiences in industry felt industry was too structured. Mlambo & Mabokela [6] found that female engineers who left industry to pursue a position in academia indicated that industry was rigid and discrimination was prevalent while a position in the

academy provided them with more flexibility and support. Despite these differences, the reason for including both academic and non-academic positions is due to the already small sample size of participants. The goal of this study is to answer the following research questions:

1. What reasons do Black women cite that influenced or may influence them to leave their engineering position(s)?
2. Is there a trend in particular factors (e.g., engineering position, sense of belonging in engineering) and Black women's decisions to leave their engineering position(s)?

## **Theoretical Framework**

In order to examine the experiences of Black women in engineering industry, critical race theory and intersectionality theory were used to understand the experiences that Black women encounter in the engineering workplace. Intersectionality theory provides a framing for studying the experiences of Black women who sit at the intersection of social identities that have been traditionally marginalized. Critical race theory supports ways to examine and understand how Black women experience, perceive, and respond to racism in the engineering workplace.

### ***Intersectionality***

When women are studied broadly, subgroups like Black women may end up being ignored or unaddressed [21]. Intersectionality, which has origins in critical theory, provides a framework to help understand and analyze the experiences of individuals who belong to multiple social categories or domains (e.g., race, gender, age, etc.). "Rather than seeing people as a homogeneous, undifferentiated mass, intersectionality provides a framework for explaining how social divisions of race, gender, age, and citizenship status, among others, positions people differently in the world..." [22, p. 15]. Kimberlé Crenshaw first coined the term intersectionality in 1989 to describe the experiences of Black women who encountered greater forms of marginalization and oppression because of their intersection of race and gender [23]. Crenshaw suggested that an examination of only women "erases Black women in the conceptualization, identification and remediation of race and sex discrimination by limiting inquiry to the experiences of otherwise-privileged members of the group" [24, p. 140]. In her examination of Black women plaintiffs, Crenshaw found that they:

sometimes experience discrimination in ways similar to White women's experiences; sometimes they share very similar experiences with Black men. Yet often they experience double discrimination – the combined effects of practices, which discriminate on the basis of race, and on the basis of sex. And sometimes, they experience discrimination as Black women – not the sum of race and sex discrimination, but as Black women. [24, p. 149]

In their examination of the empirical data on the educational experiences of postsecondary women of color in STEM, Ong et al. [19] discovered that environments were complex for women of color due to racial and ethnic discrimination. Women of color were often situated in difficult positions where they encountered various systems of oppression [19].

Collins and Bilge [22] indicated that intersectionality is used as an “analytic lens” to stress the multi-faceted aspects of individual identities and how variable combinations of categories like class, gender, race, sexuality, and citizenship differentially situate each individual. Similarly, intersectionality is used in this study to examine how the race and gender of Black women may affect their experiences in the engineering workplace and their decision to leave or stay in engineering industry. This intersectionality framework grounds the findings in experiences that actually represent Black women versus a potentially inaccurate representation from a single-axis study (i.e., race only, gender only), which overemphasizes the experience of privileged group members (e.g., White women).

### ***Critical Race Theory***

Research indicates that women and people of color in engineering encounter sexism and racism biases, and other inequalities in the engineering workplace that their White male counterparts do not [8][11]. While its existence is often suppressed, racism is still prominent today [25]. Omi and Winant indicated that “Structural forms of racial inequality persist and in many cases have deepened” [25, p. 1]. Because Black women are the focus of this research, racial biases in engineering are crucial to the examination of the experiences of Black women in engineering, a discipline that has been and still is composed mainly of White men. Critical race theory (CRT) provides a lens for examining race across dominant cultures.

Delgado & Stefancic described CRT as a movement engaged in “transforming the relationship among race, racism, and power” [21, p. 3]. CRT provides a race-conscious approach to interpret inequality and structural racism in addition to examining systems and customs to reveal the explicit and implicit ways that racist ideologies and institutions create and preserve racial inequality [26]. CRT will be used to analyze how Black women experience engineering workplace environments that are typically characterized as being dominated by White males and having institutionalized structures that are exclusionary to minorities like Black women. CRT will also help to examine and understand how Black women experience, perceive, and respond to racism in the engineering workplace and whether or not these experiences influence their decision to leave or depart from engineering.

### **Methods**

This study collected both quantitative survey data in responses to anchored numeric scales and qualitative write in data from 3,807 undergraduate engineering degree holders from a single Midwestern institution (7.8% response rate to alumni with emails on file). The survey was first distributed in July 2019 through the institution’s alumni association, with a follow-up email reminder three weeks later. In August and September 2019, another round of recruitment occurred through four engineering majors of interest to the larger project (namely, biomedical, chemical, mechanical, and electrical and computer engineering). Potential participants were given a link to an online survey, asking them to help the university prepare the next generation of engineering students [27].

### ***Survey Instrument***

The survey instrument was divided into three sections: (1) characterizing the participants' post-baccalaureate pathways; (2) describing their experiences with and beliefs about engineering; and

(3) collecting personal information about participants, including their demographics. First, to characterize career pathways, we asked participants to identify the number of career positions that they have experienced, including educational opportunities and periods of unemployment. For each position where the participant was an employee, we asked participants for the job title, occupational sector (e.g., public, private, etc.), and industry sector (e.g., manufacturing, finance, etc.). For student positions, participants selected the most appropriate degree title (e.g., Ph.D., J.D., MBA, etc.) and wrote-in the specific program that conferred the degree. Beyond these processes for identifying each position, this section of the survey also asked participants to share their perceptions of relatedness to engineering, the extent of their use of their engineering degree, and reasons that influenced or may influence their decision to leave the position. For reasons that influenced or may influence their decision to leave the position(s), participants were able to select from nine options (e.g., natural career progression, laid off/fired, pay, promotion opportunities, work responsibilities, work conditions, work environment, job location, change in career or professional interests, and family-related reasons) and also had the option to write-in reasons not listed. If participants selected “work conditions” or “work environment” as one of the reasons that influenced them to leave or would influence them to consider leaving, the survey prompted a write-in question asking for an additional explanation from the participant. In the second section of the survey, we asked participants to select any engineering- and career-relevant experiences that they had as an undergraduate student, including internships, pre-professional organizations, and attending job fairs. Next, participants described their current (or most recent) work experiences in terms of their developmental opportunities, turnover intentions, and job attitudes. In the third section of the survey, participants provided information relating to their demographics, undergraduate degree, and additional write-in comments. We asked participants to report their year of graduation, undergraduate major, residency status as an undergraduate student (in state, out of state, international), gender, and race/ethnicity.

### ***Participants***

For this study, participants were chosen based on their responses to the gender and race/ethnicity survey questions. Only ten of the 3,807 graduates identified as a woman and as Black or African American and were included in this study. Based on this sample size, all analyses are descriptive. Table 1 provides an overview of the participant characteristics.

**Table 1.** Participant Characteristics

<b>Participant</b>	<b>Gender</b>	<b>Race/Ethnicity</b>	<b>Undergraduate Major</b>
1	Woman	Black or African American A race or ethnicity not listed	Industrial Engineering
2	Woman	Black or African American	Civil Engineering
3	Woman	Black or African American Asian A race or ethnicity not listed	Electrical and Computer Engineering
4	Woman	Black or African American	Chemical Engineering
5	Woman	Black or African American	Mechanical Engineering

6	Woman	Black or African American	Interdisciplinary/Multidisciplinary Concentration: Biomedical
7	Woman	Black or African American	Environmental and Ecological Engineering
8	Woman	Black or African American	Chemical Engineering
9	Woman	Black or African American	Chemical Engineering
10	Woman	Black or African American	Electrical and Computer Engineering

### ***Data Analysis***

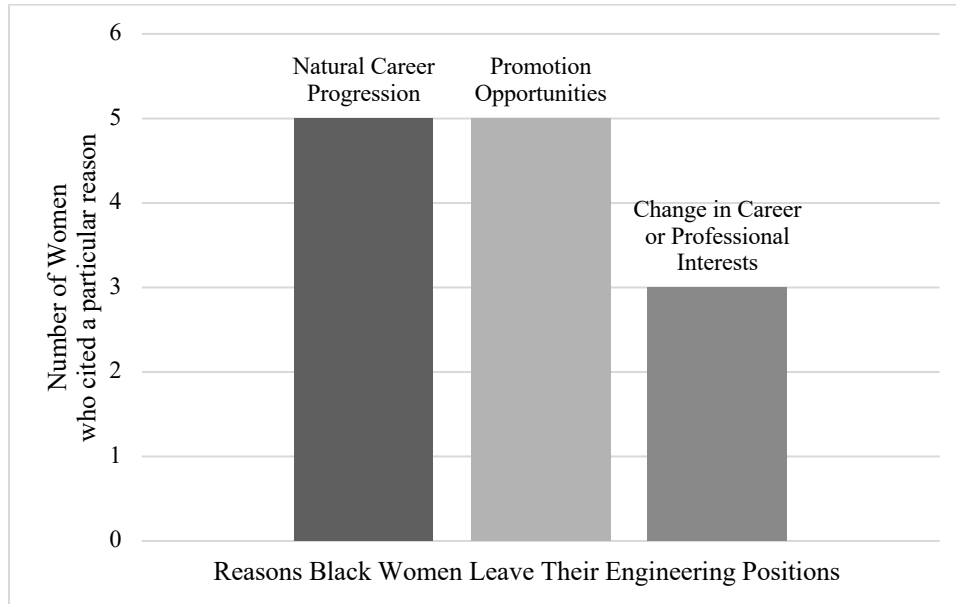
Data analysis consisted of two phases. First, we used descriptive statistics to describe trends in the participant responses to the survey questions. Second, we engaged in systematic coding and thematic analysis of the responses provided for the write-in questions. Thematic analysis is most valuable in capturing the intricacies within a textual dataset [28].

A total of nine participants were used for data analysis. We excluded one participant from the study (Participant 6) because she completed the survey incorrectly. The survey requested information about participant positions (up to 5) held immediately after receiving their undergraduate degree. The participant identified their first position as a resident physician. This signified to us that the participant omitted prior positions that included positions related to medical school in which they were a student. We could not account for that large gap and furthermore, the positions that the participant provided were not engineering related in any way. Since the focus of this study is on Black women in engineering workplace, this participant was omitted.

### **Preliminary Results**

The women studied held various numbers of positions at the time of the study. Five of the women held five positions, two of the women held four positions, one of the women held two positions and one of the women held one position after receiving her undergraduate degree. Our analysis showed that of the nine participants, one of them left the engineering field altogether after leaving her first engineering position. Reasons cited by the woman included change in career or professional interests and family-related reasons. All of the other women stayed in engineering or engineering-related careers, but cited various reasons for leaving each position. One woman has remained in the same engineering position for her entire career trajectory thus far. She cited pay, being laid off/fired, and work conditions as reasons that may influence her to leave her current position.

We identified the top three reasons cited by Black women that influenced them to leave their engineering positions. The top three reasons that influenced Black women to leave their engineering positions were natural career progression, promotion opportunities, change in career or professional interests (see Figure 1).



**Figure 1.** Top three reasons Black women leave their engineering positions

Natural career progression and promotion opportunities were also in the top three reasons cited by Black women, that may influence them to leave the engineering position in which they are currently employed. Being laid off/fired and work conditions (e.g., hours, equipment) tied for the top three reason.

One woman did indicate that the work environment (e.g., culture, interaction with coworkers/bosses) influenced her to leave her engineering position. When asked to provide additional information about the work environment she said:

There were hiring freezes the year I started networking to get back onto an Engineering team; nothing was open for a year. When side opportunities came up, my manager blocked me from pursuing them even though I had the time to spare. Another coworker was able to participate in this national opportunity however.

Two other women indicated that work conditions may influence them to leave their current engineering positions. One woman said:

Work life balance is important for anyone. If you are working 10+ hours a day you do not get the chance to decompress and spend it with those that matter. You cannot fully enjoy life in this way.

Another woman said:

My current position at times requires long work hours so I have thought about looking for opportunities that would afford a healthier work-life balance.

Together, these results indicate that early on in their careers, Black women may often switch positions based on the current work environment, opportunities for better employment, or



particular driving interests. None of the women surveyed indicated particular reasons related to bias experienced in the workplace or other reasons. We discuss the implications of this finding below.

## **Discussion**

Although the literature describes challenges that women face in engineering including “chilly” climates, lack of diversity, discrimination, and challenges that are influenced by race and gender; surprisingly, the work environment was not a common reason cited for Black women leaving their positions. In fact, only one woman cited the work environment as a reason that influenced her to leave her engineering position and two women indicated that work conditions may influence them to leave their current engineering positions. This is surprising to us because intersectionality and critical race theory speak to the complex systems of oppression that Black women are often situated in due to the intersection of their race and gender. The engineering workforce is widely known to be composed of White men, so the absence of experiences related to race and gender was shocking. We attribute these unexpected results to our sample. The small sample size and characteristics of the participants likely influenced the results. We may have also surveyed more recent graduates who have not had a career-long set of experiences and the opportunities for reflection on those experiences. Previous studies on Black women in engineering industry, although few, have often focused on women with more extensive experiences (ten years or more).

We also note that the smallness of the sample is an indicator of earlier barriers to entry into engineering and graduation rates that must be addressed if more Black women are to enter the workforce. Out of over 3,500 survey participants, only ten were Black women (less than 0.3% of the sample). These numbers indicate the challenges of studying this group as well as future work that must be done to open pathways. All of the participants were from the same institution, a large predominantly white institution (PWI). These Black women have likely had experiences in their undergraduate engineering program similar to some of those encountered in engineering industry (e.g., lack of diversity). These women may be accustomed to certain types of environments where other Black women who may have attended another institution, such as a historically black college and university, are not familiar. Indeed, a prior study of women who stayed in the engineering workforce found that many of the women who stayed over ten years attended a historically black college and university [4]. We also theorize that Black women who have endured challenges in the engineering workforce may be less apt to complete a survey of this type and talk about the challenges they have experienced in the workplace with someone they are not familiar with. A more personalized approach such as establishing rapport with the participants prior to administering the survey or participant interviews may elicit information that participants may initially be hesitant to share.

## **Future Work**

Data analysis is ongoing and will consist of a complete analysis of the reasons that influence Black women to leave their engineering positions. Trends and relationships between other factors and the decision to leave will also be examined. We also asked participants for their emails and permission to contact them about their survey responses. We plan to conduct more in-

depth interviews with these women to better understand their experiences within the workforce. Our hope is that this study will help provide insights into Black women's career experiences in engineering.

## Conclusions

In a large survey of alumni at a single institution, we found very few Black women graduates, only ten. In understanding why these women moved between positions early on in their careers, we found three main reasons they cited. The top three reasons that influenced Black women to leave their engineering positions were natural career progression, promotion opportunities, and change in career or professional interests. These descriptive numbers and trends provide some insight into the experiences of Black women, but do not tell the whole story of their experiences. Our future work will delve into these experiences and reasons for leaving engineering in more depth.

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