Women of Color Engineering Faculty: An examination of the experiences and the numbers

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An Examination of the Numbers: African American Female Faculty in Engineering

Abstract

In December 1975, a group of underrepresented minority women pursuing careers in science, engineering, medicine, and dentistry convened under the auspices of the American Association for the Advancement of Science (AAAS). The women shared common experiences related to the "double oppression of sex and race or ethnicity plus the third oppression in the chosen career, science". They discussed their unique positions, identified common barriers and challenges to their success, and formulated plans for change at departmental and institutional levels. The ensuing publication, *The Double Bind: The Price of Being a Minority Woman in Science,*[1] marks the first collective report on the unique challenges faced by underrepresented minority women in the sciences. 7

According to Malcolm et al.,[1] much has changed regarding women of color (WOC) since 1975. The conversation has moved from "rights versus wrongs" and more about support versus neglect; less about the behavior of individuals and a culture that was accepting of bias as the 'natural order of things' and more about the responsibilities and action (or inaction) of institutions". Yet, much has also stayed the same. Over thirty years since this seminal publication, relatively little is known or published about the quality of the collective experiences of WOC faculty in engineering and the distinct issues that WOC encounter.

We aim to fill this gap by presenting emergent themes arising from panel discussions held at the 2006 American Society for Engineering Education (ASEE) Conference, Frontiers in Education (FIE) Conference and the 2007 "Keeping our Faculties of Color Symposium," a synthesis of relevant WOC literature, and the current status of WOC faculty in engineering using numerical indicators from the American Society for Engineering Education. Our goal is to motivate further studies and empirical analyses that explore the experiences of WOC in engineering. Thus, key stakeholders (e.g., higher education institutions and policy makers) will have pertinent information and evidence to design initiatives and policies to effectively recruit and retain diverse science, technology, engineering, and mathematics (STEM) populations.

Introduction

In 2006 and 2007, seven African American women engineering faculty representing the ranks of Assistant, Associate, and Full Professors at ABET-accredited institutions held two panel sessions to discuss their experiences in academia. The 2006 session was held at the 36th annual American Society for Engineering Education (ASEE)/Institute of Electrical and Electronics Engineering (IEEE) Frontiers in Education Conference in San Diego, California,[2] and the 2007 session was held at the "Keeping Our Faculties of Color Symposium IV" in Minneapolis, Minnesota.[3] The motivation for these sessions stemmed from the fact that, with the exception of a few personal reflections, little is known about the quality of the collective experiences of African American women academics in engineering and the distinct issues that African American women encounter. Rather, the tendency has been to extrapolate knowledge from the experiences of all women in science, technology, engineering, and mathematics (STEM).

Based upon the positive feedback and overwhelming interest by diverse stakeholders (e.g., administrators, graduate students, and majority faculty) about the academic experiences of African American women engineering faculty at these conferences, the authors were encouraged to explore in more detail the national demographics of African American women in engineering and the available information about the national demographics and the available information of African American faculty women in engineering. Such an exploration might move the engineering education community from anecdotal accounts of these experiences to an increased number of empirical studies exploring this group. In this way, key stakeholders at institutions housing minority faculty may reevaluate and ultimately enhance the climate and the environments for African American female faculty. It is hypothesized that by knowing more about the demographics along with current trends, it will be possible to recruit and to retain African American women in the engineering professoriate. With this in mind, the main question addressed in this paper is, "What can we learn from data about African American female faculty within U.S. accredited engineering programs, and how might these data provide a foundation for the development of new initiatives promoting the experiences of African American female faculty in engineering?"

Literature Review

This section will present a survey of research and data related to several demographic groups in STEM and engineering including women of color (WOC). Although the primary focus of this paper is WOC in engineering, the authors will provide information about the larger landscape of WOC in STEM in an effort to make connections and distinctions within the literature. This is necessary since there is such a large disparity of data explicitly targeting WOC in engineering. This section will provide a historical perspective regarding African American women in academia, particularly in engineering. Such a review is timely, since it is often difficult to find literature on this subject matter and since many times the challenges of African American women in academia are assumed to be the same as white women or other majority or minority populations.[4]

Minority Faculty in the Academy

Authors have found several disparities between the experiences of men and women faculty in all disciplines. With respect to tenure, women are less likely to be employed in tenure-track positions and if so are more likely to be at the assistant professor rank.[5] Women are also less likely to earn tenure or become a full professor.[5] Whether women faculty earn tenure or not, there are still perceived disparities in salary, teaching assignments, space, awards and resources for WOC. Such disparities have led to barriers to success, including isolation and marginalization.[4]

Gregory[6] indicates that African American women in the academy are more likely to remain if they have tenure status at a four-year institution. Some of the barriers that African American women face include organizational barriers, institutional climate, lack of respect from colleagues, unwritten rules of university life, and a lack of mentoring. Gregory further stated that important factors for success and achievement among African American women included connections to God, early mentorship, personal and professional autonomy, connections to public service, and commitment to community and family life.

One of the seminal faculty of color books, authored by Christine Stanley,[4] is universally common across many types of universities and racial and ethnic groups. Among the challenges facing faculty of color, particularly African American and Latino faculty, are negative experiences in the classroom. Many times, majority students feel that minority faculty member's expectations are too high or are not similar to the perspectives of white professors. Since white males have been found to relate better to white women, it is also hypothesized that white women could be integral in bridging the gap between faculty of color and white men. Stanley goes on to state that African American faculty experience a slightly higher mean level of stress than other faculty, typically because they must convince a small group of people, typically white men, that they are good enough to be a part of a majority academic community.

Experiences of Women of Color in Science, Technology, Engineering and Mathematics (STEM)

According to the American Society for Engineering Education (ASEE), underrepresented minority (URM) groups in the United States include African Americans, American-Indians, Asian-Americans, Hawaiian/Pacific Islanders, Hispanics, and two or more races (where one of these races is a minority). Such populations are classified as URMs given the low numbers of women and minorities represented in all areas of the U.S. STEM workforce.[5] Despite national calls for increased represented of URMs in STEM, only a small number of studies have focused upon the experiences of WOC in STEM. Among these include Malcom et al's[1] seminal work in which thirty WOC discussed the "double bind" of being a woman and a person of color in STEM. Malcom and Malcom[7] revisited the "double bind" 35 years later. Other work related to WOC in STEM include Ong's[8] synthesis of research studies about WOC's career choice identification, their early experiences, and their workplace conditions and Lucero's examination of the early career experiences of ten African American women faculty and exploration of the negotiation strategies of these early career faculty.[9]

Malcom and Malcom[7] state that after 35 years, African American women in STEM face different challenges because the focus is more directed toward support than neglect. This new focus has moved from the behavior of individuals and a culture of bias to the responsibilities and action of institutions at large. One result of Malcom et al.'s work[1] is the development of programs targeting female underrepresented minorities in STEM fields, who are more likely to pursue life, social or behavioral science careers than engineering careers. Malcolm and Malcolm[11] argue that the slow growth in computer science and engineering may be due to barriers produced by the lack of faculty diversity and rigid cultures in certain disciplines.

In1970, 76 black women were identified as college or university teachers.[1] In addition, 775 black women were identified as engineers across all occupational sectors, according to the U.S. Census. In 1973, only one black woman graduated with an engineering doctorate in the U.S. In 1970, across all minority populations only 1400 minority women taught in STEM fields in U.S. colleges and universities.[7] Despite efforts to advance WOC in the academy, by 2008, minority women faculty were more likely to be employed at 2-year or non-doctoral granting four year institutions than white female faculty or minority male faculty.[7]

In May 2013, the Institute for Women Policy Research, with support from the National Science Foundation ADVANCE Program, convened and released a report entitled, "Accelerating Change for Women Faculty of Color in STEM."[11] This report provides recommendations for improving

advocacy, funding opportunities, and institutional practices regarding WOC in STEM within the academy. This report states that WOC representation in the STEM professoriate is lowest among Black, Hispanic and Native American women. Women make up 15% of the population of working-age adults but only 5.7% of those with STEM doctorates in the United States. As highlighted by Malcom,[11] the largest disparity is in computer and mathematical sciences. The WPR report states that as the workforce becomes more diverse, not capitalizing on a more complete diverse STEM pool will cause the nation to suffer and not benefit from the innovations, discoveries, breadth of knowledge, and experiences that this population can contribute. Some presenters stated that STEM WOC move from being highly visible to invisible via a phrase coined "pet to threat".

Recommended support strategies to improve the climate for WOC in STEM include expanded program initiatives, more convening opportunities for networking, and increased institutional transparency.[11] Advocacy recommendations include access to information increasing awareness about the status of WOC in STEM, national standards for volunteer and service work for faculty members, and metrics for monitoring and publicizing an institution's progress on diversity in STEM. With regard to improved funding opportunities, the panel recommended structured funding to increase the visibility and prestige of WOC, the creation of programs to support the financial security of WOC, and the provision of greater transparency about the gender and racial/ethnic background of those who apply and receive federal grants. With respect to institutions, recommendations included developing institutional leadership that values diversity, forming diverse search committees for new hires, requiring new employees to demonstrate cultural competence, changing academic work practices to improve conditions, encouraging contextualized mentoring, and implementing regular, transparent salary reviews.

African American Female Faculty in Engineering

African American women in engineering are targeted as the group of exploration within this paper for several reasons. First, despite a national focus on the conditions of African American women in the academia, African American women data often includes both U.S. born and non-U.S. born black women. (Despite this inconsistency, this group will be referred to as African American within the rest of this paper.) This clumping implies an inflation in the actual numbers of African American female engineering professors working at U.S. institutions. Even with the combining of both U.S.-born and non-U.S. born African American female faculty data, overall numbers are often nonexistent in national databases and in literature. This is especially true for data displaying current demographics about the numbers and ranks of all African American women faculty at U.S. institutions conferring engineering degrees. Another reason for focusing on African American women in engineering is interest by members of majority and minority groups in learning more about the numbers and experiences of this group given prior presentations at conferences in which African American female engineering women are affiliated.[2,3] Despite this interest, no central meeting location connects African American women faculty in *engineering* across engineering disciplines.

Also missing among the data about African American female engineering faculty is qualitative explorations about their faculty experiences. The most recent highlights of these experiences are noted in works by Butler-Purry,[12] Fleming,[13] and Decuir-Gunby et al.[14] Butler-Purry's chapter reflects upon the positive and the negative aspects of her engineering faculty life, Fleming's brief

article suggests alternate ways to define diversity within engineering classrooms, and Decuir-Gunby et al.'s chapter uses Critical Race Theory and Critical Race Feminism to explore the experiences of African American female engineering faculty.

African American engineering female faculty also have addressed the challenges via grants obtained from the National Science Foundation. Although its focus is on all women in STEM, the NSF ADVANCE program has supported efforts to engage URM women faculty in professional development opportunities exploring topics such as teaching, leading large-scale research enterprises, becoming a faculty entrepreneur, and pursuing academic leadership positions. Of particular note are efforts led by two African American female engineering faculty, Dr. Gilda Barabino, Professor of Biomedical Engineering at Georgia Tech, and Dr. Christine Grant, Professor of Chemical Engineering at North Carolina State University.

As a result of ADVANCE funding, Dr. Barabino and Dr. Grant have established the National Institute for Faculty Equity and the Purpose Institute, respectively. The National Institute for Faculty Equity sponsored six workshops between 2004 and 2012 targeting underrepresented minorities in STEM representing all academic ranks and diverse research and professional interests. Since 2001, Dr. Grant has facilitated workshops for underrepresented women in STEM. Institutionalized at North Carolina State University, the Purpose Institute has contributed to increased numbers of underrepresented women obtaining academic leadership positions, earning tenure at diverse institutions, being recognized nationally and internationally for their faculty accomplishments, and pursuing traditional and nontraditional entrepreneurship ventures.

One of the authors who has reported explicitly the number of African American women in engineering is Dr. Donna Nelson. In her most recent report, Nelson compared the percentage of African American female engineering faculty in chemical engineering, civil engineering, electrical engineering, and mechanical engineering in top 100 engineering departments.[15] Although these data highlight the low percentages of African American women faculty at U.S. institutions, they include numbers of women who are U.S. born and foreign born and do not include *all* engineering disciplines in which African American are employed as faculty. Therefore, African American faculty with science and engineering doctorate were less likely to be employed at one of the nation's top research universities compared to Asians and Whites.

Methods

In an effort to tell a comprehensive story about trends of African American female faculty in engineering, the authors extracted data from databases at the American Society for Engineering Education (ASEE), which houses disaggregated data of engineering faculty working at accredited engineering programs parsed by gender, race, rank, and discipline. The limitation of the ASEE data, however, is its inclusion of data from institutions that agree to provide institutional data and from ABET accredited engineering programs. Data for African American women is only available from 2001-2012. Therefore, this data might exclude programs that are new or in the process of being accredited or might omit WOC who entered and left in the academy prior to 2001. Some of the more significant results of this analysis are summarized in the subsequent section.

Results

Prior to exploring data about African American female faculty in engineering, the authors present longitudinal data about the numbers and percent of of tenure-track and non-tenure track faculty in engineering (Table 1), the number and percent of tenure-track male and female faculty in engineering (Table 2), and underrepresented minority (URM) faculty across accredited engineering institutions (Figure 1). (All data are reported from ASEE databases.)

Table 1: Engineering Faculty at U.S. Engineering Schools (2001 - 2012)

Year	Tenure-Track Faculty (Number/Percent)	Non-Tenure Track (Number/Percent)	TOTAL per year
2001	19901 (67%)	9601 (33%)	**29502**
2002	20826 (67%)	10153 (33%)	**30979**
2003	21622 (67%)	10480 (33%)	**32102**
2004	22264 (69%)	10066 (31%)	**32330**
2005	23028 (68%)	10918 (32%)	**33946**
2006	23322 (67%)	11738 (33%)	**35060**
2007	23900 (65%)	12795 (35%)	**36695**
2008	24207 (64%)	13340 (36%)	**37547**
2009	24315 (62%)	14766 (38%)	**39081**
2010	24408 (60%)	16022 (40%)	**40430**
2011	24526 (60%)	16525 (40%)	**41051**
2012	25004 (60%)	16902 (40%)	**41906**
TOTAL	**277323** (64%)	**153306** (36%)	**430629**

Informed from data in the ASEE database, Table 2 demonstrates the steady increase in female engineering faculty members over the last decade. This represents an increase from 9% to 12% of total tenure-track engineering faculty. Figure 1 indicates that there has been a significant increase in Hispanic and African American faculty over the last decade. African American tenure-track faculty have increased from 2% to 3%, while Hispanic faculty have increased from 3% to 4%.

Table 2: Tenure-Track Engineering Faculty at U.S. Engineering Schools (2001 - 2012)

Year	Asst Prof Female	Assoc Prof Female	Full Prof Female	Asst Prof Male	Assoc Prof Male	Full Prof Male	TOTAL
2001	722 (4%)	608 (3%)	431 (2%)	3375 (17%)	4932 (25%)	9833 (49%)	**19901**
2002	765 (4%)	659 (3%)	495 (2%)	3728 (18%)	5098 (24%)	10081 (48%)	**20826**
2003	852 (4%)	723 (3%)	561(3%)	4030 (19%)	5207 (24%)	10249 (47%)	**21622**
2004	896 (4%)	747 (3%)	650 (3%)	4174 (19%)	5283 (24%)	10514 (47%)	**22264**
2005	981 (4%)	753 (3%)	700 (3%)	4356 (19%)	5343 (23%)	10895 (47%)	**23028**
2006	1077 (5%)	822 (4%)	735 (3%)	4426 (19%)	5423 (23%)	10839 (46%)	**23322**
2007	1133 (5%)	870 (4%)	813 (3%)	4472 (19%)	5570 (23%)	11042 (46%)	**23900**
2008	1160 (5%)	924 (4%)	888 (4%)	4450 (18%)	5644 (23%)	11141 (46%)	**24207**
2009	1192 (5%)	969 (4%)	926 (4%)	4324 (18%)	5692 (23%)	11212 (46%)	**24315**
2010	1197 (5%)	1048 (4%)	978 (4%)	4154 (17%)	5837 (24%)	11194 (46%)	**24408**
2011	1211 (5%)	1112(5%)	1053 (4%)	4040 (16%)	5905 (24%)	11205 (46%)	**24526**
2012	1241(5%)	1173 (5%)	1101 (4%)	4190 (17%)	6013 (24%)	11286 (45%)	**25004**
TOTAL	**12427** (4%)	**10408**(4%)	**9331** (3%)	**49719** (18%)	**65947** (24%)	**129491** (47%)	**277323**

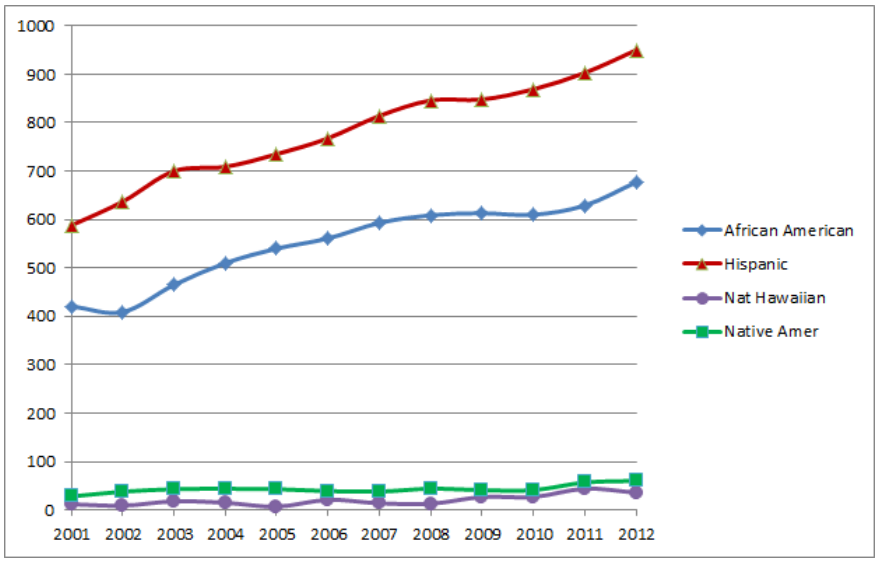

Figure 1: URM Engineering Faculty at U.S. Engineering Schools (2001 - 2012)

African American women make up 4% of all women currently in the engineering professoriate, an increase of 1% since 2001. However, Figure 2 shows that African American female engineering women faculty have increased from 12% to 20% of all tenure-track African Americans since 2001, a slight increase compared to the population as a whole. Figure 3 shows that in 2012, there were fewer than 30 African American female full professors despite strides being made at the associate level. In addition, there are only approximately 150 African American engineering female faculty members across all ranks and engineering disciplines. One assumption made in the analysis of this trend is that Assistant Professors continue to advance in the academy via promotion and tenure and become associate professors as opposed to some leaving the professoriate.

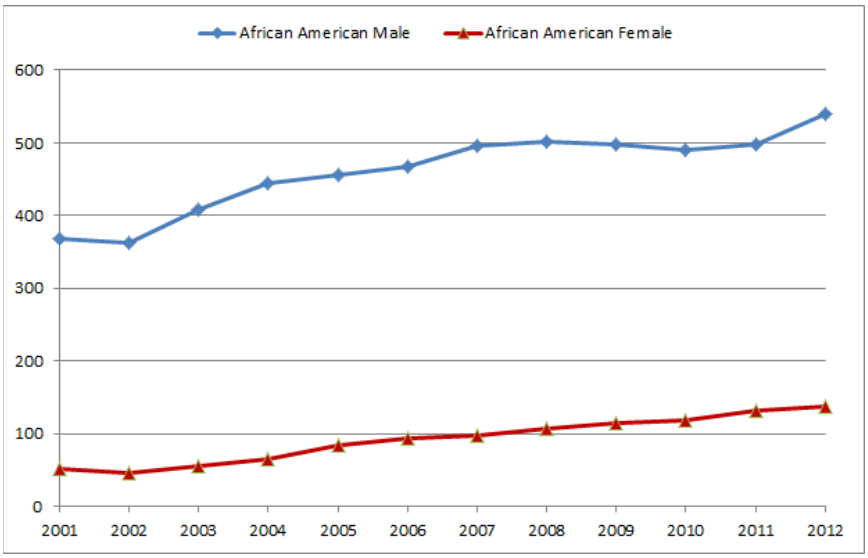

Figure 2: African American Faculty at U.S. Engineering Schools (2001 - 2012)

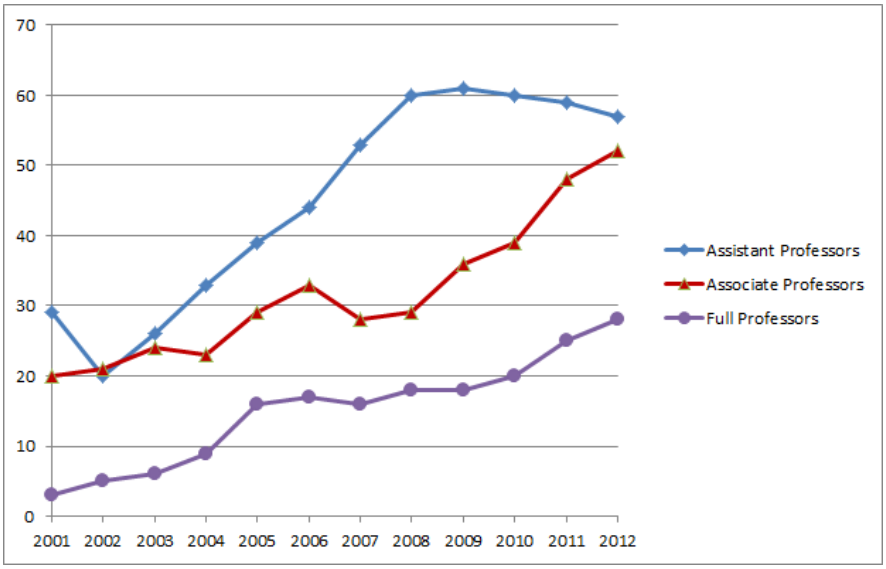

Figure 3: African American Women Faculty at U.S. Engineering Schools (2001 - 2012)

Figure 4 presents a graph of the number of African American female faculty members in the largest engineering disciplines (i.e., mechanical, electrical, computer, civil, industrial, chemical, and biomedical) as well as Computer Science in 2001, 2006, and 2012. It is evident that the numbers are still low despite growth in mechanical, electrical, computer, chemical and biomedical engineering.

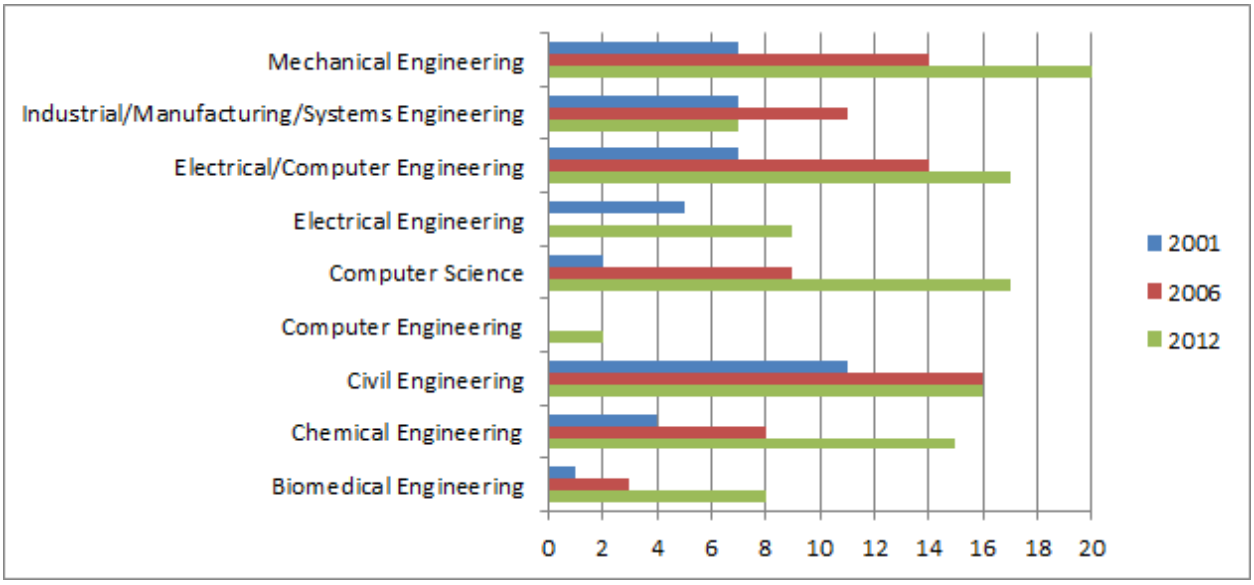

Figure 4: African American Women Faculty by Discipline at U.S. Engineering Schools (All Ranks) (2001 - 2012)

Figure 5 examines the number of African American female faculty across all ranks at the 12 Historically Black Colleges and Universities (HBCUs) that house engineering schools in the database versus the other 295 engineering schools. Figure 6 indicates that despite there being

fewer HBCUs with accredited engineering programs, approximately one-third of the population of African American female faculty is concentrated at HBCUs. However, it is promising that the number of African American female engineering faculty at predominantly white institutions is on the rise.

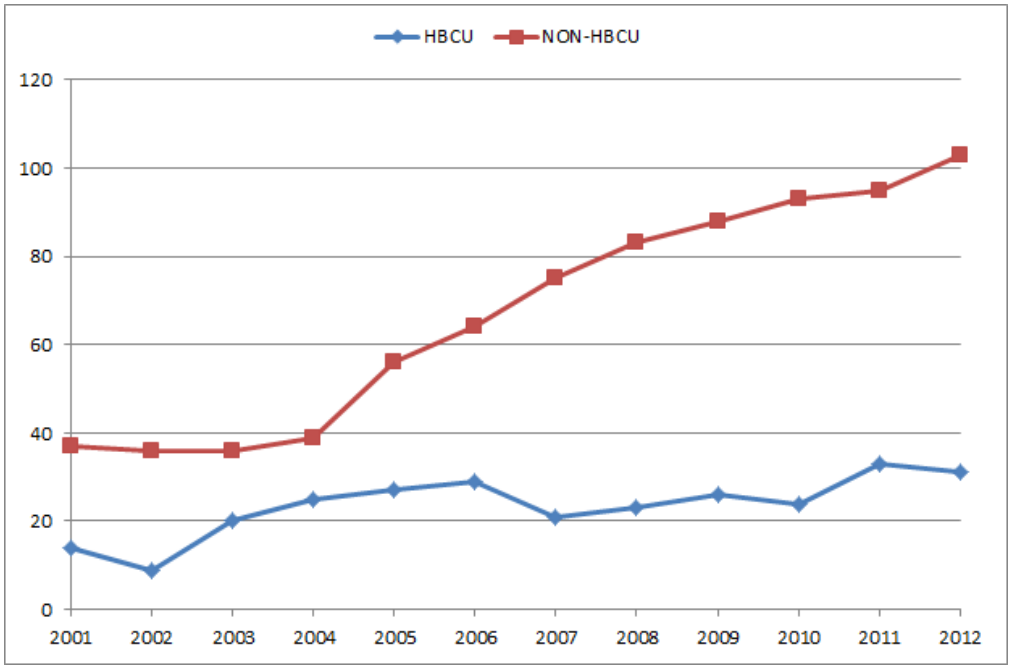

Figure 5: AA Women Faculty by Institution Type at U.S. Engineering Schools (2001 - 2012)

Discussion

Although the ASEE database provides a rich source of information regarding the number of African American female engineering faculty at various institutions, concerns remain. First, the data do not tell us about individual longitudinal tracking of faculty over time (e.g., Although the Assistant Professor numbers are decreasing at HBCUs as the number of Associate Professors increase, this doesn't mean Assistant Professors are being promoted to the Associate Professors are the same people.). This information would be especially beneficial at HBCUs, where there are large numbers of African American female faculty but limited information about the recruitment and retention of these faculty along with the effective practices that are being for recruitment and retention in these environments. This information is crucial since numbers of Assistant Professors are decreasing as the numbers of Associate Professors at HBCUs increase. While we anticipate that women are being promoted, the reality may be that women are not earning tenure or are leaving the academy to obtain nonacademic jobs. Finally, the manual method of compiling data and generating graphs of African American women is somewhat cumbersome, since data have to be searched across institutions for multiple years, cleaned, sorted, and compiled pictorially in a meaningful way.

Although the authors present initial data about the numbers of African American women faculty in engineering, there are numerous ways to extend this presentation of data to other groups across disciplines and ranks. Among these ways may be to parse the data by Carnegie

classification in an effort to identify the number of African American women who are tenure-track and non-tenure track across a variety of institutions, not just HBCUs. Such queries might be extended to note trends of Hispanic faculty at Hispanic-serving institutions. With such information, policy makers and institutions might connect data to effective recruitment and retention practices in engineering.

The benefit of presenting data by Carnegie classification, however, is that researchers and practitioners can note where African American women are and are not housed within the academy. The limitation of this and future studies regarding WOC, however, is the identifiable nature of the data. Efforts might need to be made to ensure that identifiable WOC in engineering are not targeted for inclusion in multiple studies and do not become the automatic faces of underrepresented minority diversity at their institutions and in their departments.

In addition to looking at the quantitative data regarding women of color, researchers may build upon this work in several ways. First, they might conduct empirical studies that use qualitative and mixed methods to answer a variety of research questions. Second, future research might include large-scale studies for WOC in engineering across multiple institutions. Finally, to add to the body of knowledge, researchers must expand current work by expanding theoretical and methodological frameworks that involve research about WOC in engineering.

Conclusions

Numerous studies and reports highlight the plight of underrepresented minority female faculty in the U.S. This paper presents data about the number of African American female faculty at accredited U.S. engineering institutions. Although the numbers have increased over time, in 2012, fewer than 150 African American women faculty across all ranks were employed in tenure-track and tenured positions in accredited engineering programs in the U.S. HBCUs house the largest number of African American women faculty, thereby confirming that African American female engineering faculty are more likely to teach other minority students in engineering. Policymakers, administrators, and faculty must continue to identify ways to increase the representation of African American female faculty via empirical studies and dissemination of information about the longitudinal experiences of WOC in engineering.

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