

Session Division: WIED 3592**Educational Trends of Minority Women in the USA:
The Untapped Resource****Kathleen M. Kaplan, D.Sc., Lt Col John J. Kaplan (Ph.D., J.D.) USAF****Howard University/USAF****Abstract**

The greatest untapped resource in engineering is minority women. According to the statistics, women are making great strides in education. Unfortunately, the numbers also show that women are woefully underrepresented in the field of engineering. Even more concerning is the percentages of minority women receiving bachelor degrees overall, and more specifically in engineering, with respect to U.S. percentages of minority women. More discrepancies are found within the group of minority women as to recipients of degrees. The two largest groups within the set of U.S. minority women, Blacks and Hispanics, are not the largest recipients of bachelor degrees, nor engineering degrees. Looking toward the future also shows a problem, minority females are not graduating from high school in the same percentages as non-minority females. This, coupled with the future population predictions from the U.S. Census Bureau, indicates a bleak future for engineering. This paper will address all of the above items: the current U.S. population and education figures, with emphasis on women; the trend of some minority groups to obtain higher percentages of both bachelor and engineering degrees over other minority groups; the next-generation of college students; the projected future populations; and some possible solutions to increasing the numbers of women minority students to benefit engineering.

Literature Search

A great deal of information has been written on minority females in education. Unfortunately, much of this information is inaccurate or misleading. Most often, minority groups are not differentiated. Therefore, all minority females are combined and while the overall increase in engineering for the entire group may look promising, the increases in the specific racial groups are not. NSF¹, for example, states, "While overall undergraduate engineering enrollment has been declining, enrollment of women and minorities has been increasing, particularly in the 1990s. The number of female students enrolled in engineering increased from 61,000 in 1990 to 68,000 in 1996. For underrepresented

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minorities, the increase was greater, from 41,000 in 1990 to almost 54,000 in 1996. By 1996, female students represented 19 percent of total undergraduate engineering enrollment, and underrepresented minorities represented 15 percent of such enrollment.” These statements are accurate, but do not differentiate by race, nor by gender and race, and therefore, hide the woefully low numbers of Black and Hispanic females in engineering.

A good paper on the subject is by The Foundation Coalition². This paper gives an accurate report on the state of minority females in engineering. The research in our paper gives more information than The Foundation Coalition paper, including the history, present, and future trends of minority females in engineering.

Our research is different than other papers written on the subject of minority women in engineering as it discusses all aspects of the educational trend: past, present, and future. In combining all three into one discussion, the entire problem can be fully comprehended and the goal can be reached.

History of U.S. Population and Education Figures with Respect to Women

In order to fully comprehend the educational trends and future of minority women, one must understand the educational history of minority women. This section will discuss the historical trends with the 1940, 1950, and 1994 census information.

The U.S. Census Bureau in 1940³, used the term “Negro” instead of “Black” and other minorities were not differentiated but rather included in statistics as “Other Races.” All females constituted 49.9% of the U.S. population and minority females constituted 4.6% of the U.S. Population, with Negro females comprising 4.4% of the U.S. population, and females from other races constituting 0.2%. Within the minority female population, Negroes were overwhelmingly the largest sector, at about 97.1%. Of all females, the percentages of White, Negro, and other races are 90.8%, 8.9%, and 0.3%, respectively, as can be seen in figure 1.

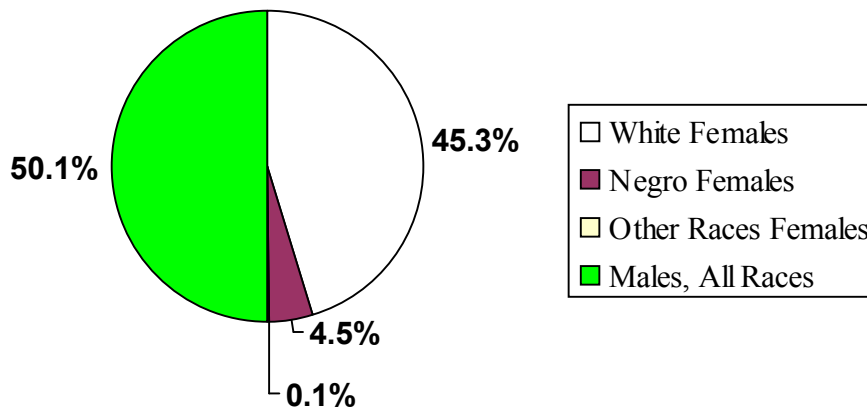


Figure 1. U.S. Population with Respect to Gender and with Females Differentiated by Race, 1940

The census gives the number of school years obtained by race and gender as well. Of all people obtaining four years or more of college, the percentage of all U.S. females obtaining this level of education is 37.7%, with White females at 36.46%, Negro females at 1.2%, and Other Races females at 0.04%. Of all females obtaining four or more years of college, the overwhelming majority is White, at over 96.7%. Negro females constituted only 3.1% and Other Races only 0.1%. The U.S. population obtaining four or more years of college with respect to gender and females differentiated by race can be seen in figure 2. Figure 3 shows the U.S. female population percentages and the percentage of U.S. females obtaining four or more years of college.

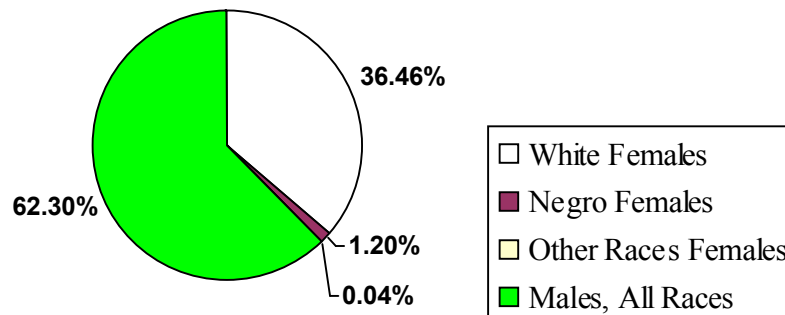


Figure 2. U.S. Population Obtaining Four Years College, with Respect to Gender and with Females Differentiated by Race, 1940

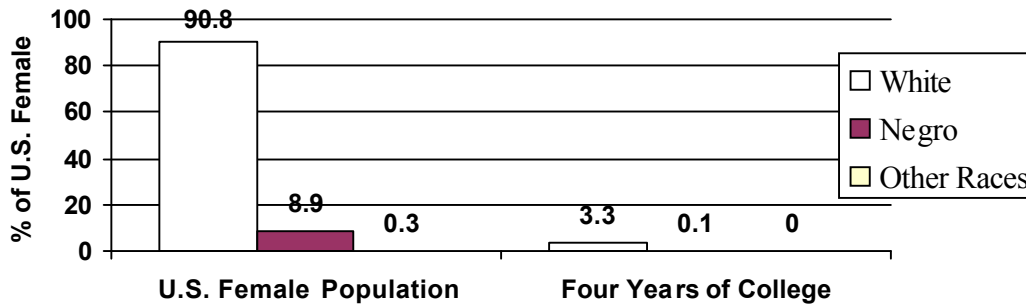


Figure 3. U.S. Female Population with Respect to Race and Completion of Four Years of College, 1940

Of all females, the percentage of females obtaining four years of college in 1940 was 3.5%. In each individual race with respect to completion of four years of college, White females obtaining this level, of all White females, was 3.8%, Negro females obtaining this level, of all Negro females, was 1.2%, and Other Races females obtaining this level, of all Other Races females, was 0.2%.

In 1950⁴, the classifications were separated into White and Non-White⁵ populations. At this time, the number of U.S. females outnumbered the males; 51.3% of the U.S. population 25 years and older were females. Of the female population, 90.6% were White females and 9.4% were Non-White females. At this time, we see an increase in the percentage of females obtaining four or more years of college: 42.7% of the total of the population obtained four or more years of college. Of this percentage, White females constituted 95.7% of all females who obtained four or more years of college and Non-White females at 4.3% of all females who obtain four or more years of college. This information, corresponding to the 1940 information found in figures 1, 2, and 3, is seen in figures 4, 5, and 6.

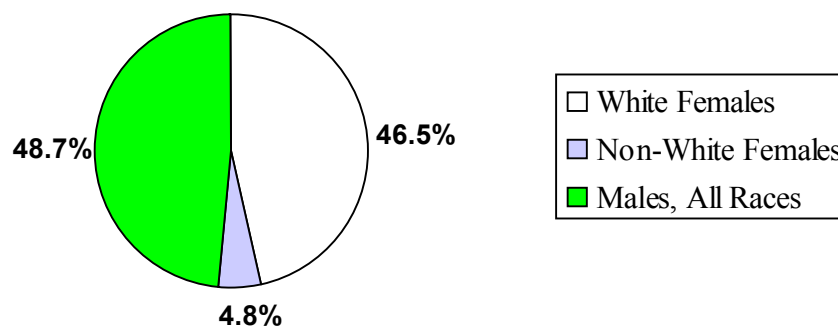


Figure 4. U.S. Population with Respect to Gender, with Females Differentiated by Race, 1950

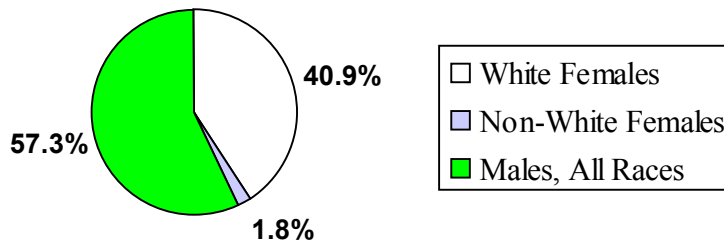


Figure 5. U.S. Population Completing Four Years of College with Respect to Gender, with Females Differentiated by Race, 1950

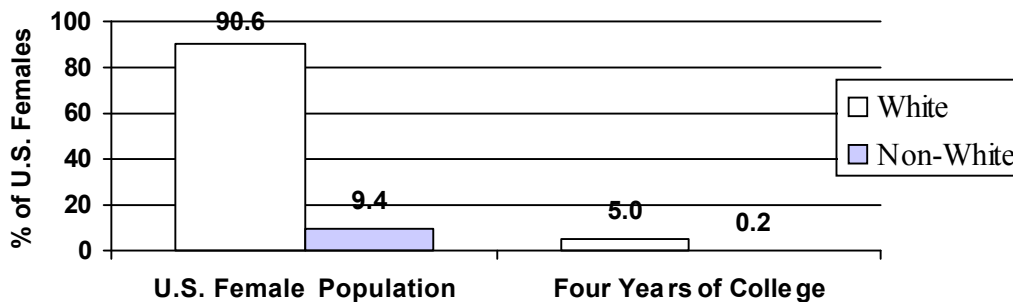


Figure 6. U.S. Female Population with Respect to Race and Completion of Four Years of College, 1950

Of all females, the percentage of females obtaining four years of college in 1950 was 5.0%, a slight increase from the 3.5% of 1940. In each individual race with respect to completion of four years of college, White females obtaining this level, of all White females, was 5.4%, again, an increase over 1940's 3.8%. Non-White females obtaining this level, of all Non-White females, was 2.3%, which, again, is an increase over 1940's 1.4%, for all minority females.

Jumping to 1994⁶, there is an overall rise in education in all categories. At this time, people were categorized as White, Black, and Hispanic, but Hispanic can be of any race. Therefore, Hispanics will be included in "Other Races" to eliminate overlap with White and Black Races. Females at this time were 52.3% of the U.S. population with a breakdown with respect to race as White: 44.1%, Black 6.1%, and Other Races: 2.1%. Within the female population, the breakdown is White: 84.3%, Black: 11.7%, and Other Races: 4.0%. At this time, 48.4% of the U.S. population with bachelor's degrees were women. Of this percentage, White females constituted 85.3% of these degrees, followed in percentage by Black females at 8.0%, and Other Races at 6.6%. This information can be seen in figures 7, 8, and 9.

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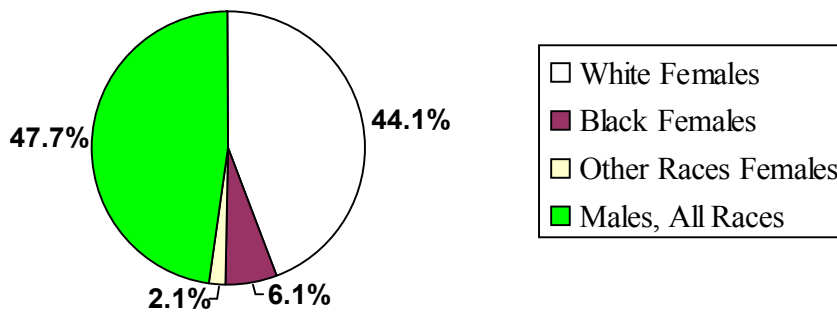


Figure 7. U.S. Population with Respect to Gender, with Females Differentiated by Race, 1994

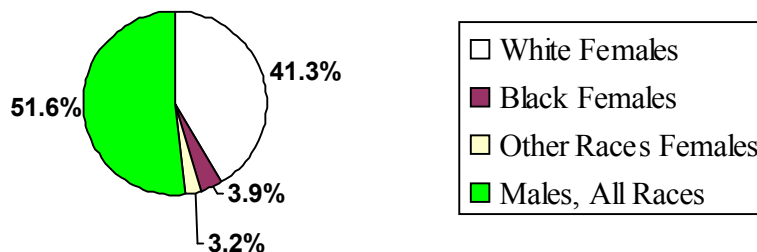


Figure 8. U.S. Population Completing Bachelor's Degrees with Respect to Gender, with Females Differentiated by Race, 1994



Figure 9. U.S. Female Population with Respect to Race and Completion of Bachelor's Degree, 1994

Of all females, the percentage of females obtaining bachelor's degrees in 1994 was 13.7%. In each individual race with respect to completion of four years of college, White females obtaining this level, of all White females, was 13.8%. Most notably in this data is the increase of minority females obtaining bachelor's degrees with respect to all minority females; this is 12.8%. On further review, Black females obtaining this level, of all Black females, was 9.4%. Most surprising in this data is the percentage of Other Races females

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obtaining bachelor's degrees with respect to all Other Races females; this is 22.5%.

Thus, there is an optimistic trend with respect to minorities and education in U.S. history, as can be seen in figure 10. This trend shows great strides, but unfortunately masks the woefully low numbers of minority females obtaining bachelor's degrees with respect to the minority female population and the numbers of minority females in engineering.

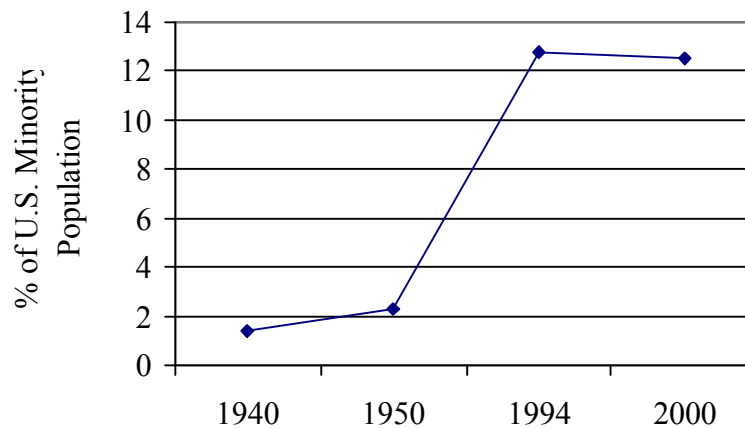


Figure 10. History of Minorities Obtaining Bachelor Degrees
(Percentage of Minorities obtaining four or more years of college with respect to U.S. Minority Population in a given year)

Current U.S. Population Figures, Including Minority Populations

According to the U.S. Census 2000, minorities constitute 29% of the total U.S. population. Of this total, minorities are grouped into different groups, such as Black, American Indian, etc., and sometimes these groups are differentiated as to Hispanic and non-Hispanic. In this paper, Hispanic will be a specific group and not contained within the other groups, if possible, from the data. For example, stating a group as “Black” means “Black, non-Hispanic.” Also, within this paper “engineering” constitutes all disciplines of engineering and includes computer science. Note that all statistics are from the U.S. Census Bureau.

Of the U.S. 2000 population, females constitute 52.3%, with White females at 38.7% and minority females at 13.6%. Minority females are classified as Black females at 6.2%, Asian/Pacific Islander at 2.0%, Hispanic, of any race, at 5.0%, and Other Races at 0.4%, of the U.S. population. This can be seen in figure 11 below, with combining Asian/Pacific Islander into Other Races. So, one would expect the numbers of engineering students to be approximately within these percentages. Unfortunately, that is not the current situation.

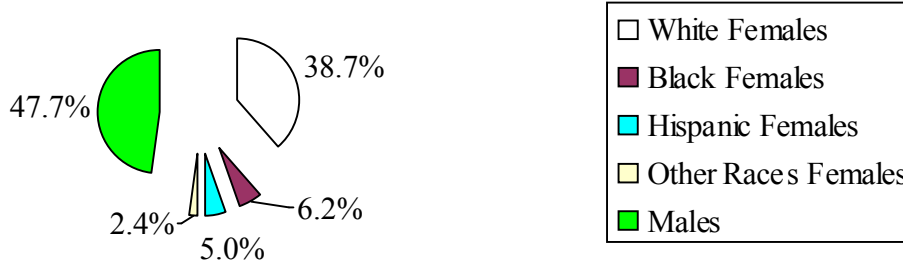


Figure 11. Percentages of U.S. Population with Respect to Gender, with Females Differentiated by Race, 2000

To fully understand the numbers of female minorities in engineering, a break-down of the female minority groups is needed. Of the overall female minority groups, Blacks constitute about 45.5%, Hispanics 36.9%, and other minorities at 17.6%, as seen in figure 12 below. So, Blacks and Hispanics make up the bulk of the female minority community in the U.S. This paper will show that the female minority community as a whole is underrepresented in engineering, and that the numbers of Black and Hispanic females within this female minority sector are unsatisfactory.

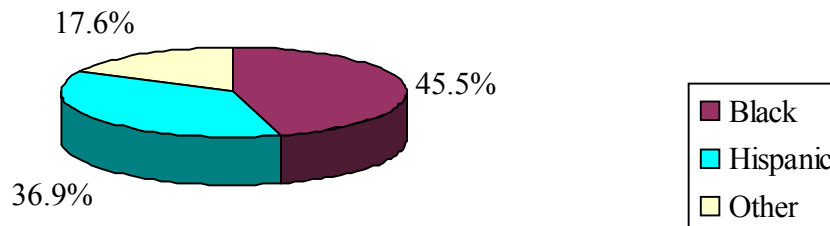


Figure 12. Percentages of Female Minority Groups With Respect to All Female Minorities

Current U.S. Education Figures, Including Minority Populations

Of any type of bachelor degree awarded in the U.S., female minority populations earn 10.0% of bachelor degrees⁷. Obviously, this percentage is below the expected 13.6% of the total population. On closer inspection, we see that Black females constitute 4.1% of the bachelor's degrees, Hispanic females 2.1%, and other minority females 3.7% of the total, as seen in figure 13 below.

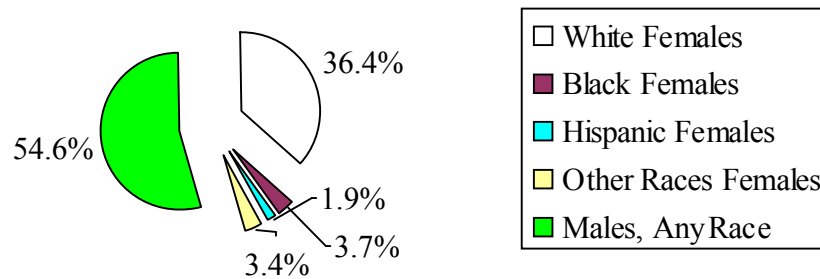


Figure 13. Percentages of U.S. Bachelor's Degrees with Respect to Gender, with Females Differentiated by Race, 2000

This indicates an interesting trend; instead of the Black-Hispanic-other female percentages of the population given above in figure 12, i.e., 45.5%, 36.9%, 17.6%, the numbers within the female minority sector with respect to bachelor's degrees awarded to minority females are 41.4%, 21.4%, 37.2%, as seen in figure 14. This means that the smaller minority sector of the "other" – American Indian, Asian and Pacific Islander non-Hispanic – is almost the same as the largest minority sector – Blacks - in U.S. bachelor degrees in the total minority domain.

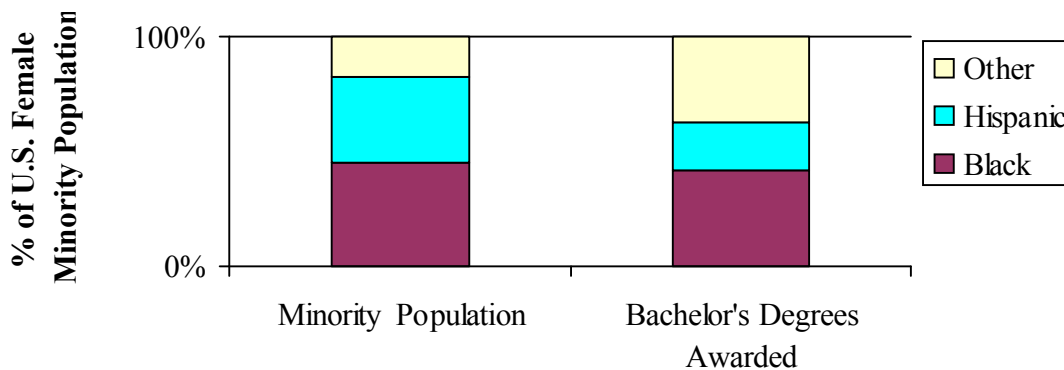


Figure 14. U.S. Female Minority Population and Bachelor's Degrees

Engineering Fields with Respect to Minority Students

Does engineering show more realistic numbers? With respect to all U.S. bachelor degrees awarded, approximately 7% are engineering bachelor degrees⁸. Of this 7%, only 8.7% are females⁹. Of all engineering bachelor degrees, White females hold 6.8%, Black females 0.7%, Hispanic females 0.3%, and Asian and American Indian Females 0.9%. Minority females, as a whole, constitute 1.9%, which is very low given the national percentage of minority female populations. Figure 15 shows the percentages of engineering degrees

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awarded to females with respect to race.

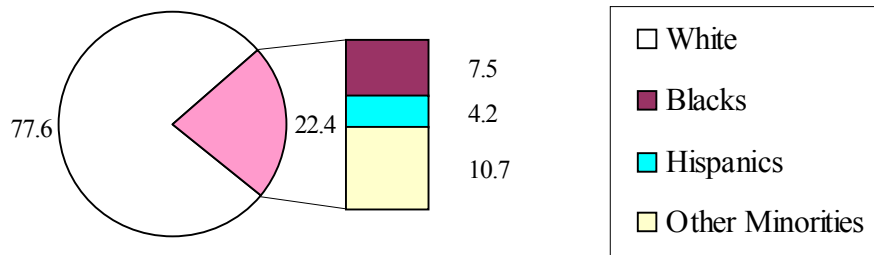


Figure 15. Percentages of Engineering Degrees Awarded to Females with Respect to Race

Trend Within the Minority Group

Specifically analyzing the female minority sector of the engineering bachelors, the low numbers of Black and Hispanic female graduates can be further understood. Looking at the female minority group’s graduates more closely, Black females total a mere 33.3%, Hispanics a smaller 18.6%, and other minorities are at a high of 34.4%. This is not in proportion to the U.S. minority female percentages of Black females at 45.5%, Hispanic females at 36.9%, and other minority females at 17.6%, given above. So the trend of the "other" minority sector overshadowing the Black and Hispanic minority groups is worse in engineering than in the total of all bachelor's degrees awarded. This can be seen in figure 16.

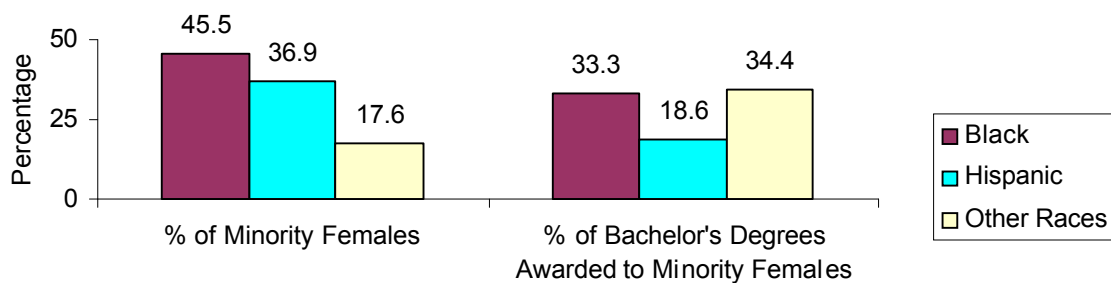


Figure 16. Percentages of Minority Females within Minority Female Sector and Bachelor Degrees Awarded with Respect to Race

There are two questions, of many possible questions, that can be asked here: Why are the numbers for minority females in engineering so small? Why is the "other" minority female

group overshadowing Black and Hispanic females with respect to bachelor's degrees? One obvious answer is to determine the number of minorities graduating from high school.

Reviewing the data for percentages colleges graduates within population groups¹⁰, specifically for people twenty-five years and older, an interesting trend is found. Of all races and both sexes, 25.6% hold college diplomas. Reviewing the statistics for all races of males, the number is 27.8%, and for all races of females, the number is 23.6%, respectively. This can be seen in figure 17.

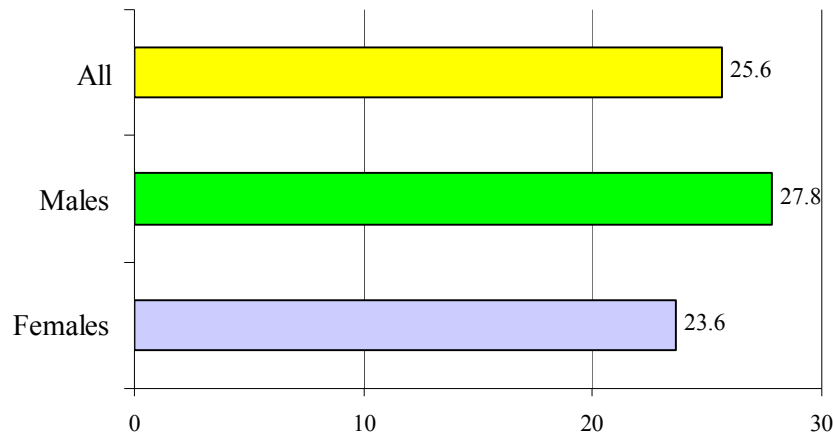


Figure 17. Percentages of College Graduates

So, the numbers of females graduating from college, with respect to all females, is lower than the number of males graduating from college, with respect to all males.

Inspecting the data within the female population, one can see an interesting diversion among the races with respect to degrees obtained. For Non-Hispanic White females, the statistics show 25.5% have college degrees. Within the Non-Hispanic Black female group, 16.8% hold college degrees. Hispanics hold the least number of degrees, 10.6%. The most interesting statistic is for the Asian/Pacific Islander female group; 40.7% has graduated from college. This information, regarding females with respect to race, can be seen in figure 18.

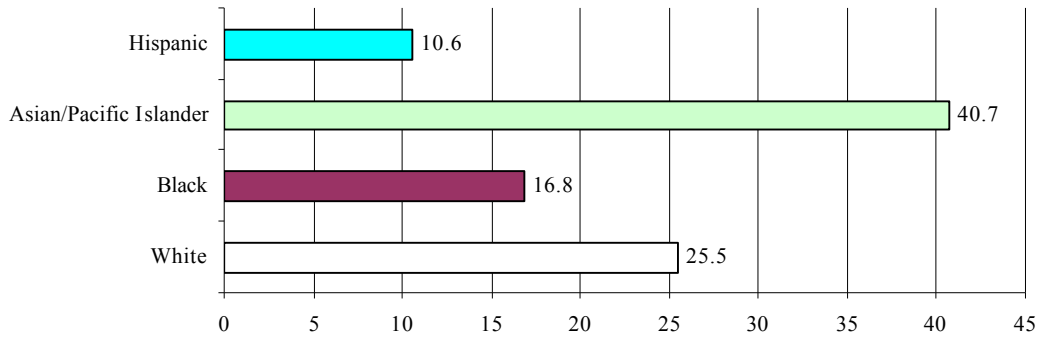


Figure 18. Percentages of Female College Graduates with Respect to Race

Here we see that the smaller population with respect to race, the Asian/Pacific Islander group, is graduating from college with a higher percentage than all other racial groups. This number is impressive with respect to all other groups, but one must be careful not to combine these statistics with all other minority groups because it hides the fact that Hispanic females have a very dismal 10.6% college graduate rate yet are 36.9% of the minority female population! The data must be carefully analyzed to create an accurate account of the current educational obtainment numbers.

Next Generation of College Students

Reviewing the data for percentages of high school graduates within population groups¹¹, specifically for people twenty-five years and older, another interesting trend is found. Of all races and both sexes, 84.1% of the population holds a high school diploma. Reviewing the statistics for all races of males and females, respectively, the numbers are 84.2% and 84.0%. This can be seen in figure 19 juxtaposed with the college data above.

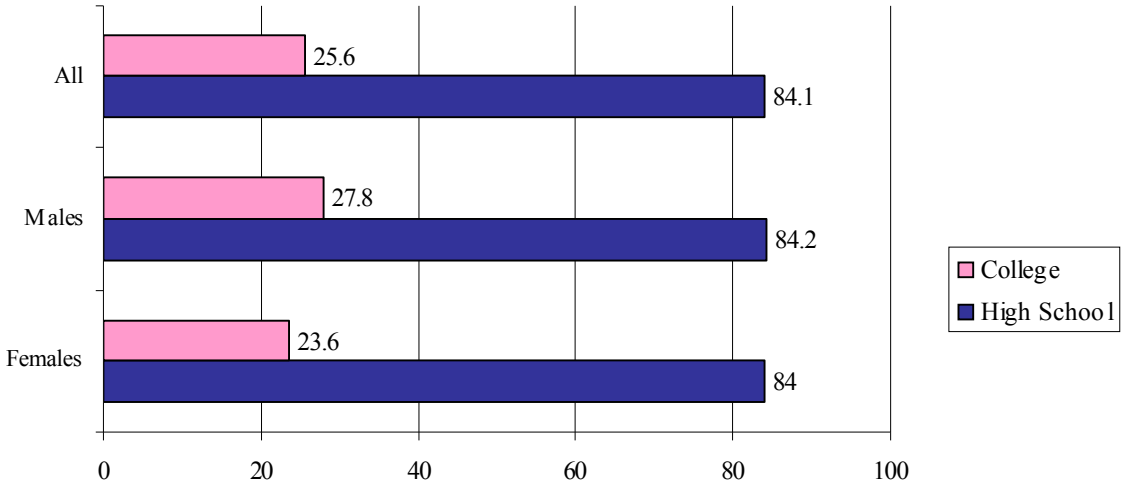


Figure 19. Percentages of High School and College Graduates

Thus, the high school graduation rate for females gives hope for the future as it is close in percentage to the numbers of males graduating from high school. Unfortunately, there are discrepancies within racial groups.

Inspecting the data within the female population, one can see an interesting diversion among the races with respect to degrees obtained. For Non-Hispanic White females, the statistics show 84% have high school degrees. Within the Non-Hispanic Black female group, 78.7% hold high school degrees. Hispanics hold the least number of high school degrees, 57.5%. The most interesting statistic is for the Asian/Pacific Islander female group; 83.4% have graduated from high school. This information, regarding females with respect to race, can be seen in figure 20 with information from figure 18 above.

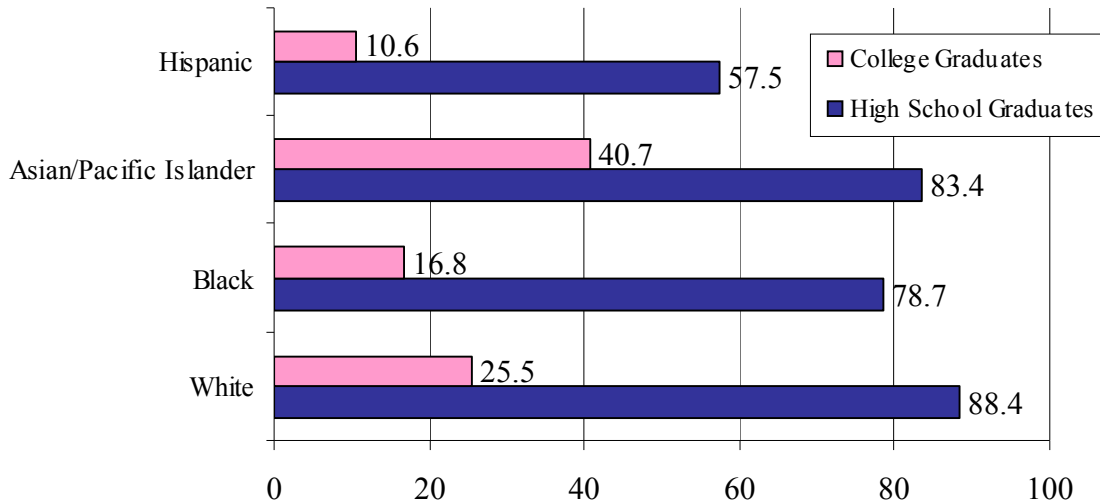


Figure 20. Percentages of Female High School and College Graduates with Respect to Race

Again we see that the smaller population with respect to race, the Asian/Pacific Islander group, is graduating from high school with a higher percentage than all other racial groups. Also noteworthy is that the Asian/Pacific Islander female sector is graduating from high school in numbers close to the national percentage, 84.1%, and national percentage for females, 84.0%. Once again the Hispanic female group lags behind at 57.5%, yet is the second largest minority group.

An investigation of the next generation of college attendees, those in the 18 to 19 year old range, and then those in the 20 to 24 year old range further illustrate the problem. In the 18 to 19 year old range, 56.0% of the U.S. population has graduated from high school. Within all males, the percentage is lower at 51.9%. Surprisingly good news is that within the group of all females of any race the high school graduation rate is 60.1%. Separating the female group by race yields 63.2% of White females, 56.5% of Black females, 65.9% of Asian/Pacific Islander females, and 47.4% of Hispanic females in the 18 to 19 year old range have graduated from high school. This information can be seen in figure 21.

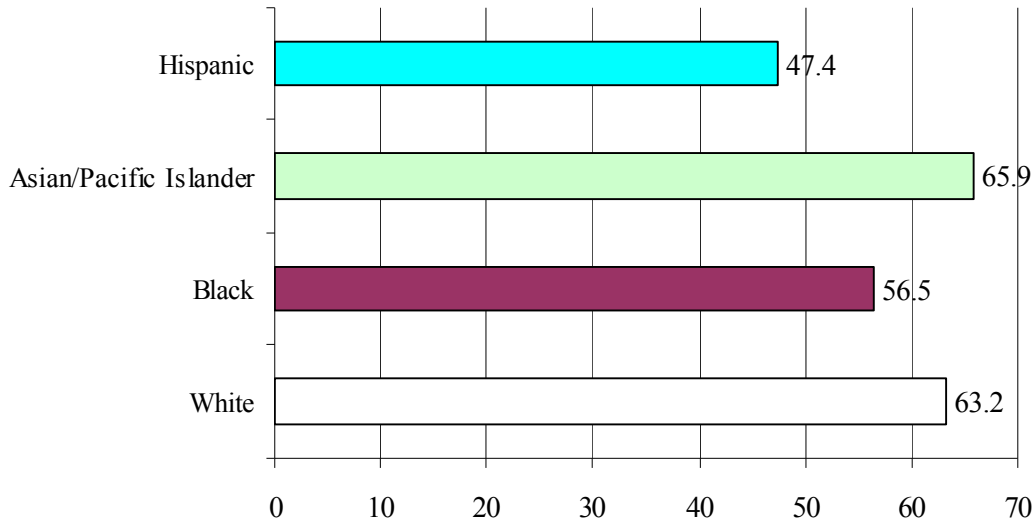


Figure 21. Percentages of Female High School Graduates, in the 18-19 Age Range, with Respect to Race

The Asian/Pacific Islander Female Group is graduating with a higher percentage than the national average, the “all males” average, the “all females” average, and the majority female population, the White females. The Hispanic female group is again low, with less than all other population groups.

In the older age group of 20 to 24 years, 85.5% of the U.S. population holds a high school degree. All races of males have an 83.7% graduation rate and females again perform better at 87.3%. Within female racial groups, White females in this age group graduate from high school with a rate of 92.6%, Black females at 82.9%, Asian/Pacific females at 97.3%, and Hispanic females trail at 62.5%. This can be seen in figure 22.

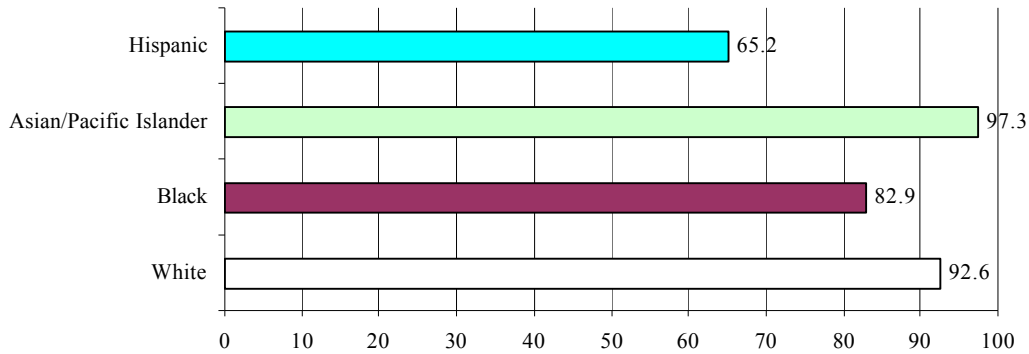


Figure 22. Percentages of Female High School Graduates, in the 20-24 Age Range, with Respect to Race

Again, in this age group there is a smaller percentage of Black females graduating from high school and an even smaller percentage of Hispanic females graduating. A huge discrepancy is seen in the "other" minority sector at this age group, 97.3% hold high school degrees.

Thus, in order to increase the numbers of minority students in higher education programs such as engineering, the students must be eligible for college; the students must graduate from high school. Secondly, the numbers are misleading with respect to individual groups within the minority sector. The "other" minorities, American Indian, Asian and Pacific Islander non-Hispanic, people, are graduating from high school in high percentages and are attending college in the technical fields.

Future Projection of Minority Populations

Of the U.S. 2000 population, females constitute 52.3%, with White females at 38.7% and minority females at 13.6%. As stated above and seen in figure 11, minority females are classified as Black females at 6.2%, Asian/Pacific Islander at 2.0%, Hispanic, of any race, at 5.0%, and Other Races at 0.4%, of the U.S. population, with combining Asian/Pacific Islander into Other Races. So, one would expect the numbers of engineering students to be approximately within these percentages. Unfortunately, that is not the current situation.

According to the U.S. Census Bureau¹², the year 2100 will reflect different population distributions than the current population. As stated above and shown in figure 11, the breakdown of the U.S. population is 52.3% female, with 38.7% White females and 13.6% minority females. Of the minority population, Black females comprise 6.2%, Asian/Pacific Islander at 2.0%, Hispanic, of any race, at 5.0%, and Other Races at 0.4%, of the U.S. population. In the year 2100 the numbers are predicted to change¹³; the females in the population will be at 50.1%. Of the females, White females will be 20.3%, Black females at 6.7%, Asian/Pacific Islander females at 6.5%, and Hispanic females at 16.7%. Thus,

the White females will not be the majority at this time, but instead the entire “minority” sector will be the majority. White females will be at 20.3% of all females, whereas the minority will be at 29.7%. The comparison of the population distributions of 2000 and 2100 can be seen in figure 23.

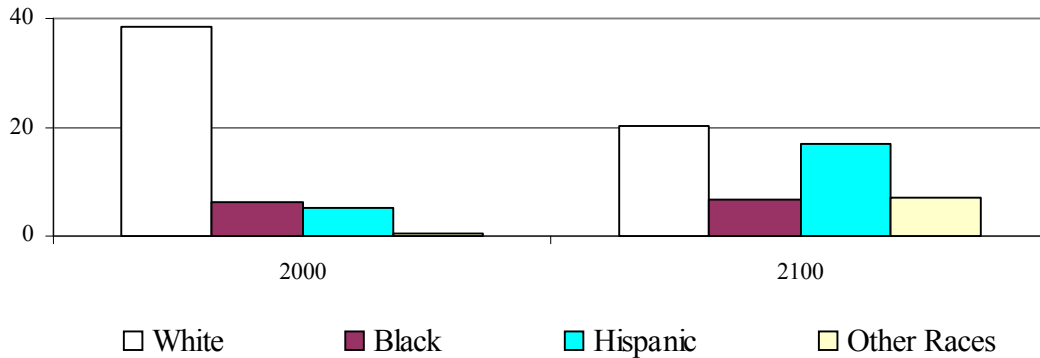


Figure 23. 2000 and 2100 Female Populations

Thus, over the next century, the minority female population is expected to outnumber the majority population, due mainly to the sharp increase in the Hispanic Population. As educators, we must be cognizant of this trend and prepare for the predicted population. In one-hundred years, the United States will have to depend more on its “minority” population than on its “majority” population. If the current trend of woefully small percentages of Black and Hispanic females in engineering continues, the future of females in engineering in the United States is bleak.

Solutions to Increase Numbers of Minority Females in Engineering

This paper has shown that females are woefully underrepresented in engineering. It has also been shown that even in this small group of female engineers, minority females are underrepresented. Furthering reviewing this small minority female engineer group shows that most are in the smallest minority female group, the Asian/Pacific population. We have also shown that the future looks good with respect to females. Females, in general, are graduating from high school in high numbers, yet do not hold the same number of college diplomas as males. The key here is to encourage these female high school graduates to attend college, and specifically to enter the engineering fields. Within minority groups, Asian/Pacific Islander females are graduating from high school in record numbers, over 97%, and are graduating from college in ranges greater than the national average. The Asian/Pacific Islander statistics though tend to be lumped into all minority statistics, which overshadows the true dilemma in education: Hispanics are not graduating in reasonable numbers, and Black females too are lagging behind.

The information in this paper also supplies current and future data on population statistics and educational attainment. We have also shown that the future of the United States will depend on the minority populations as the minority population is predicted to outnumber the majority population in the year 2100. What will the U.S.’s engineering sector become

if the majority of the population contains the fewest number of engineers?

The goal of increasing the number of minority engineering females depends on sub-goals. As seen in figures 21 and 22 above, certain groups within the minority population are not graduating from high school in the same percentages as other groups. Specifically, the Black and Hispanic female populations are not graduating from high school in the percentages that correspond to the population percentages. If one does not graduate from high school, one cannot attend college, let alone become an engineer. This is the first sub-goal: to encourage Black and Hispanic females to graduate from high school.

The second sub-goal is to encourage Black and Hispanic females to attend college. This may seem like a trivial step, but as we have seen in figure 20, Hispanic females, in particular, are not obtaining the appropriate percentage of any type of bachelor degree. Therefore, college attendance is necessary.

The final sub-goal is to introduce engineering to minority females prior to college enrollment, or as soon as possible once the student has matriculated. As any engineer knows, the progression of future college engineering courses depends on the first-year courses, so the sooner the student enters engineering, the better for the student.

How can these three sub-goals be met? State and local governments, and college educators, must be willing to focus more on middle and high school females. A partnership between middle and high schools and colleges would be beneficial. Professors and college students, especially females, could come to the middle and high schools and introduce engineering as a field of study and college as a necessary goal for the student. Interaction and introduction is the key.

Current Programs

Many programs have been developed to increase the number of minority females in engineering. Listed below are a few:

- The National Academies have been studying this area, including preparing a guide, “Guide to Recruiting and Advancing Women Scientists and Engineers in Academia.” The National Academies also have a *Directory of Organizations Encouraging Women in Science and Engineering* (<http://www4.nationalacademies.org>) for further information.
- The National Academy of Engineering (NAE) has conducted summits on Women in Engineering, which have focused on female engineers, including diversity.
- The Human Resource Development (HRD) Division supports the following programs for women and girls: (1) Program for Gender Equity in Science, Mathematics, Engineering and Technology, and (2) Professional Opportunities for Women in Research and Education (POWRE).

While these show promise for the future of minority females in engineering, better partnerships must be made. At the very least, a central location must be established for the dissemination of information for these and other programs.

Conclusion

In our goal to discuss increasing the number of minority engineering females, we have presented the current state of affairs showing a lack of representation of specific groups of minority females obtaining academic degrees. Engineering, in particular, woefully lacks representation among all females, with Black and Hispanic females the least represented. We have showed that the statistics indicate that the two main groups within the minority female population, Blacks and Hispanics, do not earn as many bachelor degrees, engineering degrees, or high school diplomas as the remainder of the minority group. We have also showed that the minority female population will become the majority female population in a century. If the current state of minority females in engineering is not improved, the field of engineering will suffer. We have also discussed our goal by breaking it into three sub-goals: (1) Increase the number of Black and Hispanic high school graduates, (2) Increase the number of Black and Hispanic college applicants, and (3) Introduce engineering to potential college students and current college students as close to matriculation as possible. The way in which all three of these goals can be obtained is to partner with middle and high schools. We must encourage our Black and Hispanic minority females to finish high school, apply and attend college, and take as their major an engineering discipline. The fate of engineering in the U.S. in the future depends on our minority population; we must act now.

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