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Women and Minorities in Commercial Aviation: A Quantitative Analysis of Data from the United States Bureau of Labor Statistics

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The low participation rate of women and minorities working in the aviation industry has been well documented by the United States Bureau of Labor Statistics (BLS). Past research has traditionally focused on the ratio of women and minorities in aviation occupations. However, there has been very little research into the rate of change over time. While the ratio of women and minorities in aviation occupations remains low, has the total number increased significantly in the past two decades? If so, how many women and minorities will be working in aviation occupations in 10 years if this trend continues in the future? How can the aviation industry and aviation education institutions work together to attract more women and minorities to work in these highly paid positions? This study will analyze existing data from the BLS to answer these questions.

Problem

According to the BLS, only 5.3% of all aircraft pilots and flight engineers were women, 93% were white, 3.9% were Black, 1.5 % were Asian, and 6.1% were Hispanic or Latino in 2021. Historically, the majority of aircraft pilot and flight engineer jobs have been held by White males (Bureau of Labor Statistics [BLS], 2021). The data concerning aircraft mechanics and service technicians was very similar. According to the 2021 BLS data, only 3.2 % of all aircraft mechanics and service technicians were women, 5.7% were Black, 4.2% were Asian, 15.3% were Hispanic or Latino, and 89.3% were White (BLS, 2021).

The participation rate of women and minorities in these highly paid aviation occupations is low compared to the total population of employed persons in the United States. Of the total number of employed persons 16 years of age and older, 47% were women, 9.8% were Black, 9% were Asian, 18% were Hispanic or Latino, and 77.5% were White. The aviation industry must find ways to increase the number of women and minorities in these occupations to avoid costly flight cancelations and safety issues that occur due to a lack of trained and qualified personnel. The BLS data demonstrates that there is a large untapped reservoir of talent that could fill these gaps.

Purpose

The purpose of this research is to determine the rate of change in the number of women and minorities working as aircraft pilots, flight engineers, aircraft mechanics, and service technicians compared to the rate of change in the number of White males working in those occupations over the last 20 years. It has been well documented by data from the BLS that the participation rate of women and minorities working in these occupations has remained low compared to the total percentage of women and minorities employed in the United States. BLS data has also documented that the number of women and minorities working in these occupations has increased, but the rate of change has not been studied. If the number of women and minorities working as aircraft pilots, flight engineers, aircraft mechanics, and service technicians has increased at a faster rate than the

number of White males and continues to do so, how will this affect participation rates 10 years from now? Conversely, what will participation rates look like in 10 years if the number of women and minorities working in these occupations has increased at a slower rate and continues to increase slower than the number of White males? This research focuses on BLS data to answer these questions.

Research Questions

RQ1: How did the number and ratio of women and minorities working as aircraft pilots, flight engineers, aircraft mechanics, and service technicians change compared to the change in the number and ratio of White males working in these aviation occupations between 2002 and 2021?

RQ2: If this trend continues, what will the number and ratio of women and minorities working in these occupations look like in 10 years?

Literature Review

Interest in research concerning the lack of diversity in STEM occupations including many occupations in the aviation industry has increased in the past two decades. The participation rates of women and members of minority groups has been historically low according to data from the Federal Aviation Administration (FAA) and the BLS. While many studies have focused on the reasons behind these low participation rates, some studies have focused on the experience of women in aviation while others have focused on the experience of minorities.

Women in Aviation

Turney (2018) looked at recent studies and what they revealed about the reasons many women were not attracted to aviation careers. The author found that there were many different factors that led to the underrepresentation of women in the aviation field. One major factor that has been addressed is women's lack of confidence in mathematical and scientific fields. Women lack the role models, parental and social influence in these programs to make them feel confident in their abilities to be equal to their male counterparts. In looking at the retention of women in collegiate aviation programs, it was found that "women are initially not prepared for aviation careers as men are. The games children play contribute to the preservation of typical sex role divisions in society by preparing boys with social skills required for careers and girls with skills required for raising families" (Lever 1974).

Marintseva et al. (2022) explored the key reasons for low female representation in pilot training recruitment. Many studies have found that the problems of gender discrimination and the stereotype of the aircraft pilot as a purely male type of job are dominant. A qualitative study was conducted utilizing the semi-structured in-depth interview of nine female pilots from Europe, Australia, and the United Kingdom to explore why there are so few women aircraft pilots. A transcript-based content analysis was done using Nvivo. In addition, a triangulation method was utilized to verify the results of the study. The study found that along

with the high cost of training, gender inequality was a large factor in women's decisions. Reasons such as "Lack of role models for young girls and women in aviation," "Cultural sexism," and "Lack of acceptance from male peers and passengers" continue to hinder the promotion of the pilot profession among women. The key recommendations regarding women's involvement in the aviation industry are to remove both real and perceived barriers to success, ensure lower entry costs and higher starting salaries, increase awareness and outreach to young girls, discuss role models, promote and maintain a culture of career development, and support women while they study (Marintseva et al., 2022).

Opengart and Ison (2016) conducted a mixed-methods study to investigate the experiences of female pilots. The researchers asked commercial and corporate female pilots "How can we recruit and retain more women pilots?" Sixty-one surveys and ten interviews were completed, and the results of this study indicated that female pilots face significant barriers to their career paths. Themes found included needs for a supportive other, a confident and strong personality, parental and familial encouragement, desire for challenge and excitement, need for awareness and role models, and systems-level problems.

A common theme found in existing literature is a lack of role models, mentors, and networking for women in aviation. It has been demonstrated that a lack of female role models and mentors tends to result in a feeling of isolation in the aviation field and diminishes the desire to continue the aviation career path. Additionally, it has been noted that support for women needs to exist at the organizational level. Leadership should make efforts to nurture female participation through creating a positive work environment that is accepting and supportive. In addition, mentoring and networking at the organizational level has been demonstrated to be helpful. Efforts by leadership to simply connect individuals or assign mentors to provide encouragement can greatly improve job satisfaction and retention (Opengart & Ison, 2016).

The Federal Aviation Administration (FAA) Reauthorization Act of 2018 included the establishment of the Women in Aviation Advisory Board (WIAAB) which was created to develop recommendations and strategies to encourage and support women to pursue careers in aviation (Federal Aviation Administration [FAA], 2022). Congress established the WIAAB to address the historically low participation rate of women in aviation careers. The aviation professionals appointed to the WIAAB were from different sectors of the aviation industry including major airlines, aviation business associations, aerospace companies, higher education institutions, and aviation career schools. The WIAAB collected data from existing research, literature, and personal interviews to determine the factors that both attract and discourage women from pursuing careers in commercial aviation. The report describes a complicated system of barriers that block women from aviation industry careers. Although women represent 47% of

the total workforce in the United States, only 20% of the commercial aviation workforce are women. Primary factors that discourage women from pursuing aviation careers include economic factors, work life balance challenges, lack of awareness about career options, lack of women in leadership, and a negative workplace culture. Recommendations made in the report include cultural interventions to reduce gender bias and sexual harassment, early recruiting efforts, better retention and advancement opportunities through training and mentoring, and data collection improvements from the FAA for tracking progress (FAA, 2022).

Minorities in Aviation

Harl and Roberts (2011) conducted an exploratory case study that looked at the experiences of Black pilots working in business or corporate aviation departments. The authors selected the case study design because of a lack of existing literature focused on this specific group of pilots. The researchers asked a group of 35 participants to answer an open-ended question about their experience of being a Black pilot working in business aviation. They were asked to describe their impressions about corporate aviation and their career paths to give the researchers some insight into their experiences. A total of 21 participants submitted descriptions of their experiences. In addition to their professional experiences, most of the participants described their family support systems, military experience, and what got them interested in pursuing a career in aviation. These descriptions were used to develop interview questions concerning themes of experience and behavior, opinion and belief, feelings, knowledge, personal reflection, and demographics. Among the authors' many findings, Black pilots indicated that White pilots' perceptions of them were oftentimes due to indifference, fear, and ignorance. Black pilots must work harder to prove themselves than White pilots. Many Black pilots who are the sole Black pilot working in their flight departments feel pressure to represent the entire Black race to White pilots. Many of the Black pilots expressed dismay about White pilots who don't seem to know about the history of racism in aviation. They seem oblivious to the history of racial discrimination in the 20th century that kept Black men and women from entering the profession. Most of the participants told stories about how their families supported them in their decision to pursue an aviation career. The authors concluded that this was evidence about the importance of mentoring which is oftentimes ignored in aviation training programs and recommended more mentoring programs to help young Black men and women navigate the challenges of entering the aviation field (Harl & Roberts, 2011).

Diversity in the workforce and the employment practices designed to increase diversity in the workforce have been the subject of much research in the recent past. Albelo and O'Toole (2021) looked at how diversity in the aviation workforce might be improved by teaching about the benefits of diversity in the classroom. Teaching collegiate aviation students about the benefits of diversity is

not only a challenge for teachers, but it can also create an uncomfortable situation for students. Education about the importance of diversity, equity and inclusion is critical to help the aviation industry improve its record of diversity. According to the BLS in 2011, 94% of all airline pilots were White, and 84% of all aircraft mechanics were White (Albelo & O'Toole, 2021). Unfortunately, research on diversity, equity, and inclusion education programs is lacking, and a lack of diversity in the educational environment can perpetuate stereotyping of minorities. The authors recommended identifying bias and creating a sense of belonging in the classroom to avoid this problem (Albelo & O'Toole, 2021, p. 268). It is critical for educators to be knowledgeable about the different methods and practices of teaching about diversity, equity, and inclusion to improve the aviation industry record of diversity in the future. Best practices involve inclusive teaching, dynamic lecturing, and sequential learning. Inclusive teaching is one that explores community and belonging. Since it focuses on the learning environment, inclusive teaching is more inclined to have success in retention of students. Dynamic lecturing involves delivery methods that identify with the student body in a learning environment. This will allow for students to learn and retain information presented to them as it relates to diversity, equity, and inclusion. Lastly, utilizing a systematic approach that involves sequencing of content is extremely effective when incorporating different learning opportunities. (Albelo & O'Toole, 2021).

According to Evans and Feagin (2012), racism has had a continuing effect on Black men and women in the aviation industry. Those who are identified as a member of a minority within the field of aviation are sometimes viewed as less intelligent than members of the White male majority. Black men and women who enter aviation oftentimes face prejudice from their White counterparts either knowingly or unknowingly. Many times, Black men and women must suppress their feelings which can have long-term effects on their psyches. This eventually can lead to what is known as the angry Black person syndrome. For example, a Black Captain who was interviewed described the following experience:

I do have to suppress my emotions at work. You can't be seen as having angry black man syndrome! Every time your emotions are worked up, some [white] people will take greater offense. If they have never been ordered or told to do something by a woman or a person of color, it becomes a problem. Since our industry is mostly white, there are a lot of white First Officers that have never been told what to do by a Black Captain. So, you tell them what to do and they question it, and it's not really their job as a First Officer to question everything you do, especially when it pertains to the safety of flight. Then you realize that they're not questioning you because your decision making is bad. They're questioning you just because you're black, and so that gets old. (Evans & Feagin, 2012, pp. 657-658)

Evans and Feagin (2012) found that Whites in the aviation industry have the luxury of mostly leaving their work at their workplace while most Blacks in these predominantly White environments often carry this racialized dimension of their work into their homes (Evans & Feagin, 2012). Unfortunately, there will continue to be a lack of interest by minorities in White male dominated industries such as aviation and aerospace if this disparity is not addressed.

Although there has been a lack of representation within the aviation field in the past, the number of woman and minorities working in aviation occupations has increased according to Ison et al. (2016). The aviation industry has grown in numbers across different demographics. With the growing shortage of pilots, there is an even greater need to attract a more diverse pool of workers in the future. According to Ison et al. (2016), 27.3% of all collegiate aviation students are members of a minority group which is greater than the percentage of minority members working as professional pilots (18.4%) (Ison et al., 2016, p. 30). While the minority participation rate in collegiate aviation programs is encouraging, the gap between minority representation in collegiate aviation programs and the professional pilot vocation is concerning. If this gap continues, there could be an even greater shortage of professional pilots in the future. The reasons for this gap were not clear according to Ison et al. (2016). Further research investigating the reasons for this gap was recommended.

Aircraft Mechanics and Service Technicians

Newcomer et al. (2018) focused on the perspectives of men concerning potential advancement opportunities and social acceptance of women in the aviation maintenance field. The purpose of this research was to determine how men perceive these opportunities for women. The research questions for this mixed-methods concurrent triangulation study included whether men thought that aviation maintenance is an appropriate career for women, whether gender or ability bias creates a barrier for women in this field, and whether male domination in this field has an impact on women entering and remaining in aviation maintenance occupations. Newcomer et al. (2018) found that men felt aviation maintenance was a suitable and appropriate career choice for women, but men differed significantly from women concerning safety and social acceptance. The researchers concluded that social acceptance is a powerful human need which causes women to avoid occupations that might expose them to social rejection and recommended increasing social acceptance through education for women and young girls about the opportunities for women in the aviation maintenance field.

Women have always been underrepresented in the science, technology, engineering, and mathematics (STEM) fields. Rouscher (2021) looked at the methods used in some of these STEM fields to attract and retain women to see if similar practices might help attract and retain women to the aviation maintenance field. This study concluded that women engineering students who connected with

a mentor early in their college careers were more likely to remain in engineering than women who did not have a mentor within their field of study. In addition, women who had female mentors were even more likely to remain in engineering than women with male mentors. Same gender peer support was recommended as the best way to retain women in the aviation maintenance field.

Methodology

This research employed an ex post facto quantitative approach to data collected from the BLS. The BLS conducts an annual survey of employment and wages by occupation in over 800 different occupational categories in 400 different industries. Transportation industry occupations in the BLS database include aircraft pilots, flight engineers, aircraft mechanics, and service technicians (BLS, 2021). A quantitative analysis was performed on this data to determine demographic changes in the number of people working in these occupations from 2002 through 2021. Pearson correlation coefficient tests were conducted on ten different sets of data: White pilots, White maintenance technicians, women pilots, women maintenance technicians, Black pilots, Black maintenance technicians, Hispanic pilots, Hispanic maintenance technicians, Asian pilots, and Asian maintenance technicians. The analysis includes both the number of people in each group and the ratio comparing each group to the overall population. Based on the initial plot of variables, it appeared that there was a linear relationship between employment numbers and time. The Pearson correlation coefficient (r) was selected as the best statistic to determine the strength of this linear relationship from 2002 to 2021. Correlation strength was determined to be small for r values between .1 and .3, medium for r values between .3 and .5, and large for r values between .5 and 1.0. The result for each group was then employed to project the number of people and ratios for each demographic group in the year 2031 assuming the rate of change for each group remains unchanged in the future.

Limitations of BLS Data

The occupational data from the BLS included the number of flight engineers employed between 2002 and 2021. Due to advances in technology, there are very few flight engineers still employed in commercial aviation today. Most if not all flight engineers have upgraded to pilot positions or retired. Therefore, the data for pilots and flight engineers was combined when projecting numbers in the future. Also, it is important to note that the number of women pilots was not aggregated by racial category, and each racial category was not aggregated by sex.

Conclusions

Pilots

There was a significant linear relationship between the number of White pilots and time, $r = .56$, $p = .01$. Though there is an observed declining trend in the ratio of White pilots over time, the linear relationship is not significant, $r = -.22$, p

= .35. The projected number of White pilots in the next ten years is 144,274, and in ten years, the ratio of White pilots is projected to decrease by 2%.

The number of minority pilots (Asian, Black, and Hispanic) was significantly correlated with time, $r = .65, p = .002$. Similarly, the ratio of minority pilots was significantly correlated with time, $r = .65, p = .002$. The projected number of minority pilots in the next ten years is 32,495, and in ten years, the ratio of minority pilots is projected to grow by 6%. The growth of all minority groups studied was significantly correlated with time: Asian pilots, $r = .51, p = .02$; Black pilots, $r = .75, p < .001$; and Hispanic pilots, $r = .54, p = .01$. The increase in the ratios of Black and Hispanic pilots were significantly correlated with time ($r = .71, p < .001$; $r = .28, p = .02$, respectively), but the ratio of Asian pilots was not statistically significant, $r = .44, p = .054$.

There was a significant linear relationship between the number of women pilots and time, $r = .68, p < .001$, and the linear relationship between the ratio of women pilots and time was also significant, $r = .59, p = .007$. The projected number of women pilots in the next ten years is 13,565, and in ten years, the ratio of women pilots is projected to increase by 2%.

Figure 1 shows the number of aircraft pilots and flight engineers according to the BLS in each group in 2021 with the projected number in 2031. Figure 2 shows the ratio of aircraft pilots and flight engineers in each group in 2021 compared to the projected ratio in 2031. Both the number and ratio of White aircraft pilots is projected to decrease while the number and ratio of women and minority aircraft pilots is projected to increase.

Figure 1

Number of Aircraft Pilots and Flight Engineers by Group in 2021 Compared to Projected Number in 2031

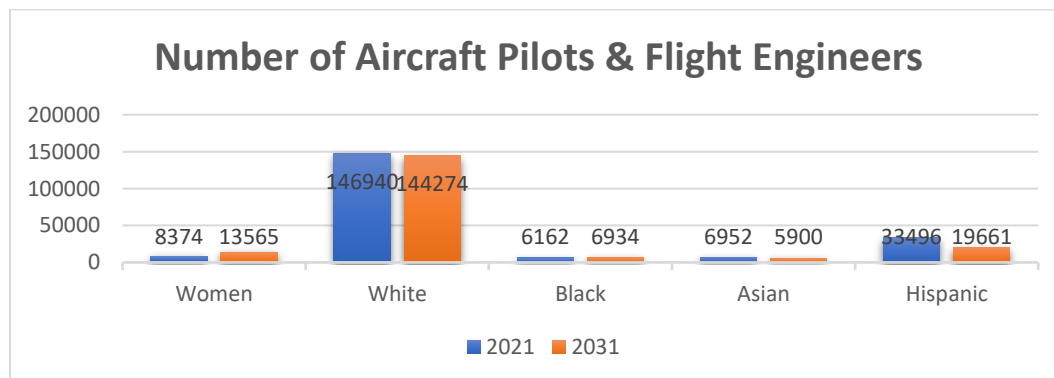
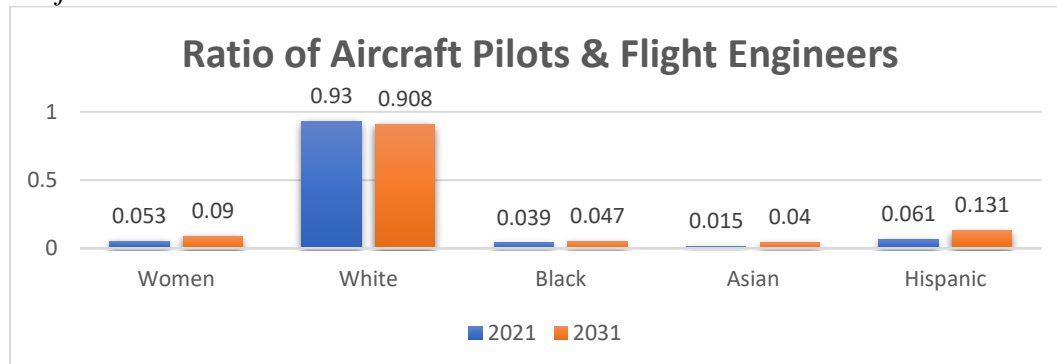


Figure 2

Ratio of Aircraft Pilots and Flight Engineers by Group in 2021 Compared to the Projected Ratio in 2031



Maintenance Technicians

There was a significant linear relationship between the number of White maintenance technicians and time, $r = .63$, $p = .003$, but the linear relationship of the ratio of White maintenance technicians was not significant, $r = .33$, $p = .15$. The projected number of White maintenance technicians in the next ten years is 140,176, and in ten years, the ratio of White maintenance technicians is projected to increase slightly by .4%.

The number of minority maintenance technicians (Asian, Black, and Hispanic) was significantly correlated with time, $r = .71$, $p < .001$. Similarly, the ratio of minority maintenance technicians was significantly correlated with time, $r = .68$, $p < .001$. The projected number of minority maintenance technicians in the next ten years is 59,994, and in ten years, the ratio minority maintenance technicians is projected to grow by .5%. Within the umbrella of minority maintenance technicians, only Hispanic maintenance technicians are showing significant growth over time regarding both the number, $r = .62$, $p = .004$, and ratio, $r = .55$, $p = .01$. Though both Asian and Black maintenance technicians are showing a positive linear relationship with time, the increase is not statistically significant: number of Asian maintenance technicians, $r = .3$, $p = .2$; ratio of Asian maintenance technicians, $r = .23$, $p = .32$; number of Black maintenance technicians, $r = .44$, $p = .054$; and ratio of Black maintenance technicians, $r = .3$, $p = .2$.

There was no significant linear relationship between the number of women maintenance technicians and time, $r = .41$, $p = .07$, and the linear relationship between the ratio of women maintenance technicians and time was also not significant, $r = .31$, $p = .19$. While the linear relationships between the number and ratio of women maintenance technicians are not significant, there is a positive correlation. The projected number of women maintenance technicians in the next

ten years is 7,709, and in ten years, the ratio of women maintenance technicians is projected to increase by .8%.

Figure 3

Number of Aircraft Maintenance Technicians in 2021 Compared to the Projected Number in 2031

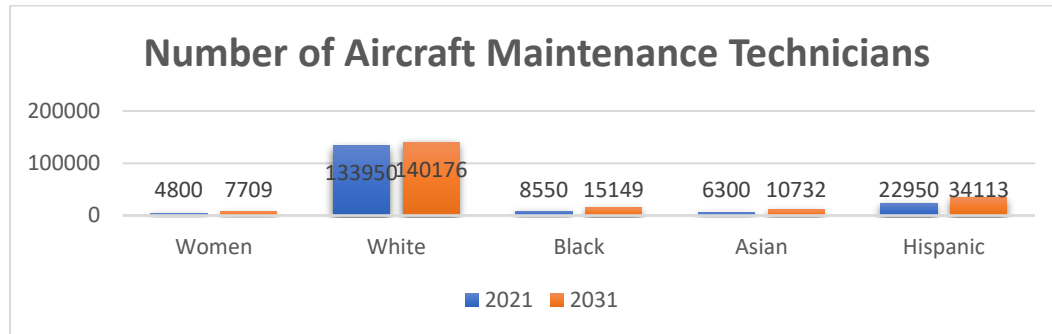


Figure 4

Ratio of Aircraft Maintenance Technicians in 2021 Compared to the Projected Ratio in 2031

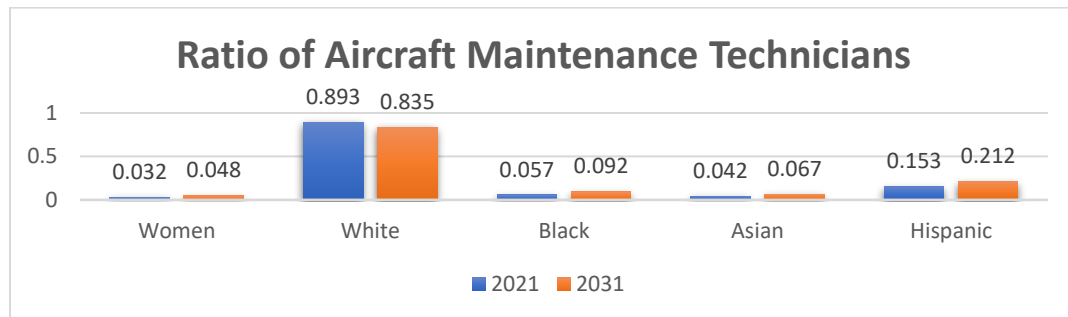


Figure 3 shows the number of aircraft maintenance technicians according to the BLS in each group in 2021 with the projected number in 2031. Figure 4 shows the ratio of aircraft maintenance technicians in each group in 2021 compared to the projected ratio in 2031. While the number of aircraft maintenance technicians is projected to increase for all groups, the ratio of White aircraft maintenance technicians is projected to decrease while the ratio for women and all minority groups is projected to increase.

Figure 5 shows the number of aircraft pilots according to the BLS between 2002 and 2021. Figure 6 shows the ratio for the same period. Although the number of White pilots increased, the ratio of White pilots decreased. The number and ratio of minority pilots increased, but there was disparity in the increase in the number

and ratio of individual minority groups (Asian, Black, and Hispanic). Women pilots also increased in number and ratio.

Figure 7 shows the number of aircraft maintenance technicians according to the BLS between 2002 and 2021. Figure 8 shows the ratio for the same period. The number of White maintenance technicians increased, but the ratio was stagnant. The number and ratio of minority maintenance technicians increased, but like aircraft pilots, there was disparity in the number and ratio of individual minority groups. Women maintenance technicians did not show statistically significant growth in both numbers and ratio between 2002 and 2021.

Figure 5

BLS Number of Aircraft Pilots and Flight Engineers (2002 – 2021)

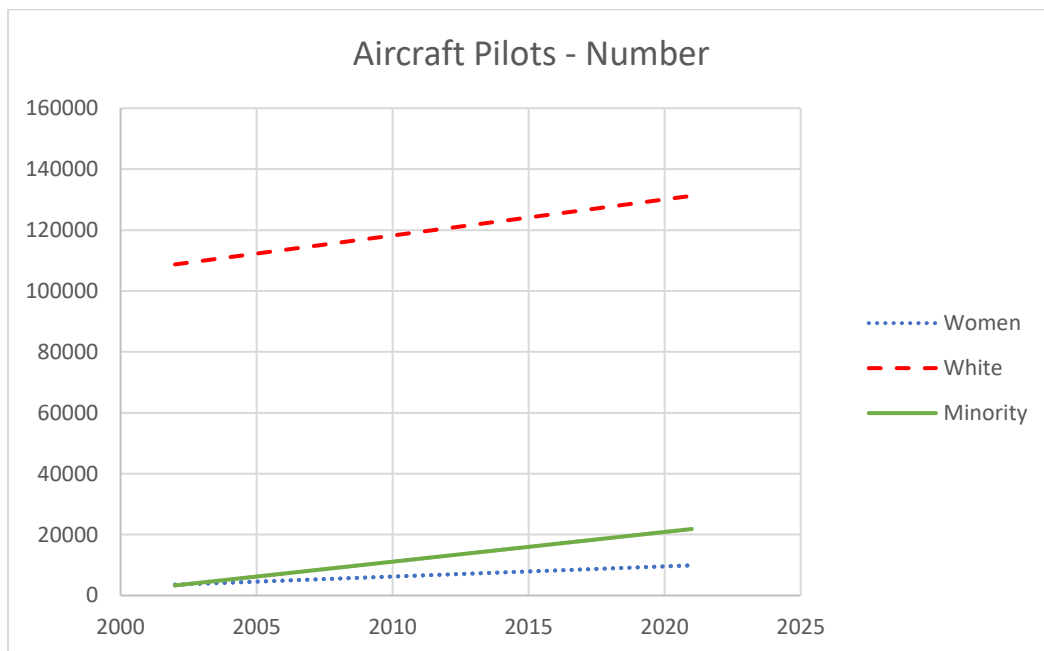


Figure 6
BLS Ratio of Pilots (2002 – 2021)

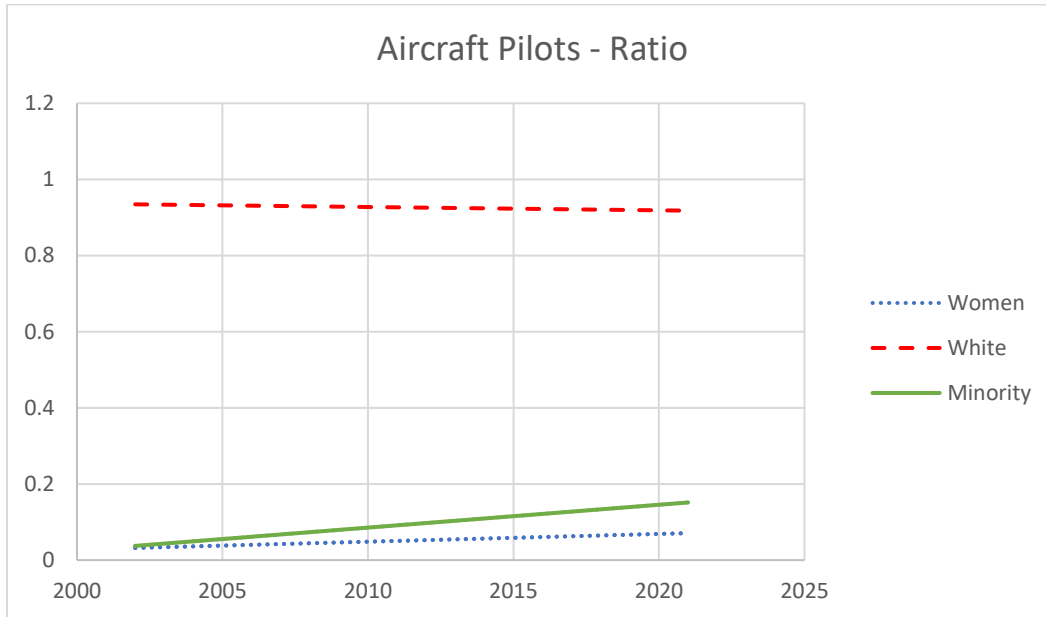


Figure 7
BLS Number of Aircraft Maintenance Technicians (2002 – 2021)

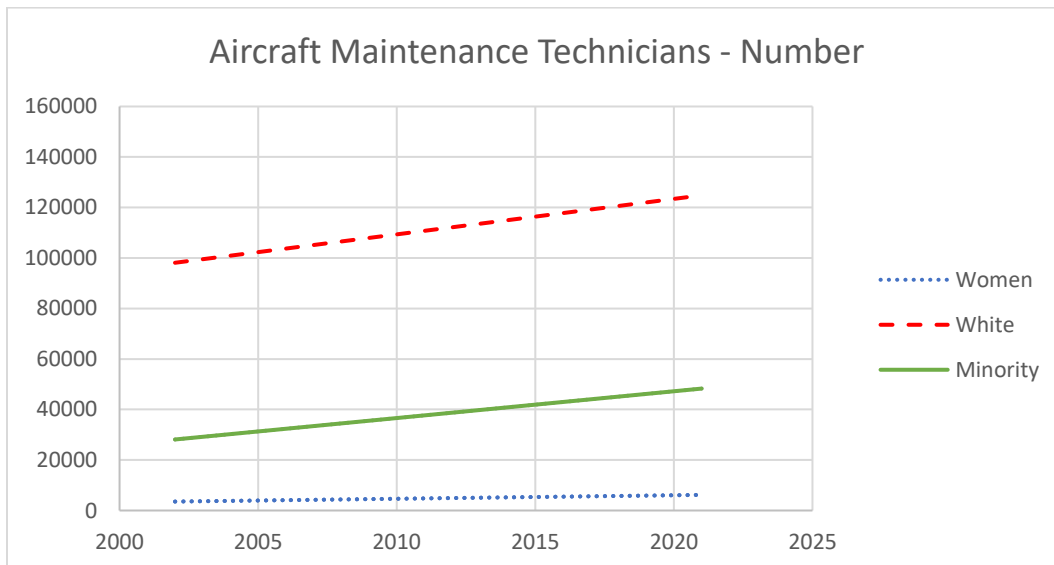
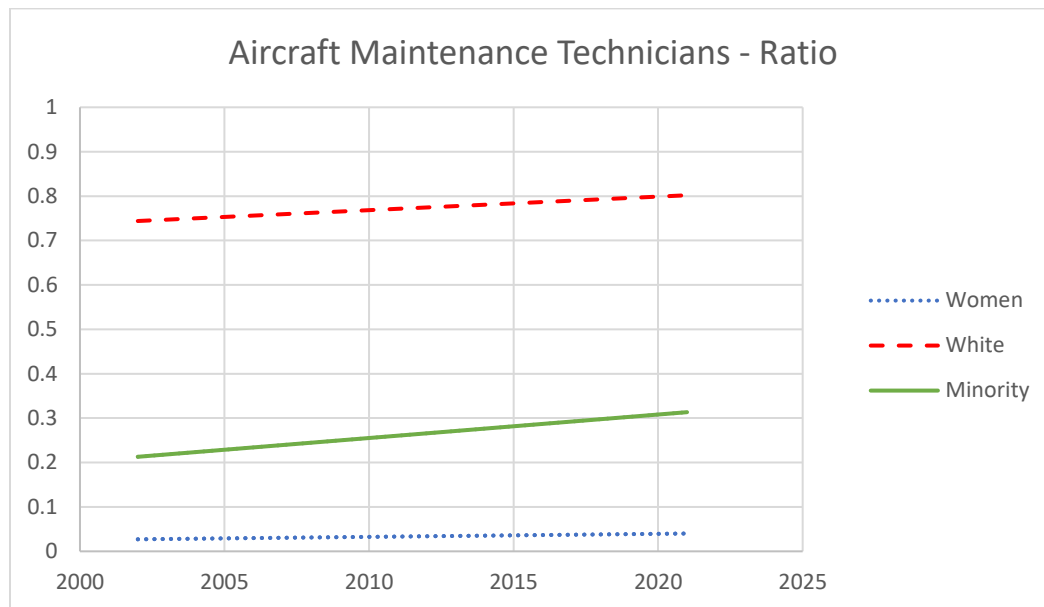


Figure 8*Ratio of BLS Aircraft Maintenance Technicians (2002 – 2021)*

Recommendations

Although the number and ratio of women and minority group members working in aviation occupations has grown since 2002, growth has been sluggish. White males continue to be disproportionately dominant as aircraft pilots, flight engineers, mechanics, and service technicians. If these trends continue for the next 10 years, there will be very little change. The growth experienced in the number of women and minorities in these highly paid aviation occupations is encouraging, but aviation industry efforts to increase diversity have fallen short. Flight training organizations and collegiate aviation programs must increase efforts to attract more women and minority group members into the training pipeline. Although the Women in Aviation Advisory Board (WIAAB) was created to address the lack of women working in aviation occupations, many of their recommendations would also benefit underrepresented minorities. For example, the report made several specific recommendations for the FAA to improve outreach, awareness and education including development of a resource center for students and teachers, expanded efforts on social media platforms to increase visibility of women working in aviation, upgrading the FAA website to include age-appropriate educational materials that ensure women and girls are represented, and establishing partnerships with secondary and postsecondary institutions to develop aviation-related curriculum (FAA, 2022).

Research has revealed that improving retention of women and minorities in the aviation industry is just as important if not more important than focusing only on recruitment. Several of the research studies previously described have revealed the importance of mentorship in attracting and retaining employees from underrepresented groups. Mentorship programs should be developed by flight training organizations and collegiate aviation programs to match aviation students with mentors who can provide encouragement and advice. Research has also revealed the importance of matching mentors with students from the same underrepresented groups, and this should be done early in their training for maximum benefit. Several specific recommendations made by the WIAAB addressed barriers to retention of women in aviation. The WIAAB recommendations to improve retention of women in aviation occupations included industry paid parental and family leave, schedule flexibility and accommodations to improve work-life balance, childcare resources and benefits, accommodations for nursing mothers, legislation to support women and other underrepresented groups in commercial aviation, and mentoring programs for women and other underrepresented groups (FAA, 2022).

If the aviation industry continues with business as usual, major improvements in the diversity of the aviation workforce will not transpire. The data from the United States Bureau of Labor Statistics demonstrates that the rate of growth in women and minorities working in the aviation industry must increase significantly for meaningful change to occur. Women and minorities represent an untapped resource that could significantly reduce the shortage of qualified aviation personnel. Previous research cited in this report has revealed that the culture of the aviation industry must undergo significant change to improve the diversity of the aviation workforce. Although women and minorities are legally protected from overt discrimination, they are not always accepted by their coworkers, and many are challenged on a daily basis by bias, stereotypes, and harassment. Unfortunately, cultural change does not happen quickly, and it requires a broad commitment from individuals in leadership positions. According to the WIAAB report, culture includes both internal and external aspects, and the internal aspects are not directly observable. Internal aspects include values, beliefs, and attitudes while external aspects include policies, organizational structures, and language. Although values, beliefs, and attitudes may not be directly observable, they are reflected by organizational structures, policies, and language (FAA, 2022). The major task for the aviation industry will be changing the culture of the aviation workplace, and cultural change requires a long-term commitment from key players in the aviation industry including government, industry, and educational institutions.

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