Women in Aviation: Identifying Trends in Industry and Higher Education

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Introduction

Aviation is of vital importance to the national and global economy. Air transportation connects people, supports economic development, and enables humanitarian missions around the globe (Belobaba, Odoni, and Barnhart 2015). Despite the global reach of aviation, the industry lacks diversity in every area including training, airline operations, and military aviation (Bridges, Mills, and Neal-Smith 2014; Sulton 2018). Globally, less than 5% of pilots are women and enrollment trends in aviation programs do not suggest there will be any significant diversity improvements unless a concerted effort for change is pursued. This underrepresentation exists despite the fact that broadening the field to welcome women would help alleviate the well documented pilot shortage and the shortages in other aviation professions such as mechanics and aeronautical engineers (Opengart and Ison 2016). Unfortunately, investigation into the factors impacting diversity in aviation has received little attention from researchers, unlike research regarding engineering, medicine and law (Carr et al. 2017; Hunt 2016; Marra et al. 2009; Trautvetter 2018). With the forecasted increase in travel demand over the next 20 years, the current and looming aviation labor shortages necessitates a more thorough understanding of these diversity issues (Boeing 2019).

Today women are more likely to earn a bachelor's degree than men, and women make up nearly half of the U.S. workforce (Bureau of Labor Statistics 2018a, 2018b). Nonetheless, underrepresentation exists in career fields characterized by high earnings and high stability such as STEM and legal fields. Women account for only 13% of total employment as engineers and 35% of lawyers (U.S. Department of Labor 2018). Given the anticipated growth in aviation careers with the expansion of global aviation, understanding the underrepresentation of women in aviation is of great importance. This importance arises not only from a diversity standpoint but also from a labor shortage, transportation capacity, as well as global trade perspectives. Therefore, this paper will provide the motivation and foundation for further research at the higher education level concerning the diversity issues observed in aviation. The first section will outline the current and historical gender trends in the aviation workforce at the national and industry levels. The second section will provide an analysis of gender in aviation programs in higher education and at Purdue University. The final section will discuss the previous research

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concerning women in aviation and male dominated career fields to provide a basis for understanding the existing gender disparity in aviation.

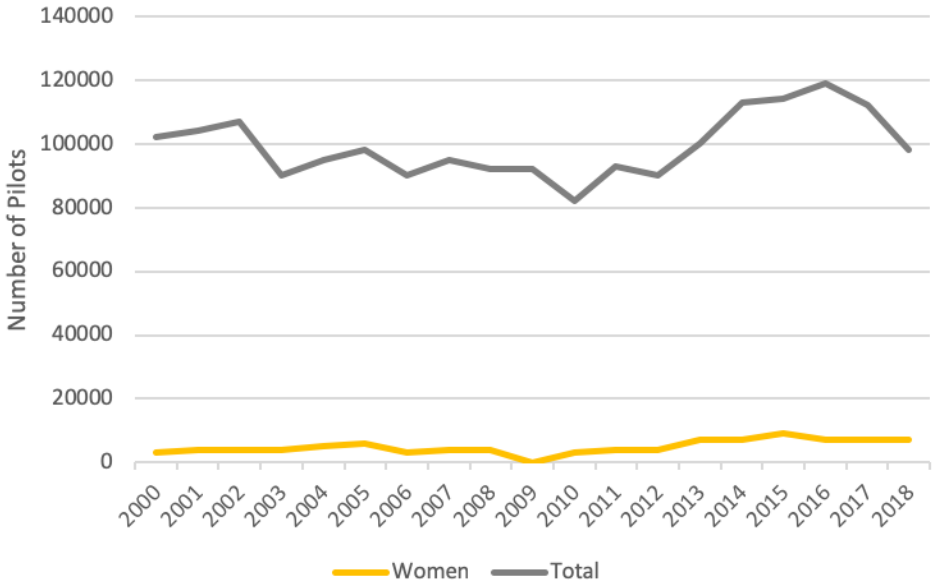
Gender Trends in the Aviation Workforce

As the global travel demand increases, the demand for skilled aviation professionals in all aspects of air transportation will increase (Boeing 2019). Despite the aviation hiring boom following the Great Recession in 2008, the number of women has not increased as the pipeline grows. The trend for the past two decades has not been very promising for women in aviation. Military aviation is not immune to this issue and has also realized a gender problem exists in their ranks as pilot shortages plague the future of the Air Force (Keller et al. 2018). With the looming global aviation workforce shortages, the urgency to increase women's participation in the aviation industry is evident. Nevertheless, employment in many aviation careers is lagging. Five of the main career areas in aviation are classified by the Bureau of Labor Statistics and tallied during Current Population Survey data collection. Each of these careers are vital to the flow of air transportation both domestically and globally. The main career areas are aircraft pilots, aircraft mechanics, aerospace engineers, aircraft structures workers, and air traffic controllers. Using the Bureau of Labor Statistics' Current Population Survey dataset, employment and wage data with respect to gender can be examined for each career.

Aircraft pilots ensure the safe operation of aircraft for the transport of passengers and cargo (Bureau of Labor Statistics 2017). The aforementioned shortage of these aviation professionals is of great concern to airlines, flight schools and military air forces around the world. One of the strategies to correct for this shortage is to increase the number of women aviators (Opengart and Ison 2016). Despite the need to shore up the future dearth of pilots, few gains have been made in increasing the number of women pilots. Figure 1 illustrates the gender gap in the pilot career field. Between 2000 and 2018, women averaged only 4.8% of the full time employed pilots in the U.S. At 7% of the total employed pilots, 2018 had one of the largest shares of women pilots in nearly two decades. One possible explanation of this could be the decline in overall full time employed pilots as retirements (of more senior, male pilots) in the industry have increased.

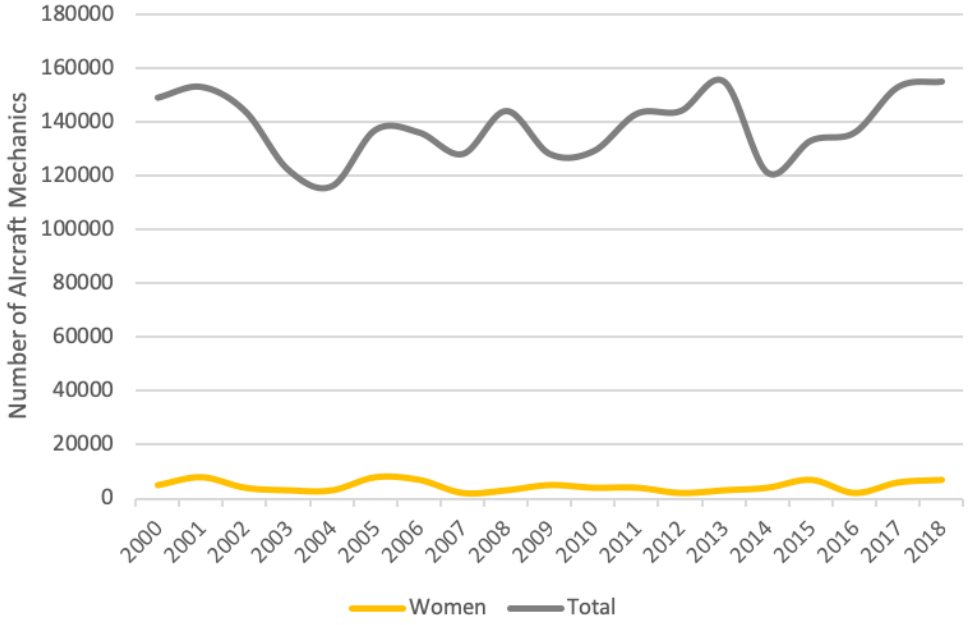
In the aircraft mechanic career field, shortages are being reported and projected as older mechanics begin to retire (Wyman 2017). As the aircraft mechanic pipeline attempts to alleviate this shortage, women are again struggling to make gains in the workforce. Figure 2 illustrates the consistent gender gap in aircraft mechanics over the past 18 years. The data demonstrates the staggering gender gap in employment that exists in the aircraft mechanic workforce. The gender gap is on average worse in the mechanic career field than the pilot field at 3.3% versus 4.8%, respectively. The latest year's data (2018) show that women represent 4.5% of the full-time mechanics employed.

Figure 1
Number of Full Time Employed Pilots in the U.S., 2000-2018*



*Source: Bureau of Labor Statistics' Current Population Survey

Figure 2
Number of Full Time Employed Aircraft Mechanics in the U.S., 2000-2018*

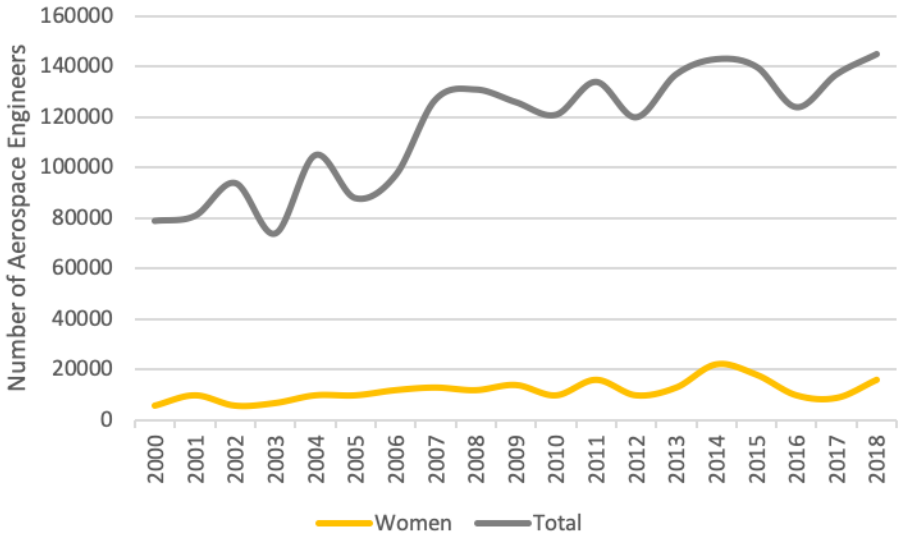


*Source: Bureau of Labor Statistics' Current Population Survey

Aerospace engineers are essential to continue the progression of air and space transport in the modern world. These professionals develop and improve the air transport capabilities through engineering improvements and breakthroughs (Bureau of Labor Statistics 2017). Wilkinson

(2007) highlights the struggle to fill the shortage of engineers in the aerospace industry and the gender gap that exists. The production of new aircraft driven by increased demand is constrained by the labor supply of qualified aerospace engineers. Figure 3 provides further evidence of the gender imbalance in aerospace engineering. As previously discussed, the engineering discipline as a whole faces its own gender issues and aerospace engineering is almost certainly evidential of this problem. Engineering schools are working to correct the imbalance (Griffith 2010); however, over the past 18 years women accounted for only 10% of the aerospace engineers in the U.S. In the most recent year (2018), women represented 11% of full time employed aerospace engineers. Despite the limited participation and inclusion of women in aerospace engineering, the field is faring better than the pilot and the aircraft mechanic career fields with respect to gender inclusion.

Figure 3
Number of Full Time Employed Aerospace Engineers in the U.S., 2000-2018*



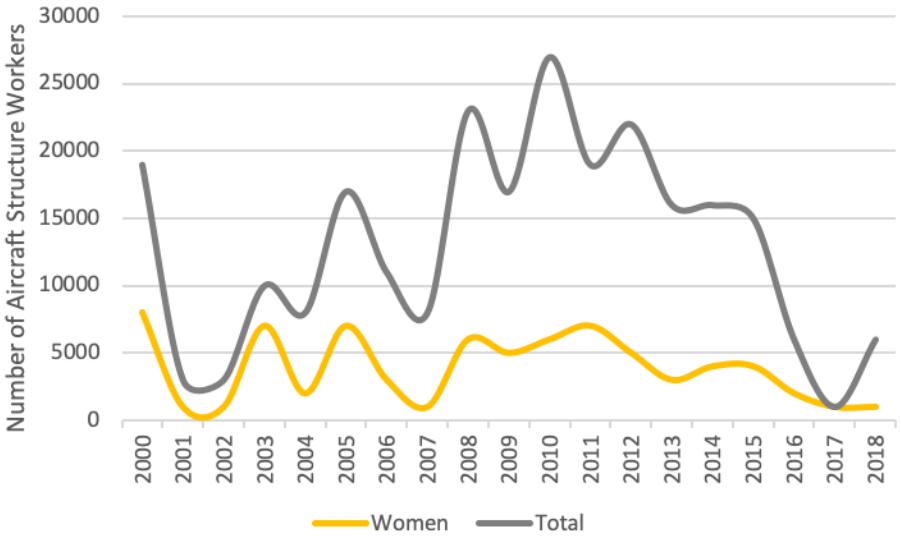
*Source: Bureau of Labor Statistics' Current Population Survey

Aircraft structure workers assemble aircraft and spacecraft and are vital to the production of these vehicles and continuance of air transport (Bureau of Labor Statistics 2017). Overall, this career field has one of the highest women-to-men ratios of all aviation careers studied. Figure 4 displays the employment data of aircraft structure workers. According to the data, the aircraft structures career field averaged nearly 30% women in its workforce from 2000-2018. This percentage of women is over six times the percentage observed in aircraft mechanics and three times that of aerospace engineers. Unfortunately, in 2018 the percentage was much lower with women comprising only 15% of the workforce.

The final aviation career examined is the air traffic controller career field. Perhaps one of the most important professions in aviation, air traffic controllers keep the airways safe and allow for the efficient flow of air traffic through the nation's airways (Bureau of Labor Statistics 2017).

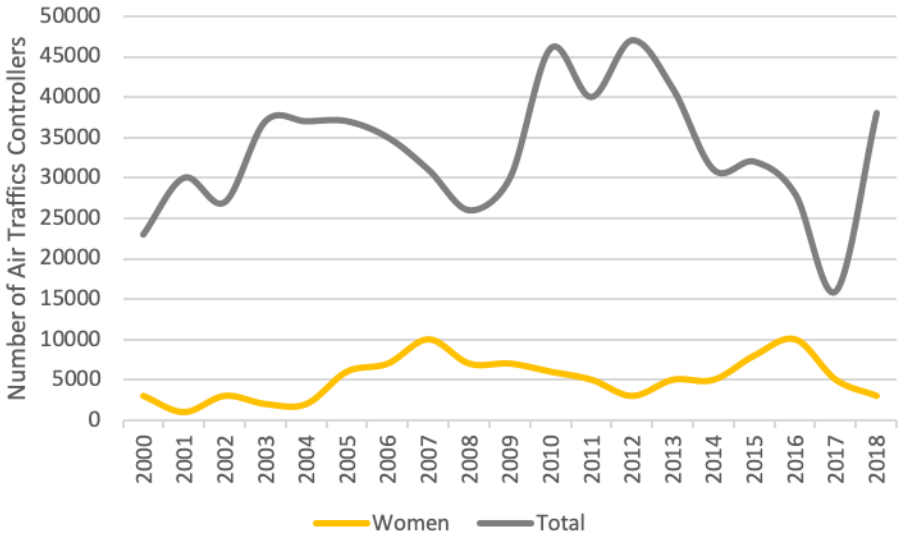
Figure 4
Number of Full Time Employed Aircraft Structure Workers in the U.S., 2000-2018*

*Source: Bureau of Labor Statistics' Current Population Survey



These professionals are currently being overworked, understaffed and face their own shortage as airport traffic demand increases (Smith 2015). The inclusion of more women into this important aviation career field could help to alleviate the strain on current air traffic controllers as well as the congested airspace. Figure 5 exhibits the trends in the air traffic controller workforce. Between the years 2000-2018, women averaged over 15% of the air traffic controller workforce. Most recently in 2018, women comprised only 7% of the air traffic controller workforce. The recent numbers are comparable to the pilot career field, higher than the mechanics career field, and lower than both the aerospace engineer and aircraft structures career fields.

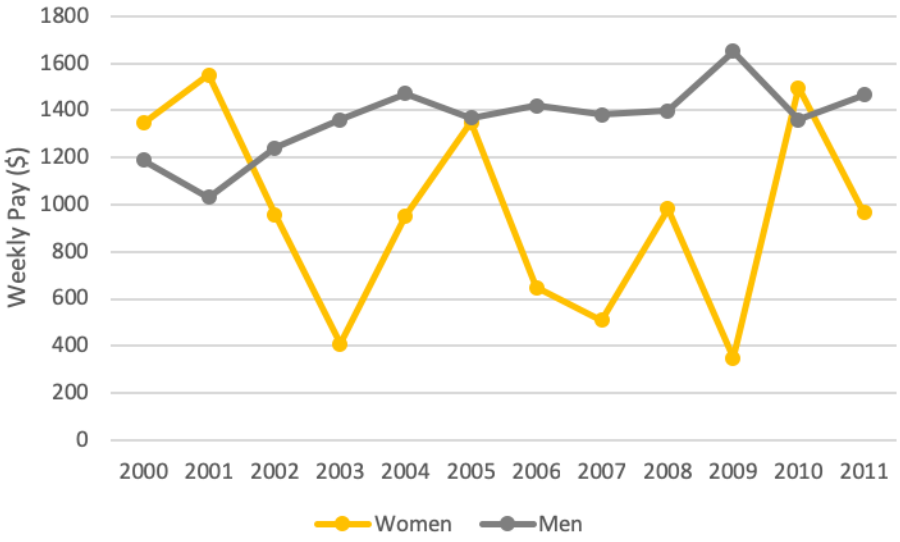
Figure 5
Number of Full Time Employed Air Traffic Controllers (ATC) in the U.S., 2000-2018*



*Source: Bureau of Labor Statistics' Current Population Survey

Median weekly earnings data for all professions in the U.S. exhibited a gender pay gap with women's-to-men's earnings ratio being approximately 82% in 2018 (Bureau of Labor Statistics 2018b). According to the Bureau of Labor Statistics's report, this ratio has remained nearly constant since 2004 (Bureau of Labor Statistics 2018b). When examining the gender pay disparity in the aviation industry, we again examine the main careers utilizing the Bureau of Labor Statistics' Current Population Survey dataset. The careers examined are high skill and high wage professions in the aviation industry. Figure 6 displays the trend in pilot pay for both men and women from 2000 to 2011. Aircraft pilots are one of the highest earning professionals in the aviation industry. The average weekly earnings for pilots exhibits an average women's-to-men's earnings ratio of 70%. This ratio is well below the national average for the gender pay gap; however, the authors note that many aircraft pilots fall under a collective bargaining contract and more investigation at the micro level is needed to ascertain the extent of the pay gap. One plausible cause of the observed pay gap is that female pilots tend to be younger and have less seniority, which is a significant factor affecting compensation. A possible explanation of the large variations in women's pay is that women may be more greatly impacted by economic fluctuations. This large impact could again be caused by the possible lower levels of seniority indicating that women are more likely to be laid off or furloughed than a more senior pilot.

Figure 6
Median Weekly Earnings for Aircraft Pilots, 2000-2011*

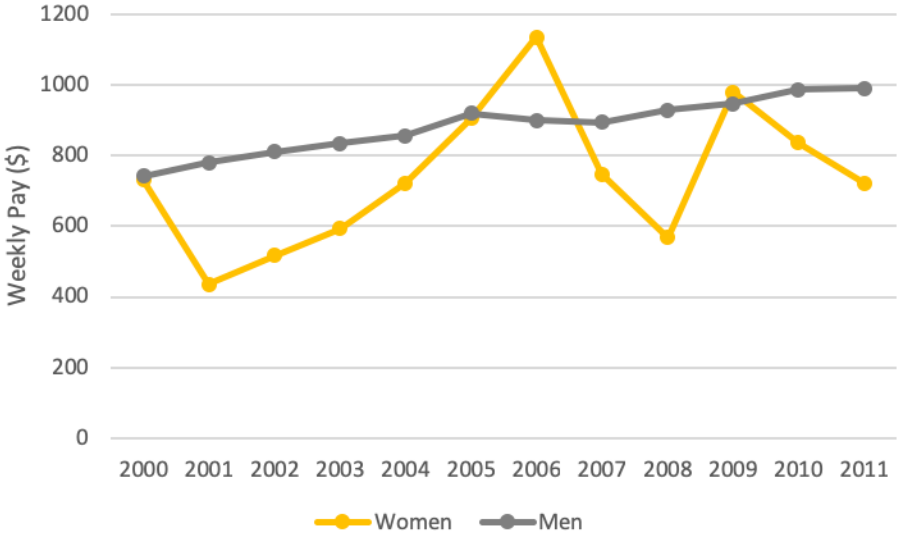


*Source: Bureau of Labor Statistics' Current Population Survey

Aircraft mechanics are highly skilled workers requiring successful completion of an arduous education and certification process (National Center for O*NET Development 2019). Figure 7 displays the trend in aircraft mechanic pay for both men and women from 2000 to 2011. The average weekly earnings for aircraft mechanics has an average women's-to-men's earnings ratio of 84%. This ratio is slightly above the national average for the gender pay gap, but still exhibits a 16% pay differential for men in the workforce. Again, the authors note that many aircraft mechanics are subject to a collective bargaining contract and a deeper investigation is needed to

better understand the seniority levels and trends in women's compensation in the mechanic career field.

Figure 7
Median Weekly Earnings for Aircraft Mechanics, 2000-2011*

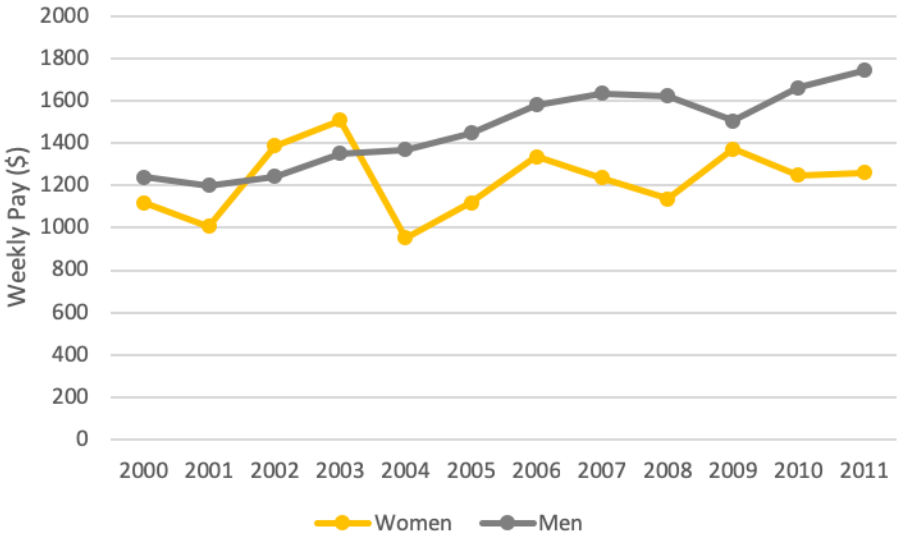


*Source: Bureau of Labor Statistics' Current Population Survey

Aerospace engineers are highly skilled workers requiring successful completion of advanced engineering degrees (Bureau of Labor Statistics 2017). These professionals have the highest wages of all five careers discussed. This high wage rate is illustrated in Figure 8. Figure 8 displays the trend in pay for both men and women aerospace engineers from 2000 to 2011. The average weekly earnings for aerospace engineers has an average women's-to-men's earnings ratio of 83%. This ratio is similar to the national average for the gender pay gap and provides another example of a high paying career that exhibits gender pay inequity.

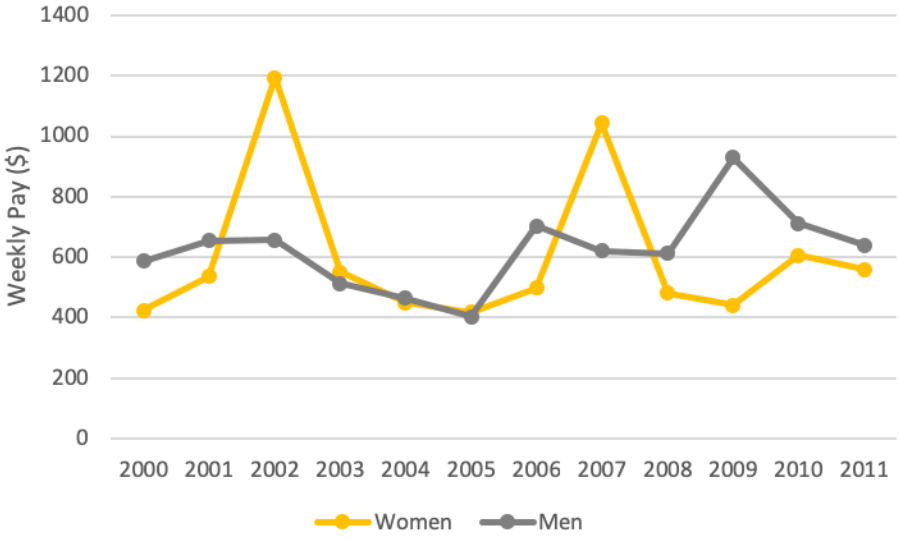
Aircraft structure workers are also highly skilled workers who must meet strict parameters in the production process of aircraft (Bureau of Labor Statistics 2017). Figure 9 displays the trend in aircraft structure workers' pay for both men and women from 2000 to 2011. The average weekly earnings for aircraft structure workers has an average women's-to-men's earnings ratio of 96%. This ratio is well above the national average for the gender earnings ratio and could provide a positive example to the aviation industry for steps to achieving pay equity. One possible explanation for the spikes in women's pay can be inferred from Figure 4. The share of women in the aircraft structures workforce declines during periods corresponding to higher pay for women in these occupations. These declines in the share of women occur when the economy is contracting and could coincide with layoffs at the less senior (and lower paid) ends of the worker distribution. This reduction would leave a pool of higher seniority (and higher paid) women in the workforce thus causing a spike in the average earnings for those remaining on the job.

Figure 8
Median Weekly Earnings for Aerospace Engineers, 2000-2011*



*Source: Bureau of Labor Statistics' Current Population Survey

Figure 9
Median Weekly Earnings for Aircraft Structure Workers, 2000-2011*

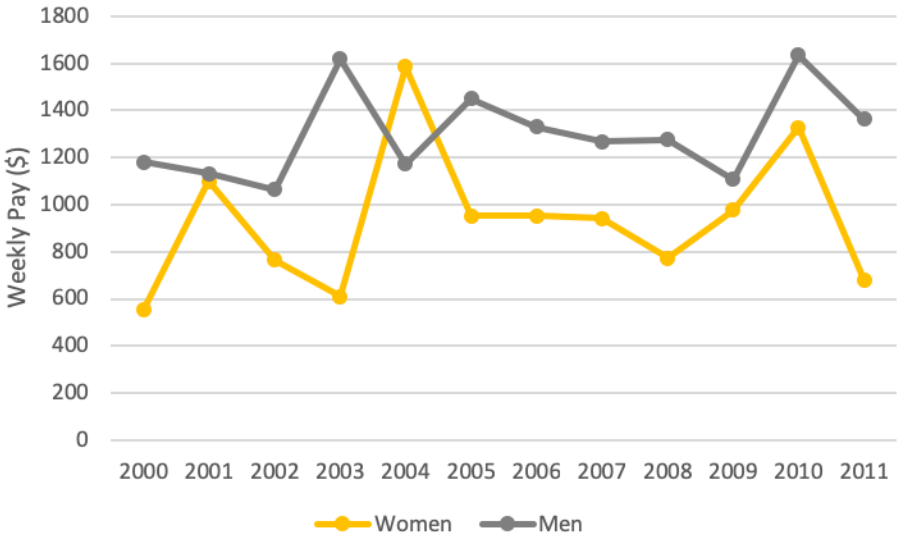


*Source: Bureau of Labor Statistics' Current Population Survey

Air traffic controllers are among the more highly skilled workers requiring successful completion of a certification process and the ability to handle high levels of stress (Ćosić et al. 2019). The high level of compensation to these professionals reflect these high skill requirements and high stress environment. Figure 10 displays the trend in air traffic controller pay for both men and women from 2000 to 2011. The average weekly earnings for air traffic control has an average women's-to-men's earnings ratio of 71%. This ratio is well below the national average for the gender pay gap. These air traffic control professionals are public servants with union and

governmental job protections. Therefore, a more micro level analysis would be required to thoroughly understand the extent of the gap in earnings.

Figure 10
Median Weekly Earnings for Air Traffic Controllers, 2000-2011*

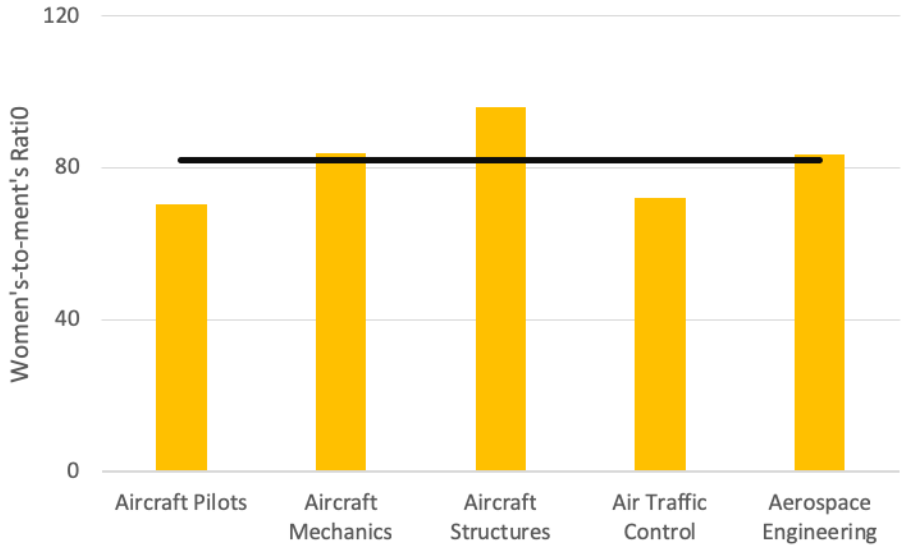


*Source: Bureau of Labor Statistics' Current Population Survey

The national women's-to-men's earnings ratio has persisted near 82% for roughly two decades (Bureau of Labor Statistics 2018b). In Figure 11, the horizontal line indicates the national average women's-to-men's earning ratio. Again, most aviation careers are at or below this national average indicating a more significant pay gap for women in comparison to their male counterparts. Further, women in the aviation industry appear to be impacted by economic declines more than their male counterparts. The one career that appears to surpass the national average at creating pay equity is the aircraft structures career field. These workers are typically employed by large aircraft manufacturers in areas such as Wichita, Kansas, Los Angeles, California, and Atlanta, Georgia. An analysis of these major firms' human resource practices could shed light on the best avenues to successful compression of the wage gap between men and women workers in the aviation industry. As the aviation industry continues to thrive and demand for air transport continues to grow, the industry has the unique opportunity to improve gender issues that exist in its career field ranks.

Overall, the data suggest the aviation industry has much improvement to make with respect to diverse employment and parity in earnings. These issues are quite visible when examining the data of currently employed aviation professionals. A more thorough understanding of the issues requires an examination of the pipeline to these positions. Most of these professions require training and education that occurs in higher educational institutions across the U.S. Therefore, an overview of the trends of women in aviation education programs will aid in generating a more comprehensive understanding of the gender issues in aviation.

Figure 11
Average Women's-to-Men's Earnings Ratio by Career, 2000-2011*



*Source: Authors' calculations of Bureau of Labor Statistics' Current Population Survey Data

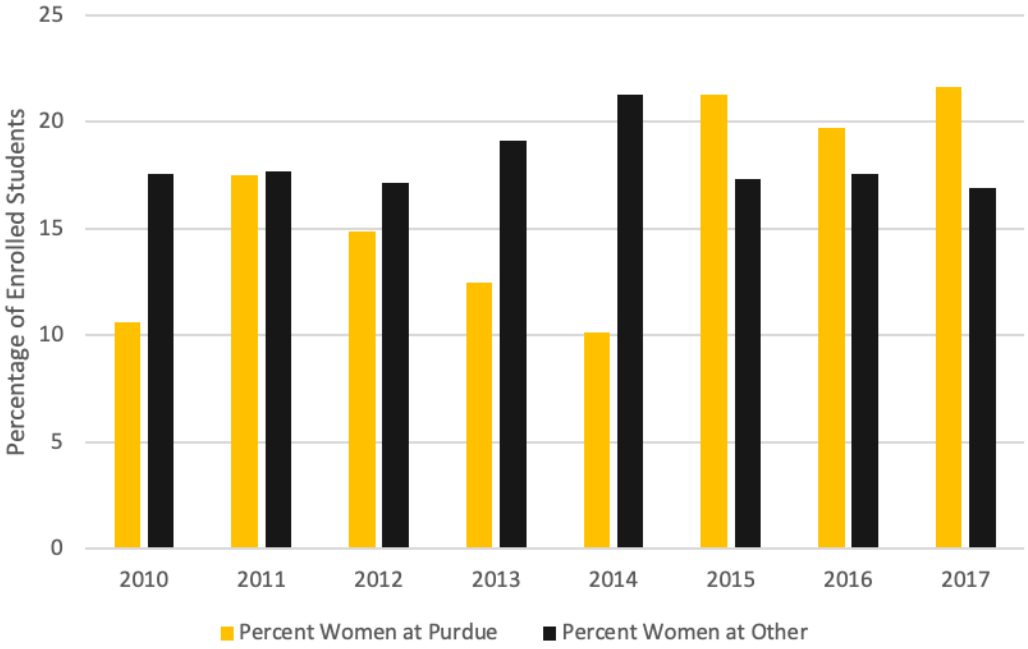
Gender Trends in the Aviation Higher Education

Enrollment in aviation higher educational programs has seen a slight decrease in women's participation over the past two decades (Ison, Herron, and Weiland 2016). Programs have struggled to increase the number of female students as well as graduates. At Purdue University, one of the leading aviation programs in the U.S., enrollment rates for female students has varied across a seven-year period and in relation to comparable aviation higher education programs in the U.S. Utilizing the Department of Education's National Center for Education Statistics database, total female enrollment at Purdue University can be compared with the average in comparable aviation programs in the U.S. Figure 12 highlights the relative reversal in women's enrollment of these comparison groups. Women enrollment at Purdue University lagged behind the average of its fellow institutions until 2015. The data for the years after 2015 reveal Purdue University as a leader in female enrollment in aviation programs.

When examining the enrollment data at Purdue University, the major subfields of study in aviation are important to note. Within the School of Aviation and Transportation Technology at Purdue University, students may elect to enroll in several programs including aeronautical engineering technology, aviation management, professional flight, and unmanned aerial systems. Students in aeronautical engineering are in a separate college and are not included in Figure 12. Micro-level data on the subfields in aviation are only available up to fall 2015. Therefore, these most recent data will be utilized to provide a closer examination of the enrollment of women in these higher education programs.

Figure 13 exhibits the women-to-men enrollment ratio for each aviation related major in the School of Aviation and Transportation Technology at Purdue University. In fall 2015, aeronautical engineering technology and professional flight had 14% women enrollment.

Figure 12
Air Transportation Related Program Enrollment (Women): Purdue University and Average of other U.S. Aviation Higher Education Schools, 2010-2017*

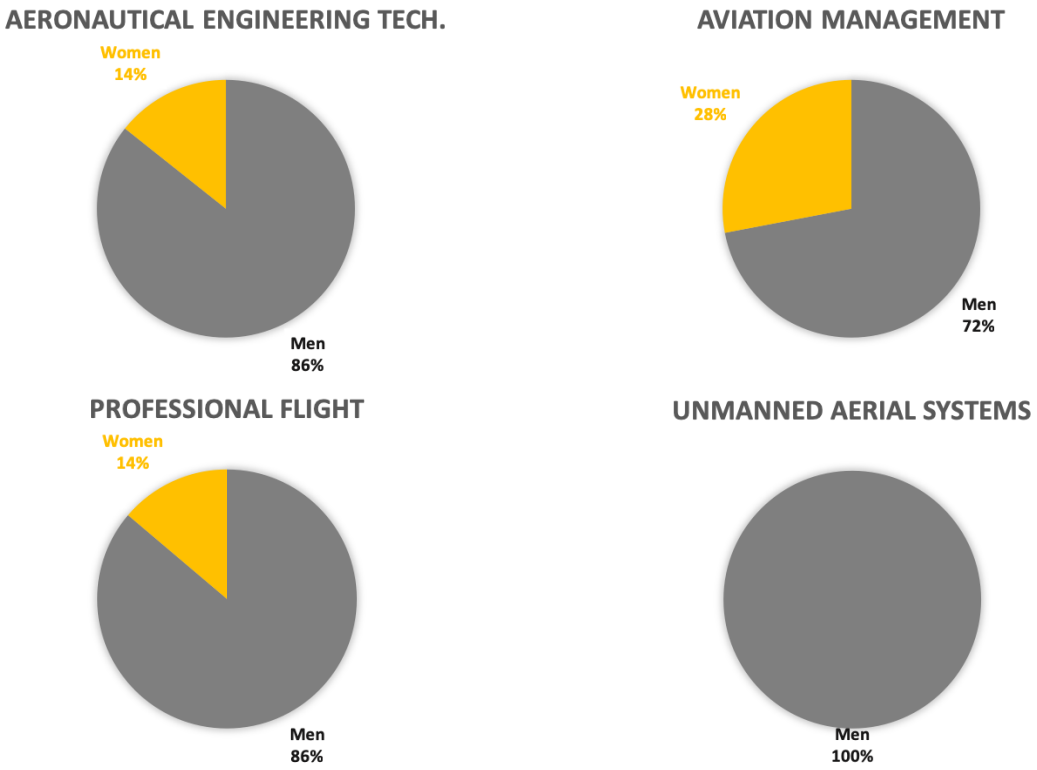


*Source: Department of Education's National Center for Education Statistics.

Aviation management had the highest representation of women at 28%. The lowest share of women occurred in the newest major (and newest field) in aviation, unmanned aerial systems. In fall 2015, no women were enrolled in this program; however, given that unmanned aerial systems is a brand-new field in aviation, it is assumed to be unlikely to suffer from the historical biases that exist in other aviation fields. These rates, with the exception of unmanned aerial systems, are far greater than the full-time employment rates currently existing in the workforce data previously examined.

Despite the greater proportion of women in these programs in comparison with the current aviation workforce, women's enrollment in aviation programs at Purdue University are far below the 42.6% of enrolled students that are women at the University as a whole during fall 2015. As one of the leading aviation programs in the nation, Purdue University has a distinctive opportunity to further improve the situation of women in aviation by working to increase enrollment of women in these programs and developing methods of inclusion and retention that may be utilized by other higher education institutions with aviation programs. Therefore, it is important to understand the factors influencing these gender disparities in aviation. The following section will discuss the barriers faced by women.

Figure 13
Purdue University Aviation Related Major Enrollment, fall 2015*



*Source: Purdue University Enrollment Data.

Barriers for Women in Aviation and in Male Dominated Careers

Many studies exist examining the factors underlying the dearth of women in male dominated careers such as STEM, law, medical and economics careers (see for example Dasgupta and Stout 2014; Ginther and Kahn 2004; Schultz and Shaw 2003). These studies find several contributing factors affecting women's participation in these fields. The main factors stem from the impact of implicit biases and discrimination. Gender norms are found to exist in the sciences and humanities and these lead to gender stereotyping casting men and women into gendered professions (Charles and Bradley 2009; Cundiff et al. 2013). These studies provide a clearer understanding of the factors impacting recruitment, retention and success of women in male dominated disciplines. Despite the academic knowledge of the disparity issues in professional fields, the recent American Economic Association's Professional Climate Survey highlighted that gender biases and discrimination are still pervasive despite historical progress in even highly respected fields like economics (American Economic Association 2019).

In aviation, the research concerning gender norms, biases, and discrimination issues are still in its infancy. Bridges et al. (2014) discusses the phenomena of gender norms in Australian aviation. They observe that female commercial airline pilots are typically assumed to be cabin crew (i.e. flight attendants) when interacting with the flying public in uniform. In the Australian military, they find that female aviators were placed into gender appropriate "caricature" roles ranging from "seductress" to "mother" roles (Bridges et al. 2014). Additionally, a study

examining online professional pilot forums in New Zealand paints a similar picture of the pervasive nature of gender norms within aviation (Zheng 2016).

Another barrier women encounter in male dominated careers is the perception of a glass ceiling (Mitchell, Kristovics, and Vermeulen 2006). Earnings data in the aviation sector highlights the pay disparity that women experience. Figure 2 shows the unstable and lower wages of female pilots in comparison to their male counterparts. Moreover, the second-generation biases created by the lack of women leaders in aviation have thickened the glass ceiling perceived by many women aviators (Hynes and Puckett 2011). The premier global aviation trade association, the International Air Transport Association (IATA), has formed a commission to better understand the leadership barriers for women in the aviation industry (International Air Transport Association 2018). The results of the IATA study are scheduled to be released in 2019, which will provide a more comprehensive analysis of the issue at an international level. For the female aviation student this shortage of women mentors and leadership is also present. Women represent a fraction of the aviation faculty at U.S. higher education aviation programs with only 8% of aviation faculty being women (Ison 2010).

Despite the gender issues in both higher education and industry levels, improving diversity and inclusion are top priorities for all aviation stakeholders. This paper has developed a foundation and motivation for further research into these gender inequalities. Future research could identify factors that contribute to the successful integration of women in aviation higher education programs. A study of Purdue University's efforts to increase inclusion could prove to enrich the recruitment, retention and success of women in aviation. This future examination could serve as an evolving process to improve policies, procedures and practices at the university level to increase the participation of women in aviation programs. The results of a future study would provide value not only to one of the highest ranked aviation programs in the country, but also to other institutions that wish to improve the diversity of their programs. The improvements in diversity at the higher education level will ultimately lead to improvements at the industry level thus reducing the level of inequality currently present in the aviation field.

References

American Economic Association. 2019. AEA Professional Climate Survey: Main Findings. American Economic Association Ad Hoc Committee. Retrieved May 20, 2019 (https://www.aeaweb.org/resources/member-docs/climate-survey-results-mar-18-2019).

Belobaba, Peter, Amedeo Odoni, and Cynthia Barnhart. 2015. *The Global Airline Industry*. New Jersey: John Wiley & Sons.

Boeing. 2019. Pilot and Technician Outlook. Retrieved May 25, 2019 (https://www.boeing.com/commercial/market/pilot-technician-outlook/).

Bridges, Donna, Albert Mills, and Jane Neal-Smith. 2014. *Absent Aviators: Gender issues in aviation*. Farnham: Ashgate Publishing Limited.

Bureau of Labor Statistics. 2017. Occupational Employment Statistics. May 2017 Occupation Profiles. Retrieved May 20, 2019 (https://www.bls.gov/oes/2017/may/oes_stru.htm).

Bureau of Labor Statistics. 2018a. Women in the labor force: a databook. *BLS Reports*. Retrieved May 20, 2019 (https://www.bls.gov/opub/reports/womens-databook/2018/pdf/home.pdf).

Bureau of Labor Statistics. 2018b. Women more likely than men to have earned a bachelor's

degree by age 31. *TED: The Economics Daily*. Retrieved May 25, 2019 (https://www.bls.gov/opub/ted/2018/women-more-likely-than-men-to-have-earned-a-bachelors-degree-by-age-31.htm).
Carr, Phyllis, Christine Gunn, Anita Raj, Samantha Kaplan, and Karen Freund. 2017. "Recruitment, Promotion, and Retention of Women in Academic Medicine: How Institutions Are Addressing Gender Disparities." *Women's Health Issues* 27(3): 374-381.
Charles, Maria, and Karen Bradley. 2009. "Indulging Our Gendered Selves? Sex Segregation by Field of Study in 44 Countries." *American Journal of Sociology* 114(4): 924-976.
Ćosić, Krešimir, Marko Šarlija, Vladimir Ivkovic, Quan Zhang, Gary Strangman, and Siniša Popović. 2019. "Stress Resilience Assessment Based on Physiological Features in Selection of Air Traffic Controllers." *IEEE Access* 7: 41989-42005.
Cundiff, Jessica, Theresa Vescio, Eric Loken, and Lawrence Lo. 2013. "Do Gender–Science Stereotypes Predict Science Identification and Science Career Aspirations Among Undergraduate Science Majors?" *Social Psychology of Education* 16(4): 541-554.
Dasgupta, Nilanjana, and Jane Stout. 2014. "Girls and Women in Science, Technology, Engineering, And Mathematics: STEMing the Tide and Broadening Participation in STEM Careers." *Policy Insights from the Behavioral and Brain Sciences* 1(1): 21-29.
Ginther, Donna, and Shulamit Kahn. 2004. "Women in Economics: Moving Up or Falling Off the Academic Career Ladder?" *Journal of Economic Perspectives* 18(3): 193-214.
Griffith, Amanda. 2010. "Persistence of Women and Minorities in STEM Field Majors: Is it the School that Matters?" *Economics of Education Review* 29(6): 911-922.
Hunt, Jennifer. 2016. "Why Do Women Leave Science and Engineering?" *ILR Review* 69(1): 199-226.
Hynes, Geraldine, and Marisa Puckett. 2011. "Feminine Leadership in Commercial Aviation: Success Stories of Women Pilots and Captains." *Journal of Aviation Management and Education* 1.
International Air Transport Association. 2018. *Soaring through the glass ceiling*. Press Release No. 52. Retrieved May 25, 2019 (https://www.iata.org/pressroom/pr/Pages/2018-09-13-02.aspx).
Ison, David. 2010. "The Future of Women in Aviation: Trends in Participation in Postsecondary Aviation Education." *Journal of Aviation/Aerospace Education & Research* 19(3): 27-40.
Ison, David, Rene Herron, and Linda Weiland. 2016. "Two Decades of Progress for Minorities in Aviation." *Journal of Aviation Technology and Engineering* 6(1): 4.
Keller, Kirsten, Kimberly Hall, Miriam Matthews, Leslie Payne, Lisa Saum-Manning, Douglas Yeung, David Schulker, Stefan Zavislan, and Nelson Lim. 2018. *Addressing Barriers to Female Officer Retention in The Air Force*. RAND Corporation. Retrieved May 25, 2019 (https://www.rand.org/pubs/research_reports/RR2073.html).
Marra, Rose, Kelly Rodgers, Demei Shen, and Barbara Bogue. 2009. "Women Engineering Students and Self-Efficacy: A Multi-Year, Multi-Institution Study of Women Engineering Student Self-Efficacy." *Journal of Engineering Education* 98(1): 27-38.
Mitchell, Jim, Alexandra Kristovics, and Leo Vermeulen. 2006. "Gender Issues in Aviation: Pilot Perceptions and Employment Relations." *International Journal of Employment Studies* 14(1): 35.
National Center for O*NET Development. 2019. 53-2021.00 - Air Traffic Controllers. O*NET OnLine. Retrieved May 20, 2019 (https://www.onetonline.org/link/summary/53-2021.00).

Opengart, Rose, and David Ison. 2016. “A Strategy for Alleviating Aviation Shortages Through the Recruitment of Women.” *International Journal of Aviation Management* 3(2/3): 200-219.

Schultz, Ulrike, and Gisela Shaw. 2003. *Women in the World’s Legal Professions*. Bloomsbury Publishing.

Smith, Aaron. 2015. “America’s Air Traffic Controller Shortage.” *CNN Money*, October 14. Retrieved May 25, 2019 (https://money.cnn.com).

Sulton, James. 2018. Gender and Racial Barriers in Flight Training. In *Ethical Issues in Aviation* (pp. 175-184). Routledge.

Trautvetter, Lois. 2018. “Institutional Practices and Policies for Recruiting and Supporting Undergraduate Women in Engineering Across Four-Year Institutions.” *New Directions for Institutional Research* 2018(179): 91-114.

U.S. Department of Labor. 2018. Employment and Earnings by Occupation. Women’s Bureau. Retrieved May 25, 2019 (https://www.dol.gov/wb/occupations_interactive.htm).

Wilkinson, Lousie. 2007. “Engineering brain drain?” *Challenge Magazine*, December 2007/January 2008, 30-39.

Wyman, Oliver. 2017. “Aging Baby Boomers Cause Aircraft Mechanics Shortage as Global Fleet Expands, Modernizes.” *Forbes*, April 24. Retrieved May 25, 2019 (https://www.forbes.com).

Zheng, Jihao. 2016. *Female Pilots: Career Experiences and Recruitment Discourses* (Doctoral dissertation, Auckland University of Technology).