

# Student Choice and Persistence in Aerospace Engineering

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**This longitudinal multi-institution study examines student outcomes and demographics in aerospace engineering in the United States over the period of 1987 to 2010. This large sample allows adoption of an intersectional framework to study race/ethnicity and gender together. In this paper, the demographics of students who choose aerospace engineering, their six-year graduation rates, trajectories of students entering and leaving aerospace engineering, and the “stickiness” of the discipline are examined. Hispanic men and women starting in engineering choose aerospace engineering at the highest rates (13.3 and 12.0%, respectively). Aerospace engineering graduation rates lag other disciplines, at best, by nine percentage points among Hispanic females and, at worst, by 24 percentage points among Black females. Retention in aerospace engineering is low for all students, but it is particularly so for Black men and women (both less than 12%). The result is an average of one Black woman graduate per program every 12.5 years. Asian women also have abnormally low persistence rates in aerospace engineering compared with other engineering disciplines (18.8 versus 40.9%). Students who start in aerospace engineering are 1.7 times more likely to leave the institution than to earn an aerospace engineering degree in six years. Recommendations for improving student retention include implementing programs to build community, as well as mentoring and encouragement.**

## I. Introduction

**D**ESPITE several calls for diversity in engineering [1,2], there is still a profound lack of diversity in aerospace engineering (ASE) [3]. Different perspectives are especially relevant in aerospace engineering, as interdisciplinary systems, the economy, and other policies become more complex [4]. Additionally, the need for cognitive diversity to improve performance and problem-solving abilities in spaceflight crews may be fulfilled by racial/ethnic, gender, and socioeconomic diversity, among other attributes [5]. This creates a need for diverse groups, yet data from U.S. aerospace engineering programs in 2013 showed that 56% of aerospace engineering graduates are White males [6], which is much higher than the 32% in the U.S. population in 2012 [7]. Research on diversity within ASE is limited. Researchers have found no gender gap in engineering persistence; however, these studies aggregate all disciplines [8–13]. Similarly, researchers show that, for each racial/ethnic population, there is no gender gap in persistence [14,15], but these studies do not disaggregate by discipline. Unlike other works that aggregate by discipline or by race/ethnicity, this study considers the intersectionality of gender and race/ethnicity in ASE enrollment, retention, and graduation rates.

## II. Previous Studies of Aerospace Engineering Education

Komlanc et al. [16] described the pipeline from kindergarten to a Ph.D. degree but focused on issues of concern more generally than the experiences and outcomes of students. Diversity issues are not mentioned among the issues of concern. National data from the American Society for Engineering Education (ASEE) [17] are useful for describing the overall disciplinary enrollments, but they do not track individual student pathways at this time, so study of the ASEE data is restricted to cross-sectional studies. Even compared to most other engineering disciplines, fewer women choose ASE. Only 13.1% of aerospace degrees were awarded to women in 2012 in the United States. In contrast, 45.5% of environmental engineering degrees were obtained by women. Other disciplines, including mechanical engineering (12.4%), graduate lower percentages of women than aerospace. Although mechanical engineering has a slightly lower percentage than aerospace, the number of women graduating in aerospace is much smaller [17].

Some published historical accounts of ASE education and the profession address pipeline issues. Although Barata and Neves [18] provided an excellent account of the history of aviation education, their account stopped short of characterizing modern aerospace engineering and aviation education beyond listing institutions that offer such degrees. Grandt and Gustafson [19] gave the history of a single program, including how its enrollment and its curriculum have changed over time. Fletcher [4] included a significant discussion of aerospace enrollments but without

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consideration of how many of those enrolled students graduate or how that graduation rate might vary among different populations. None of these emphasized diversity issues in the profession or the related cultural forces.

Studies focusing on student outcomes in ASE are rare. One paper points to gaps in aerospace engineering education (particularly, lack of systems engineering principles) as a root cause of cost and schedule overruns and underperformance in government projects [20]. There is a reasonable amount of ASE literature promoting and studying specific pedagogical approaches [21–25]. Publications describing the design, implementation, and (less frequently) evaluation of aerospace curriculum are even more common [4,20,26–30]. Still, other research was set in the context of aerospace engineering, but it did not focus on the disciplinary nature of the experience [31–33].

The lack of diversity among pilots [34,35] and aircraft maintenance crews [36] is recognized. Indeed, the inclusion of a four-chapter section titled “Diversity in Aviation” in *Ethical Issues in Aviation* [37] not only shows an awareness of the issue and the importance of addressing it, but it recognizes the importance of diversity, not simply as a means to recruit sufficient numbers to meet workforce needs but as a matter of social justice to improve access to the profession. Although none of this work focuses on aerospace engineering, the legacy of racial/ethnic and gender discrimination and the resultant lack of diversity in these related professions may provide insight into the diversity issues in aerospace engineering. These discussions of diversity in aerospace-related professions are not new. Although the title of Session 6 of the 2009 Inside Aerospace International Forum (“Focus on Diversity—Tapping a Virtually Untapped Resource Pool”) seems to focus on diversity as primarily a numbers issue, the description of the panel shows a concern for the benefits of having diversity in perspectives and skills [38]. Another sign that ASE educators are paying attention to issues of diversity is evidence of precollege outreach efforts focused particularly on attracting women to the field [39,40].

If we focus on research describing student demographics and outcomes in ASE that maintains the integrity of the student experience through longitudinal study, recognizes the effect of race/ethnicity and gender on the student experience, and maintains focus on the unique disciplinary character of ASE, there is little literature to choose from. One of the few studies that disaggregated by gender and discipline found that women were more likely to persist in mechanical engineering (ME) than their male counterparts; however, ASE was not offered at that institution [41]. Prior research in ME asserts that “women outpersist men in ME, and Hispanic students are more likely to leave ME than other engineering majors” [42]. ME and ASE curricula often have significant overlap, which could lead to similar trends in enrollment and student outcomes, but that is not always the case [43]. Stine’s single institution study included ASE and saw no gender difference in choosing ASE (12% of engineering male starters choose ASE vs 13% of women) [44]. Graduation rates in ASE are 39% for women and 38% for men [44]. Pieronek and Pieronek posited that there were significant gender differences in reasons to pursue degrees, satisfaction levels throughout undergraduate experience, and postgraduation goals for ASE students [45]. Furthermore, women are more influenced by other people, especially parents, to pursue ASE [45,46]. Gender differences, especially social ones, may also vary by race and/or ethnicity. This underscores the importance of considering race/ethnicity and gender in ASE using an intersectional approach [47,48].

Thus, serious limitations of the current body of knowledge on student demographics and outcomes in ASE are that most studies focus on a single institution, the findings are published primarily in conference venues, and that they never gain much attention. Scholarly peer-reviewed ASE education research will facilitate the success of students and the field. This multi-institution longitudinal study fulfills the need to explore gender and race/ethnicity issues beyond a single institution.

### III. Methods

#### A. Multiple-Institution Database for Investigating Engineering Longitudinal Development and Its Demographic Characteristics

The Multiple-Institution Database for Investigating Engineering Longitudinal Development (MIDFIELD) includes academic records for first-time-in-college (FTIC) and transfer students at 11 U.S. institutions [49]. Results from the study of the MIDFIELD database are expected to generalize to the same type of institution (large public universities with above average enrollment of engineering students), and therefore are relevant to institutions producing the most engineering graduates in the United States. Approximately 70% of ASE graduates are from large public universities [6].

#### B. Population Studied

Six of the 11 MIDFIELD institutions offered ASE degrees during the years studied: 1987–2010. All six were ranked among the 20 largest ASE degree-granting institutions in the United States in 2010 [50]. This study includes only students at the six ASE degree-granting institutions. Furthermore, only cohorts with six years of data available are used. Not all institutions report data for all years. At least nine cohorts with six years of data are available for each institution in this study. The average number of cohorts reported per institution is 12.5. International students are excluded because no race/ethnicity data was collected from them. Likewise, students who self-identified as “other” or chose not to report their race/ethnicity are excluded. Students who self-identified as Native American/American Indian/Pacific Islander had to be excluded because of their small numbers. The 72,042 students who started in engineering are used as a reference, but the focus of this work is the 10,082 students who meet the criteria listed previously and enroll in ASE at any point in their studies.

#### C. Metrics Used

Several metrics are used in this analysis: the race/ethnicity–gender of those who start in ASE, the trajectories of the students, the six-year graduation rates, and the “major stickiness,” which is a ratio of the number of students who graduate in a major divided by the number of students who ever enrolled in that major [51].

To facilitate the comparison of the pathways of ASE students at schools with first-year engineering (FYE) programs and schools where students matriculate directly to specific engineering majors, the initial ASE enrollment at FYE schools is imputed as in previous work [52]. This imputed enrollment, labeled year 0, is calculated by allocating the total FYE matriculated population to specific majors at year 0 in the same proportion that students chose each major after FYE. This assumes that the retention through the transition from FYE programs is the same for all engineering majors. The retention rates used in imputing year 0 enrollment are computed for each race/ethnicity/gender combination. Throughout this paper, the term “starters” refers to the total of FTIC students who matriculated directly in a major and those imputed to start in that major. “Transfers” refers to students who were designated as transfer students by the participating institutions. Transfer students are assigned as starting in a particular curricular semester where, for every 15 credits they transfer, their starting semester is increased by one.

In this paper, graduation is defined as having graduated by the sixth year from matriculation, following a standard of reporting by the Integrated Postsecondary Education Data System [53]. The population at matriculation (year 0) is a useful referent and is needed for defining the persistence of the matriculating cohort. The population graduated or continuing at year 4 has been used as a measure of success by Seymour and Hewitt [9] and others. Finally, graduation, as defined previously, is labeled year 6. It is important to include the year 6 outcome in addition to the year 4 outcome because differences in the graduation rate beyond Year 4 have been observed when the data are disaggregated by race/ethnicity and gender [14].

**Table 1 Demographic distribution of all students starting in engineering and those starting in aerospace engineering**

Race/ethnicity gender	Starters in engineering	Starters in ASE	% ASE
Asian female	1,031	64	6.2
Black female	1,484	52	3.5
Hispanic female	485	58	12.0
White female	11,664	1,229	10.5
Asian male	3,845	356	9.3
Black male	2,771	260	9.4
Hispanic male	1,737	231	13.3
White male	49,025	5,755	11.7
All female	14,664	1,403	9.6
All male	57,378	6,602	11.5
All students	72,042	8,005	11.1

**Table 2 Top destinations of any students ever enrolled in ASE**

Destination	Number
1) Did not graduate in six years	3921
2) Graduated in ASE	3009
3) Graduated in mechanical engineering	618
4) Graduated in business	254
5) Graduated in civil engineering	199
6) Graduated in industrial/systems engineering	188

**IV. Results**

**A. Who Chooses Aerospace Engineering?**

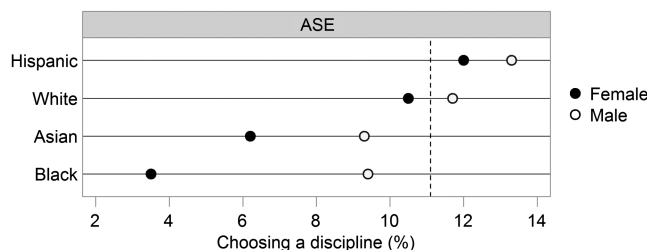
There are a total of 72,042 engineering starters at MIDFIELD schools that offer ASE degrees and have six years of data (Table 1, second column). This includes all first-time-in-college students whose first major was engineering. The third column of Table 1 indicates how many of these selected ASE as their first major. “Starters in ASE” includes those who matriculated directly into aerospace engineering, those who selected ASE immediately after an FYE program, and an imputed fraction of students ultimately lost from FYE programs without choosing a major. This imputed number of starters assumes that the students who leave FYE programs without choosing a specific major are distributed to each major in the same proportion that students choose those majors if they stay in engineering. The fourth column represents a ratio of the third and second columns. The rows are ordered alphabetically. Just over 11% of all students choose ASE. Aggregating all races/ethnicities, males choose ASE at a slightly higher rate (11.5%) than females (9.6%).

For the race/ethnicity–gender groups in the top eight rows of Table 1, the percentages of engineering starters choosing ASE as their first major are shown in Fig. 1. The rows indicate race/ethnicity, and the data markers indicate percentages by gender. For example, 11.7% (5755/49,025) of White male engineering starters choose ASE, whereas 9.3% (356/3845) of Asian male engineering starters choose ASE. Racial/ethnic groups are ordered by decreasing representation in ASE. Thus, Hispanic students are in the top row because ASE attracts the highest fraction of that population (13.3% of males and 12.0% of females; 13.0% of all Hispanic students). Black students are in the bottom row of the panel because only 7.3% of that population chooses ASE.

Within each race/ethnicity, men (open dots) choose ASE at a higher rate than women (filled dots). Gender differences in choosing ASE are small among Hispanic and White students but larger for Asian and Black students. Although they are the smallest ethnic group in terms of the population of those studied, *Hispanic men and women are the most likely engineering students to choose ASE*. Asian and Black students, however, are less likely to choose ASE. By raw numbers and percentages, *very few Asian and Black females opt for ASE*.

**B. Who Succeeds in ASE?**

Next, we examine graduation rates in ASE by race/ethnicity–gender: that is, the percentage of ASE starters who graduated in ASE within six years (Fig. 2). For comparison, a short vertical line indicates the aggregate rate of a family of disciplines, including aerospace, biological/biomedical, chemical, civil, computer, electrical, industrial/systems, and mechanical engineering. It represents the fraction of students who graduated in their first major. *Every race/ethnicity–gender group has a lower graduation rate in ASE than in the aggregate of a family of disciplines. ASE lags the other disciplines, at best, by nine percentage points among Hispanic females and, at worst, by 24 percentage points among Black females*. Asian females typically have one of the highest graduation rates in engineering [41,54,55], but in ASE, their graduation rate



**Fig. 1 Engineering starters choosing ASE.**

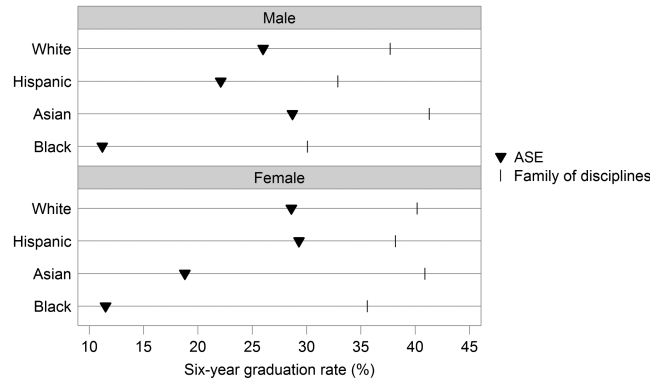


Fig. 2 ASE starters graduating in six years.

is the third lowest of the race/ethnicity–gender groups (an alarming difference of 22 percentage points). As shown in [43], all race/ethnicity–gender groups have higher graduation rates in mechanical engineering than in ASE, except Hispanic females. Among Asian females, ASE lags mechanical engineering by more than 10 percentage points.

Only six Black females who started in ASE have graduated in ASE within six years. At 6 of the top 20 producers of aerospace engineering graduates, that is an average of one per institution every 12.5 years. This distressing fact means that it is highly unlikely that a Black woman majoring in ASE would ever have an ASE class with another Black woman.

C. Who Joins ASE?

Figure 3 is a pair of time-series plots showing the number of students enrolled in ASE at matriculation (0), enrolled or graduated four years later (4), and graduated by six years later (6), disaggregated by race/ethnicity and gender. Starters are shown with dashed lines. The solid lines include “many of the ‘all’ lines” ASE students: starters, transfer students (from other institutions), and switchers (from other majors). The vertical scale (numbers of students) is logarithmic, for ease of comparison between populations that differ by orders of magnitude. The horizontal scale (years from matriculation) is linear. The steeper the slope of the trajectory, the greater the fraction of students lost from a major.

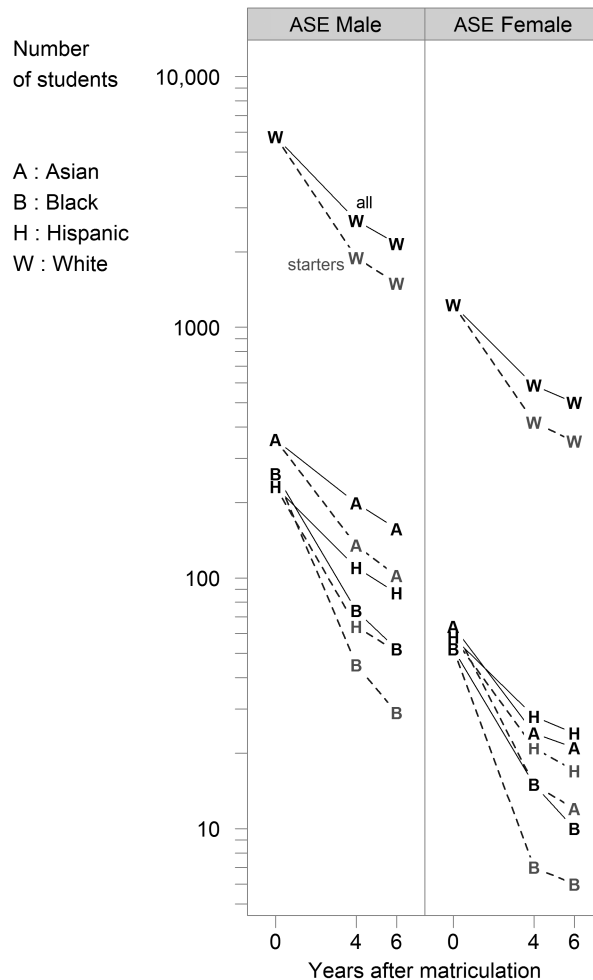


Fig. 3 Trajectories of starters (dashed line) and all students (solid line) by race/ethnicity and gender.

Many starters are lost from all race/ethnicity–gender groups. Some other students enter the major, but not enough students are joining ASE to replace those that left, and the patterns are similar for all race/ethnicity–gender combinations. Black females and Black males show particularly steep slopes. The negative slopes indicate that ASE is losing many students and not attracting many switchers or transfer students. In mechanical engineering, a close relative of ASE, many of the all lines have shallow or even positive slopes. For example, more Asian and Hispanic students graduate in mechanical engineering than start [42].

#### D. Who Sticks in ASE?

Another way to include switchers and transfers in a single metric is to calculate the stickiness of the major for each group. The major stickiness is the number of students who graduate in a major divided by the number of students who ever declared that major, regardless of the path by which students enter the major. It includes starters, switchers, and transfer students [51]. In Fig. 4, the rows indicate race/ethnicity and the data markers show stickiness in the major as a percentage by gender. The vertical reference line indicates the aggregate stickiness of ASE for all students in the panel. For comparison, mechanical engineering has an overall stickiness of 55%, ranging from 43% for Black males to 63% for Asian females: there is no overlap [42]. This is even lower than what has been reported for computer engineering (44%), which has the lowest stickiness of any engineering discipline studied previously [56].

Here, we see a clear racial distinction. *Black students, male or female, are unlikely to stay in ASE*, regardless of when or how they entered. Unfortunately, this study cannot answer the question of why. Do these students feel unwelcome? Do they feel even more isolated in ASE than they do in engineering as a whole because ASE is a low-enrollment field? Are they pulled away by other majors? The available MIDFIELD data suggest that this is not due to poor math preparation. Black males who ever enrolled in ASE did better on the ACT and the math portion of the SAT than the average for all Black males who were ever engineers at these institutions. Black females who were ever enrolled in ASE had an average SAT math score that is 5.5 points lower than all Black females who ever enrolled in engineering and a slightly higher ACT.

White and Hispanic females, however, are more likely to stick with ASE than their male counterparts. Among males, Asian students are the most likely to persist in ASE.

#### E. Where do ASE Starters Go/Where do ASE Graduates Come From?

Figure 5 is a Sankey diagram showing all students who were ever in ASE. The width of each path is proportional to the number of students it represents. This shows that, for any students who ever enroll in ASE (including those who were imputed), the most likely outcome by far is to not have graduated in six years: it is 1.7 times as likely for an ASE starter to earn no degree at all in six years than to earn a degree in ASE. It also shows that about 30% of ASE graduates started in another major or at another institution. Students who leave ASE that still graduate are about equally likely to graduate in another engineering major or in a nonengineering major.

After aerospace engineering, mechanical engineering was the most popular destination of graduates who were ever enrolled in ASE for all groups except Black females, who were most likely to graduate in industrial engineering. The top destinations of all students ever enrolled in ASE are shown in Table 2. The remaining 1893 students were spread across 45 different majors.

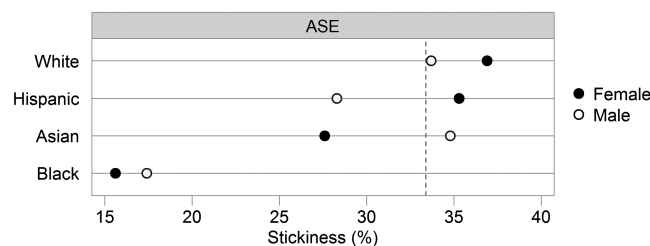


Fig. 4 Stickiness in ASE.

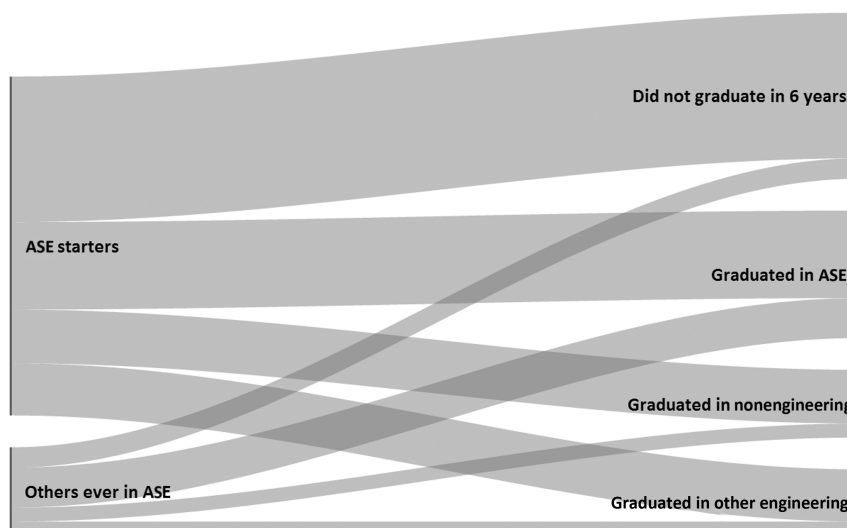


Fig. 5 Destinations of students ever enrolled in ASE.

## V. Discussion

### A. Summary

This section focuses on the issues of race/ethnicity, gender, and their intersection in ASE matriculation and persistence. First, ASE retention rates are compared to other engineering majors in terms of race/ethnicity and gender. The discussion leads into issues of stereotypes, discrimination, and other social and cultural facets of the ASE landscape. The section also explores job market impacts and some possible explanations for the high rate of students leaving ASE, including students' prior experiences and interests. Finally, the authors make several recommendations that can easily be implemented by educators and administrators to create a more inclusive environment in ASE.

Two images dominate the student success landscape in aerospace engineering. The first is that ASE students, of all race/ethnicity–gender populations, are leaving ASE in large numbers. The second is that ASE exhibits some concerning racial dynamics. Black students, both female and male, have extremely low persistence in ASE which is much lower than in other engineering disciplines. Asian women in ASE are more than 20% less likely to graduate in ASE than Asian women are to graduate in their first choice if they choose other engineering majors (19 vs 41%). Prior work has shown that Asian women are the most likely students to graduate in their first chosen major when that major is mechanical engineering (48%) or chemical engineering (48%) [57]. In electrical engineering, they are second only to Asian males (43%): in computer engineering, they rank third at 30% behind Asian and White males [56]; and in civil engineering, they are fourth at 42% behind White females, Asian males, and White males [58]. Thus, their low persistence in ASE is of concern and should be examined further, including qualitative research. It is important to remember that “Asian” here does not include international students: these are all domestic students who self-identified as Asian. A common implicit bias is that all Asians are “forever foreigners” who are unfamiliar with U.S. language and culture, regardless of where they were born or how long they have lived in the United States [59,60]. However, even “positive” stereotypes, such as Asian students being a “model minority” (hardworking and good at math) can be detrimental to individuals [60].

Even worse is what is happening to Black women who start in ASE. Although their persistence is typically not the highest, 11% is an unacceptable 24 percentage points lower than in other engineering disciplines. At the intersection of racism and sexism, these students often face subtle and sometimes overt discrimination in science and engineering. Further, in many studies and support efforts, they are often lumped with other women or other Black students; thus, their unique needs are often overlooked.

Black men also substantially lag their counterparts in other disciplines. A recent issue of *Prism* magazine addressed some of the academic, social, and cultural hurdles that African-American men face, including poor preparation, low expectations from faculty and peers, and trouble finding community [61]. In a study of 49 African-American and Latino men in engineering programs, Strayhorn et al. noted four themes: 1) feelings of alienation and invisibility; 2) lack of same-race peers and faculty; 3) difficulty applying theory and curriculum to practice, and limited opportunities to do so in introductory engineering courses; and 4) lack of precollege preparation for science, technology, engineering, and mathematics coursework in college [62].

It is certainly possible that aerospace engineering, as a more focused discipline, loses students to more general disciplines (likely mechanical engineering) when the job market for aerospace engineering is unfavorable. Even if engineering students consider market conditions as they make academic decisions, this does not explain why the graduation rates for some race/ethnicity–gender populations are notably lower than others.

It is critical to the discipline to determine whether the generally high rate at which students leave ASE might be related to fluctuations in job market conditions. If that is the case, the aerospace industry might be more successful in filling its ranks through aerospace concentrations within mechanical engineering or even electrical engineering degree programs [63]. If market conditions cannot explain student departure from ASE, then the discipline faces difficult questions about what cultural conditions have led to the current situation. Although this study cannot shed light on the effect of job market conditions on ASE students, our other findings do constitute evidence that some cultural problems exist. The conditions that make ASE less attractive as a major for women to start in may be related to the conditions that make ASE less attractive to all students as a major to switch into. These may also be related to the conditions that make ASE less able to hold onto the students who do enroll. For example, many students may select ASE due to interest in becoming an astronaut or designing space shuttles and rockets without recognizing the importance of fluid dynamics and other technical topics. There are some indications that precollege activities that have a surface relationship to ASE have an impact on major choice. Findings from a study of precollege engineering activity participation shows that students choosing ASE are more engaged in precollege engineering activities than majors with larger enrollments (civil engineering and industrial engineering) [64].

### B. What Can be Done?

Research has shown that a sense of belonging is critical to student persistence and success [62,65–68]. If you have ever walked into a room where no one looked like you and suddenly felt out of place, then perhaps you understand why this presents an extra challenge for underrepresented students, particularly in a low-enrollment field like aerospace engineering where an underrepresented student is often the only one of his or her race/ethnicity and gender in a class.

Pieronek and Pieronek have summarized some strategies that have been particularly helpful for women in engineering programs [45]. Key aspects include opportunities to form community and mentoring relationships with other female engineering students; opportunities to assume different roles in the program as students progress through their studies; participation in social and other nonacademic activities; and involving all stakeholders, students, faculty, and administration. They also note some issues specific to ASE that can affect enrollments: specifically, the stagnation of aerospace as a technological discipline, declining public interest in space exploration, and the changing nature of today's college students. This resonates with national reports on changing the conversation [2] and messaging for engineering [69], but changing the conversation is not enough. We must also change the culture. ASE leaders might benefit from the work of researchers critically examining the engineering culture [70–73] and from listening to the voices of women in the field including graduate students [74].

The varying rates of success among minority groups (Hispanic women are the most likely to persist in ASE, and Black women are the least likely) seems to suggest that a cross-cultural peer-mentoring program could help students find needed supports and navigate barriers. In fact, a cross-cultural approach may be essential where students of particular groups are few and far between. Being a member of the majority does not preclude you from mentoring and encouraging minority students [75]. There are a variety of student organizations that can help you reach out. Invite students from the National Society for Black Engineers to tour your laboratory. Ask if they need a speaker, a review session, a faculty mentor, or even a faculty advisor. The National Action Council for Minorities in Engineering, National Association of Multicultural Engineering Program Advocates can also provide resources and contacts. Find out if your institution has articulation agreements with nearby minority-serving institutions and then visit. Above all, note that a little encouragement can go a long way.

## VI. Conclusions

With 72% White men at matriculation, aerospace engineering is even less diverse than other engineering disciplines for which the starting populations average 68% White male. Even accounting for their lower representation in the engineering population, women avoid aerospace

engineering (ASE). Compared to their male counterparts, Hispanic and White women in engineering are a bit less likely to choose ASE (12 vs 13.3% and 10.5 vs 11.7%, respectively); and Asian and Black women in engineering are much less likely to choose aerospace (6.2 vs 9.3% and 3.5 vs 9.4%, respectively). After enrollment in ASE, gender effects are less prominent, and even mixed. Although Asian and Black women are less likely to graduate than their male counterparts, Hispanic and White women exceed their male counterparts in this regard. Six-year graduation rates are well below the aggregate of aerospace, biological/biomedical, chemical, civil, computer, electrical, industrial/systems, and mechanical engineering for all groups, but they are especially so for Black women, Black men, and Asian women (by 22–24 percentage points).

This research gives a data-driven quantitative picture of undergraduate students in ASE and can be used to better target recruitment and retention efforts. More research is needed in this area, including exploration of the various pathways, depicted in Fig. 5, disaggregated by race/ethnicity and gender, as well as qualitative research, to investigate why students have these outcomes. The challenge is that there are not many Black, Asian, and Hispanic women in ASE to study. As ASE leaders and educators better understand who their students are, they can work to enhance diversity, and thereby strengthen the field. Much is known about improving the perception of and the climate of engineering: ASE leaders and educators need to act on that information.

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