

Zero to 36% in Thirty Years – A History of Female Undergraduates at Caltech

Carol Mullenax
Tulane University

Abstract:

Over the now thirty-four years of female undergraduate presence on the Caltech campus, a steady increase in female enrollment has occurred. The nature of this increase, the driving factors behind it, and the portion of the female population in engineering at the Institute over time are investigated and compared to both total Institute population and national norms.

Motivation:

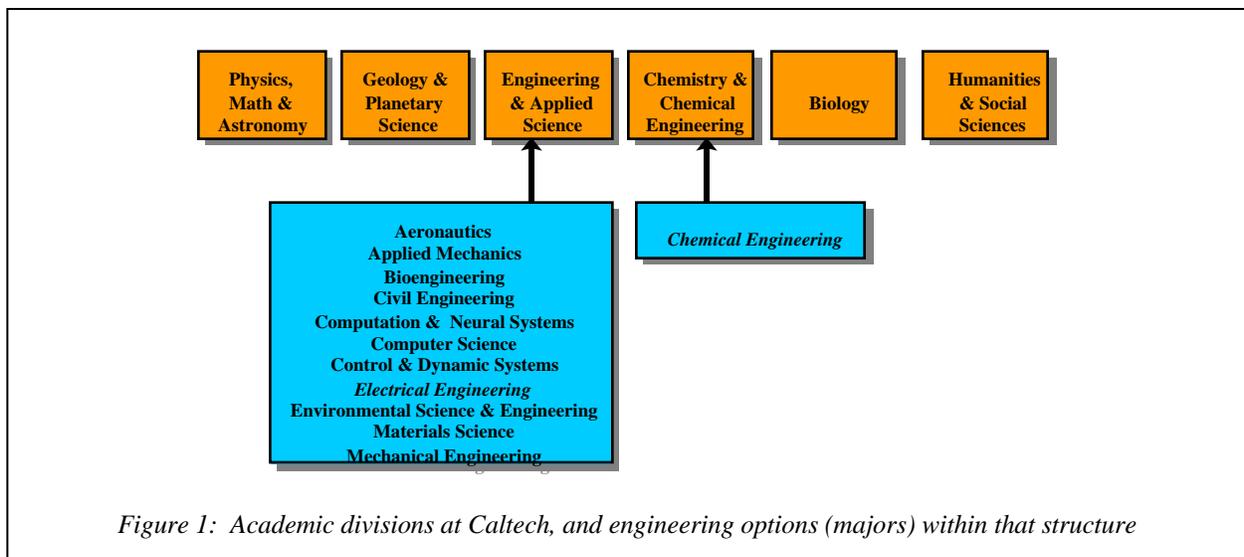
The author hopes to quantify the enrollment gains for undergraduate women at Caltech, to determine whether the increases have been homogenous across fields of study, and also to detail what mechanisms have been employed by the Institute in order to encourage more women to enroll.

Background:

A small, private institution focused on science, math, and engineering, the California Institute of Technology (Caltech) is located in the quiet Los Angeles suburb of Pasadena, CA. Although women had taken part in graduate programs since the turn of the 20th century, the Institute's first baccalaureate degree was awarded to a woman in 1973. To date, less than one thousand women are undergraduate alumnae of Caltech.

Academics

Caltech is organized into six divisions as shown in Figure 1, one of which is Engineering & Applied Science. This division encompasses all engineering disciplines except Chemical



Engineering, which is contained within the division of Chemistry & Chemical Engineering. Degrees awarded in engineering are not named by specific discipline, except for two fields: electrical engineering and chemical engineering. All other degrees read “Engineering & Applied Science.” As a result of this lack of specificity, only engineering in general can be analyzed.

It should be mentioned that the difference in curriculum between a Chemical Engineering or Electrical Engineering degree and an Engineering & Applied Science degree could be as little as one course not taken by the student.

Admissions

Caltech is classed as the “most difficult” entrance level by the college guides, with only 15% of applying students admitted.^[1] A private school, Caltech employs assessment of grades, standardized test scores, essays, and activities/experience in making admittance determinations for undergraduate students. A very small number of upperclass transfer students are accepted each year, either individually or through formal 3-2 programs established with liberal arts schools.

The size of the graduating class at Caltech has averaged 193 over the past 30 years. Admissions numbers are generally quite similar. Consequently, we are dealing with small numbers.

The Caltech Admissions staff is small, but potent. There is a segment called Undergraduate Admissions Support (UAS) which coordinates alumni volunteer efforts to help with undergraduate admission. UAS was started in the mid-70’s. None of the current staff date back to the program’s inception, but they feel that the timing (coinciding with the initial admittance of women to the Institute) is not mere coincidence. In the 90’s, UAS began sponsoring a Caltech Signature Award at high schools which typically generate applications to the Institute and thereby have a long-term relationship with the Institute – the award is given to a junior on nomination by the high school’s science teachers, and is often presented by a UAS representative.

Caltech, by nature of its small size, has never been able to run regional admissions information sessions of similar number to its competitors. In the past couple of years, the Admissions travel budget has been drastically reduced so staff members have offered even fewer regional information sessions in the fall. To help fill this void, UAS volunteers have begun conducting regional information sessions. Some of these volunteer-run sessions replace those which had been run by staff members, but others are located in areas not previously served by staff either due to small size of the target population or other factors.

UAS is one way of reaching pre-applicants. The media is another; Caltech’s reputation for its students pulling pranks has provided a level of notoriety in the press. Recently the Institute has made a considerable effort to gain publicity for its research accomplishments, not only affecting the potential applicant pool but also encouraging investment by private foundations. Caltech also purchases the direct mail lists generated by standardized tests (PSAT, SAT) and sends information materials to potential applicants.

In the early 80’s, Caltech instigated what was called Pre-Frosh Weekend. Initially, only admitted women were invited to campus at the school’s expense for one weekend in April – they would stay with current students in the student housing, sit in on classes, and partake of social activities. Starting in 1989, the program was expanded to include invitation of admitted men (without the offer of travel reimbursement), and additional budget was committed to helping fund campus social events over the weekend. UAS representatives also contact all admitted students to congratulate them and answer any questions they might have.

Methods:

Caltech graduation data

As a long-time volunteer to the Alumni Fund, I was granted use of the alumni database. Extracting graduation data from this database was relatively easy. Flags were set to denote gender and graduation year.

Graduates were grouped by graduation year and also segmented into the following groups: woman engineer, woman other field, man engineer, man other field. A person is categorized as an engineer if s/he received a degree in any engineering field. A person is categorized as a nonengineer if s/he received no engineering degree. Some persons received bachelors degrees in multiple fields; the above definition classes such persons as engineers if at least one of their degrees is in engineering.

Caltech admissions data

Also a volunteer for UAS, I requested that their staff members provide admissions data. Unfortunately, that information is not so well archived. Admissions numbers for women in the last twenty entering freshman classes were available, but no full historical database exists. Available numbers for men were only for the past five years. Received data includes number of applications received, number of admits, and enrollment.

Data for transfer students is even less retrievable; it was unavailable for this study. Only a small number of transfer students arrive each year, typically as juniors, at Caltech; it is probably overestimated by the 2% listed in the college guides.^[1] This predicts only 4 or 5 students per year.

National data

The National Science Foundation (NSF) collects and publishes aggregate demographic data relating to education. A table of bachelors degree totals by field and gender provided the basis for comparison with Caltech data.^[2] To make the most valid direct comparisons to Caltech, the total degrees conferred in science and engineering nationally was modified by subtracting out the degrees conferred in the social and behavioral sciences. These modified totals were used in the calculation of percentages.

Results/Discussion:

The overall picture

Graduation data for the past thirty years at Caltech is shown in Figure 2. Two perspectives are shown; the first shows the relative composition of the entire graduating class by group, and the second compares the relative size of each group within each graduating class. Tabulated values are given as well. The number of degrees awarded has grown only slightly, averaging 193. Degrees are grouped by gender and field; solid colors represent engineering degrees, stripes denote other fields. Yielding to stereotype, men are denoted by blue and women by pink.

The graduating class of 1974 was the first class with women admitted as freshmen. The 1973 class contained female upperclass transfer students.

A noticeable increase in degrees awarded to females occurred in 1993. From that time forward, degrees awarded to women averaged 55 versus 24 beforehand. This roughly corresponds to the expanded participation and administrative support of Pre-Frosh Weekend activities, and may have been influenced by these changes.

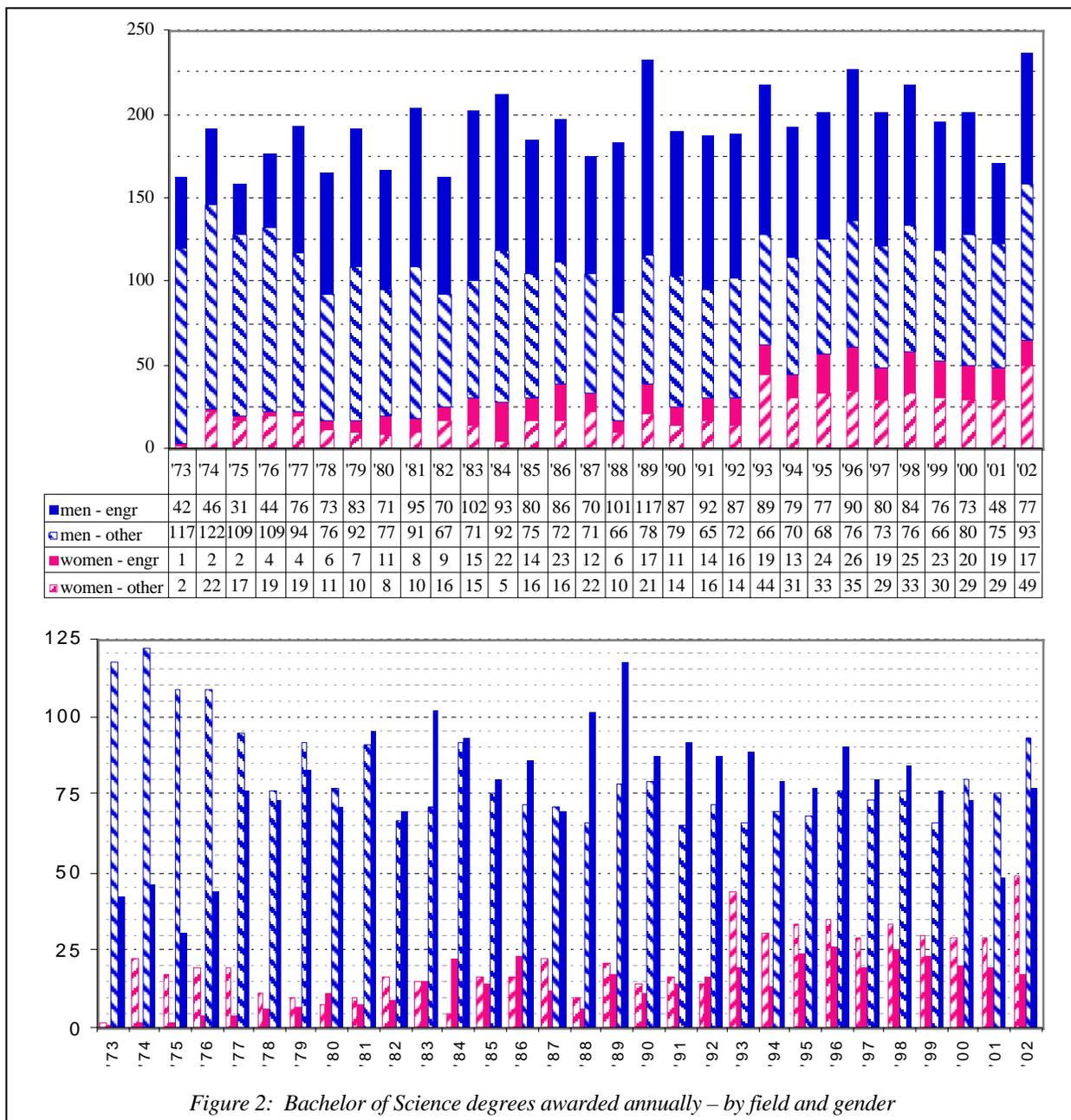


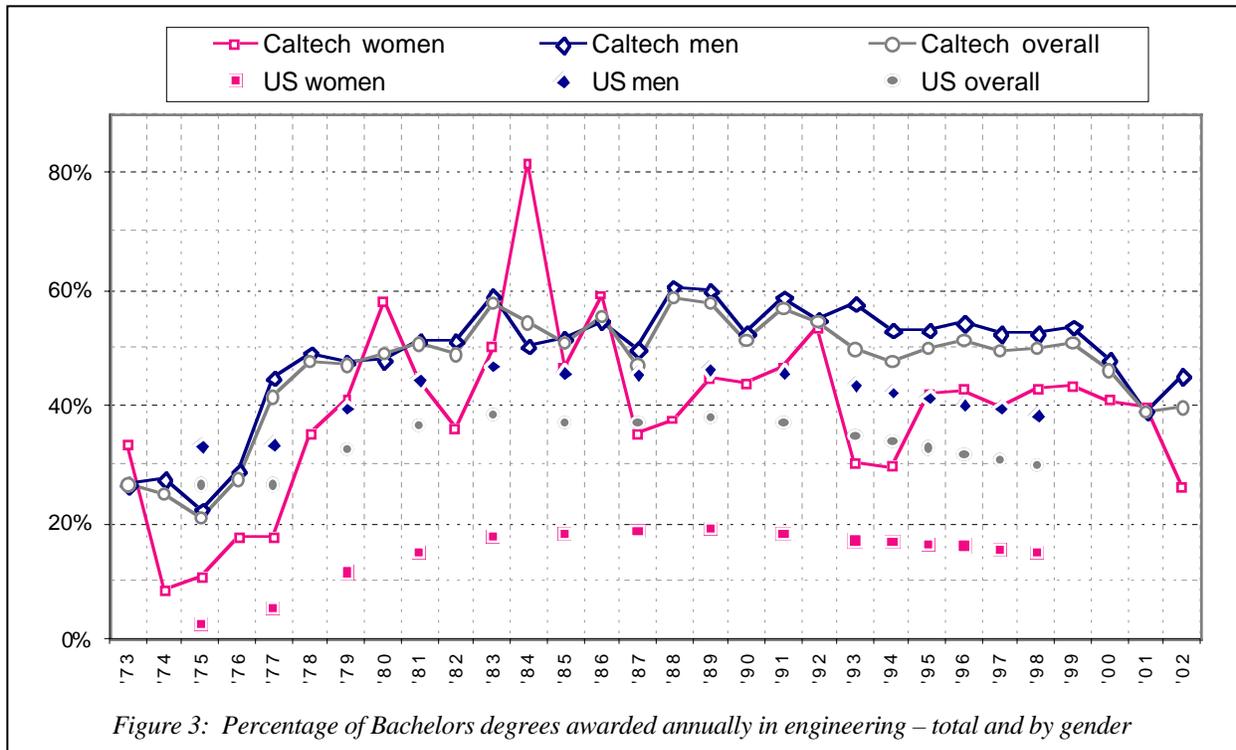
Figure 2: Bachelor of Science degrees awarded annually – by field and gender

In the early 70's, the predominant group was men in non-engineering fields. Through the 80's, men engineers took the lead, but recently have lost their superior numbers back to the men in other fields. Similarly, women engineers were outnumbered by women in other fields through the 70's but started gaining and eventually outpaced them in the 80's. 90's women have once again graduated more often in non-engineering fields.

Students choosing the engineering field

Caltech is unusual in that nearly half of its BS recipients obtain degrees in engineering. Figure 3 displays the percentage of degree recipients obtaining engineering degrees. Percentages are

calculated by gender ($\#engr_men/total_men$, $\#engr_women/total_women$) and overall ($\#engr/total$). For national data, the totals are taken as the total degrees awarded in science and engineering less degrees awarded in social and behavioral sciences (to provide the most appropriate direct comparison with Caltech). Caltech data is denoted with line and open symbol; national data is denoted by solid symbol only.

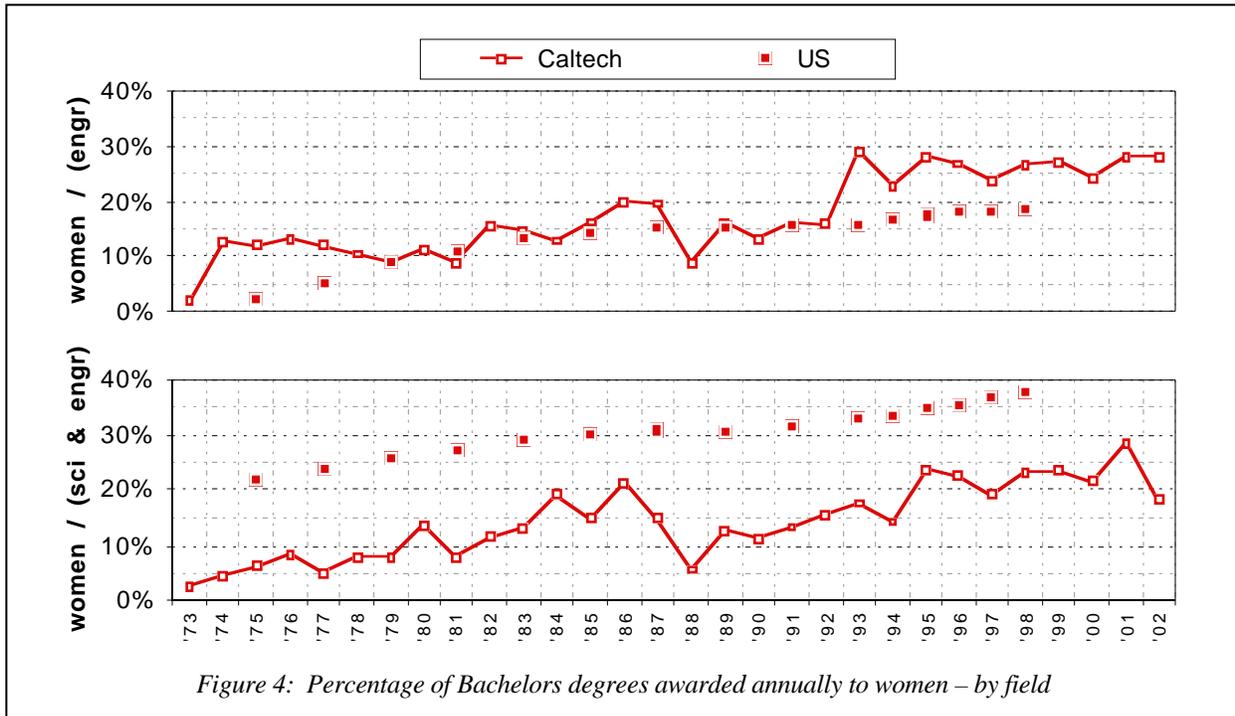


Women have been consistently awarded engineering degrees in lower proportion than men, with only a couple of exceptions at Caltech over thirty years. Caltech has, however, awarded engineering degrees in higher proportion than the national average, even of science and engineering degrees.

It is interesting to note that, although engineering enrollments nationally peaked in the mid-80's and have decreased since then,^[2] engineering degrees are still awarded currently at Caltech in numbers only slightly below those of 20 years ago. This is undoubtedly a function of the self-selection of the applicants to the school; they are a very specific cross-section of the college-bound population.

The percentage of women

While women obtain engineering degrees within gender at similar proportions to men at Caltech, they still are outnumbered heftily by them. As shown in Figure 4, women have recently received just below 25% of all BS degrees awarded at Caltech; nationally women receive just under 40% of all BS degrees awarded in science and engineering (excluding social and behavioral sciences, so as to compare most closely to Caltech).



Interestingly enough, engineering degrees are awarded at a slightly higher percentage than the overall average for women at Caltech. The engineering percentage is also higher at Caltech than the national average of 19% as of 1998;^[2] the jump in number of female graduates at Caltech in 1993 is also evident in the percentage of female engineers from that time since. This would suggest either that women have made greater inroads into engineering at Caltech, or that men have exited the field or have been displaced. In contrast, Caltech women in science and engineering are at a much lower proportion than in the US; the difference has been consistent since the beginning of female enrollment at Caltech.

Admissions data for women

The number of applications received by Caltech from women has increased over the past twenty years, as has the proportion of women who matriculate into the freshman class. Figure 5 shows these increases, plus the admit/apply ratio and enroll/admit ratio (yield rate) for each entering class.

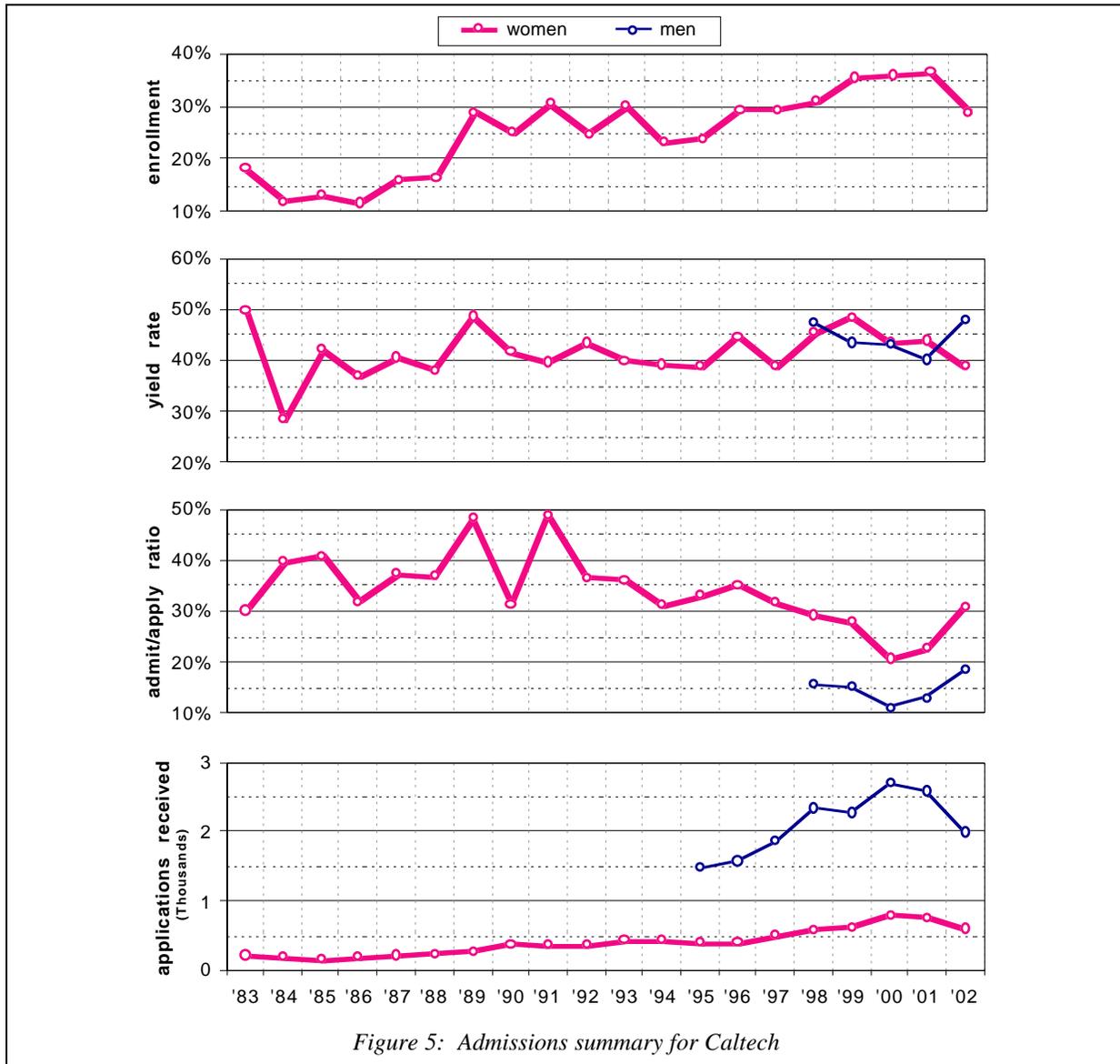


Figure 5: Admissions summary for Caltech

Gross receipt of applications from women has increased from ~200 in the early 80's to ~400 in the early 90's to a peak of over 800 in the late 90's. The college-aged US population has increased during this time, but not nearly in these proportions. However, the application habits of high school seniors has changed dramatically over the past 20 years; students applying to Caltech used to apply to an additional one or two colleges, but now the typical Caltech applicant is applying to eight to ten schools. Consequently, a corresponding increase in received applications is also seen in the male population. Decreased applications for 2002 are attributed to a general decrease in application by East Coast students to West Coast schools after 9/11/2001. One interesting observation by the

Admissions staff is that the women seem to be more highly self-selective in applying to Caltech; on average their test scores, grades, and accomplishments are better than the male applicants.

While applications have increased, the percentage admitted from that pool has for the most part decreased. This is not surprising given that Caltech makes a conscious effort to maintain a fairly constant undergraduate enrollment. As such, one would expect the admit ratio to somewhat mirror the number of applications received while also being somewhat reactionary to the size of the prior year's entering freshman class. The overall admit ratio for both genders typically averages somewhere around 15%, so women are admitted at a consistently higher rate than men. The entering class academic characteristics (SAT I & II scores, high school GPA & class standing) have not changed appreciably through the past thirty years.

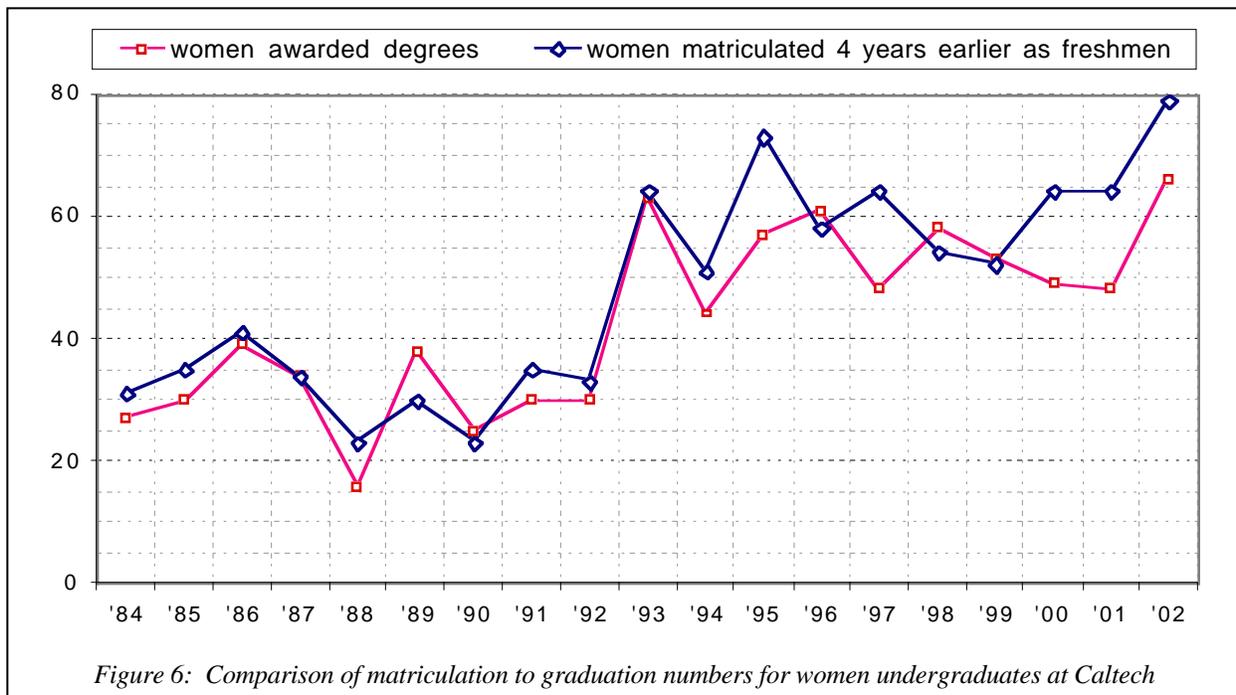
The yield from admitted students is always a matter of some conjecture before the fact, and yearly estimates of it influence the admit ratio for all students. The yield for women has remained a fairly consistent level near 40%, and males appear similar. There are a few radical departures from the average, for instance an increased yield was seen in 1989, the first year of a major increase in the number of matriculating women. This could have been influenced by the greater emphasis on Pre-Frosh Weekend, both due to an increase in activities and the relatively large number of women in the graduating senior class which the pre-frosh would have met during their stay. It should also be noted that, although in general it has been a positive influence on yield, Pre-Frosh Weekend also had negative effect for the class entering in 2002 – a vocal minority of disgruntled students set out to “scare” the pre-frosh, and yield from women and underrepresented minorities (who are the largest constituents of pre-frosh) decreased. It is hoped that this will not become a trend.

To assess why admitted students accept or decline Caltech's admissions offer, surveys are collected and examined. Student perception of the school is key in the attendance decision process. Some factors affecting these perceptions are within the school's control, and others are not. For instance, student perception of Caltech has been that there is a lack of diversity in the study programs offered. Due to its size Caltech is somewhat limited in its course offerings, but it has for many years had agreements allowing students to enroll in courses at nearby universities. Recently, Caltech has formed partnerships with overseas universities to broaden study abroad opportunities. Correcting such misconceptions will be important in securing a student's commitment to attend.

The percentage of women in enrollment is influenced not only by the number of applications, admit ratio, and yield, but also by the overall size of the entering class including male counterparts. Still, it is relevant here to show that, overall, the percentage of women in the entering classes has increased over time to a peak of 36% in 2001. Changes in percentage enrollment can often be paired with a corresponding change in either admit ratio or yield.

Comparison of admissions to graduation data

That's nice, Virginia, but do the entry and exit numbers match? Enrollment and graduation data can not be compared by field since entering students do not declare a major until the end of the freshman year. Figure 6 shows the number of women awarded Caltech degrees in any field compared to the number of women enrolled as freshmen four years earlier. Differences can be due to several factors including delayed completion of degree requirements (a situation becoming much more common for engineering programs), departure from Caltech, or transfer in. In general, the trends line up well. One somewhat disturbing trend shows fewer degrees awarded for the past three years than women admitted four years prior – admits consistently outnumbering degrees in subsequent years tend to suggest that departures rather than delays truly are the cause for the differences.



In total over the years for which both admission and graduation data are available, 816 women graduated with bachelor's degrees as compared to the 908 who matriculated as freshmen. This is a 90% degree completion rate. Even allowing that possibly 38 transfer students over those years were women, the adjusted completion rate would still be 86%. The corresponding completion rate for men at Caltech over this same period is 94% (2501 of 2658) without allowing for transfer students, or 92% with transfer students. The national average for women is reported as 35% for all science and engineering degrees (including social and behavioral sciences) from a 1992-1998 cohort study of 119 schools; the corresponding statistic for men is 39%.^[3] Caltech's higher completion rate is not unexpected, since any person who applies to Caltech is, by nature of that fact, expressing a strong interest and aptitude for science and engineering; at Caltech, the only way to get a degree in something other than science, math, or engineering is to leave the university.

Conclusions

Analyzing the available data has answered most of the questions raised for this study.

Q: Is the percentage of women choosing engineering different than men? Is it changing at a rate different from men?

A: Women select engineering fields at similar yet slightly lower rates as men at Caltech, and the trend is fairly stable.

Q: Is the percentage of engineering women keeping pace with percentage of women in other fields at Caltech?

A: Women at Caltech select engineering at only a slightly lower rate than they select other fields. As a gender percentage within their field, women engineers are in slightly higher proportion than in other fields at Caltech.

Q: Is the percentage of women in engineering at Caltech higher than the national average?

A: Caltech's percentage has grown recently to roughly 8-10% higher than the national average. By contrast, the overall percentage of engineers (both men and women) at Caltech is roughly 20% higher than the national average.

Q: What are the biggest players in the changing female enrollment at Caltech, and what actions have influenced them? (apply – admit – accept – matriculate – graduate)

A: By far, the number of applications by women to Caltech has increased most dramatically. Admit ratio has decreased, acceptance ratio has remained about the same, those who accept do tend to matriculate, and overall 90% of the number who matriculate graduate. This suggests that Caltech has done better recently at getting the school name out to qualified women who then apply, thus increasing the applicant pool from women; media coverage and Undergraduate Admissions Support activities have likely contributed to this. Additionally, efforts to maintain good acceptance rates, such as Pre-Frosh Weekend and UAS contact, have been generally successful.

Q: What should Caltech do to continue increasing the proportion of women undergraduates at the school?

A: Keep increasing the qualified applicant pool. Influence the acceptance rate further upward. Provide support so that those who matriculate will stay and graduate; the recent hiring of a professional rather than professorial VP of Student Affairs may help counter the waning graduation numbers for women.

Summary

Overall, the percentage of women at Caltech is growing at a slow rate. Caltech receives fewer applications from women than men, but the high quality of that smaller applicant pool dictates that women are admitted at higher rates; admitted women choose to attend Caltech at similar rates to admitted men. Once at Caltech, women choose engineering fields in higher percentages than the national average, yet they have only a slightly higher presence by percentage in the total Caltech engineering population than national average. Women who attend Caltech obtain undergraduate degrees in similar high proportions (~90%) to their male counterparts.

For the future, it is desired to obtain data from universities similar to Caltech, as well as additional historical data for males at Caltech, to provide more complete and relevant comparison.

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CAROL MULLENAX. P.E.

Carol Mullenax is a Doctoral Candidate in Biomedical Engineering at Tulane University in New Orleans while on leave of absence from The Boeing Company. She received her BS in Engineering and Applied Science from Caltech in 1989, an MS in Mechanical Engineering from Washington University (St. Louis) in 1995, and is currently supported by an AAUW Educational Foundation Selected Professions Engineering Dissertation Fellowship.