Characteristics of First-Time Freshmen in 4-Year Institutions Intending to Major in Engineering and Computer Science; an analysis of survey data collected by the Higher Education Research Institute (HERI)

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Abstract. The central focus of this paper is on describing changes in the characteristics of new freshmen in 4-year colleges and universities planning to major in engineering and computer science during 1983 – 2002, exploring their evolution in the critical dimensions of race/ ethnicity, sex, high school achievement, personal attributes, and "soft skills."

Demographics: The demographic composition of first-time freshmen in 4-year institutions has changed considerably in the last two decades. Proportions of white (non-Hispanic) students declined from 43% (females) and 42% (males) to 40% and 34%, respectively; proportions of black males and females changed only little; and proportions of each of the remaining demographic groups rose considerably from 1% or less to 3% - 4%. **The overall proportion of under-represented minorities rose from 12% in 1987 to 19% in 2001 but then dropped to 17% in 2002, possibly reflecting growing restrictions on affirmative action.** Females outnumbered males in 2002 in every subgroup, particularly in under-represented groups.

Student preferences for engineering and computer science: The preferences of subgroups of freshmen for engineering vary enormously both across groups and over time, ranging from a low of 2% of white, Hispanic, and American Indian women in some years, to a high of 35% of Asian males in 1985. Examining freshmen preferences only on the basis of sex, **a striking finding is that women exhibit largely the same changing annual preferences for studying engineering as men -- at one-fifth the scale of male preferences.** The percentages of freshman planning engineering majors that are female have remained low -- ranging from a high of 21% (in 1993) to a low of 17% (in 2002). On the other hand, the percentages of freshmen planning computer science majors that are female dropped steadily from 35% in 1991 to 15% in 2002. Minority groups initially were a growing proportion of freshmen planning engineering majors, but have dropped from a peak of 18% in 1994 to 16% in 2002. Minority groups, particularly blacks, were also once a major presence among computer science freshmen. However, the under-represented minority proportion of computer science freshmen has fallen from a peak of 33% in 1991 to 21% in 2002. The decline occurred mostly among black men and women. **When contrasted against the rising proportions of under-represented minority students and females among all freshmen, these declines are very disappointing findings.**

Personal attributes: There is a stereotypical image of undergraduate engineering majors as studious and intellectually able but also socially awkward and relatively unskilled at effective teamwork as well as oral and written communication. This image was explored by examining data on 5 key attributes on which entering freshmen rated themselves: intellectual self-confidence, social self-confidence, public speaking ability, writing ability, and popularity (which may provide insight about potential leadership and effective teamwork). Both engineering and computer science majors were above average only on intellectual self-confidence. Engineering students were average on social self-confidence and well below average on public speaking, writing, and popularity. **Men and women planning engineering majors were nearly identical on all scales. Computer science students scored below engineering students on all 5 characteristics**, but scored almost as well during periods of rising popularity of computer science as a major, evidently attracting more promising freshmen at those times. Among students preferring computer science, women matched men on social self-confidence and writing ability but scored below them on the other 3 attributes. A major surprise was that **men intending to major in the social and behavioral sciences were higher on all 5 attributes than men preferring engineering.** The differences were very large in social self-confidence, writing ability, and public speaking ability. Women preferring the social and behavioral sciences were higher than their engineering counterparts on writing, public speaking, and popularity, but lower in intellectual self-confidence. They were much lower than men on the latter attribute. **These results support the validity of the concern of engineering educators to better develop the "soft skills" of engineering majors.**

HS grades: The expectation that students with superior high school achievement (measured by GPA) are attracted disproportionately to engineering and natural science majors was confirmed. Freshman choice of

undergraduate major could be characterized in engineering as A%>B%>C% -- significantly higher proportions of all A students than of all B students are attracted to engineering, and significantly higher proportions of all B students than of all C students are attracted to engineering. The biological sciences had the same pattern. In contrast, the social and behavioral sciences proved to be collection of disciplines where A%=B%=C%. During the 1980s, computer science was also an A%=B%=C% undergraduate major. But in the early 1990s, it evolved to an A%<B%<C% discipline. ("Business" is also A%<B%<C%.) This change in computer science happened as the proportions of women and under-represented minorities planning computer science majors were shrinking steadily, suggesting many of the best students from these groups were no longer choosing CS.

Introductory Note

The central focus of this paper is on describing changes in the characteristics of new freshmen in 4-year colleges and universities planning to major in engineering and computer science during 1983 – 2002, exploring the evolution in the critical dimensions of race/ ethnicity, sex, high school achievement, and personal characteristics, including "soft skills." Because there is overlap between the curricula of computer engineering and computer science -- and considerable uncertainty about where to draw the boundary -- this paper also covers computer science. This paper also characterizes freshmen intending engineering majors by comparison to freshmen intending to major in other undergraduate disciplines.

The analysis is in the form of detailed tabulations of data acquired through lengthy HERI surveys of a sample of full-time freshmen as they enter college for the first time. The HERI survey is very rich in background information about entering freshmen, including questions about self-perception, personal values, habits, personal achievement, parents' achievement, and race/ ethnicity/ gender. In 1983 the total HERI sample of freshmen of all types in 4-year institutions was 165,000 -- about $1/6^{th}$ of the estimated 1983 total freshman population in 4-year institutions. The sample size has gradually grown – both absolutely and relative to the population, reaching 266,000 in 1998, about $1/4^{th}$ of the estimated population that year. (The 2001 and 2002 samples were 278,000, slightly less than $1/4^{th}$ of the population.)

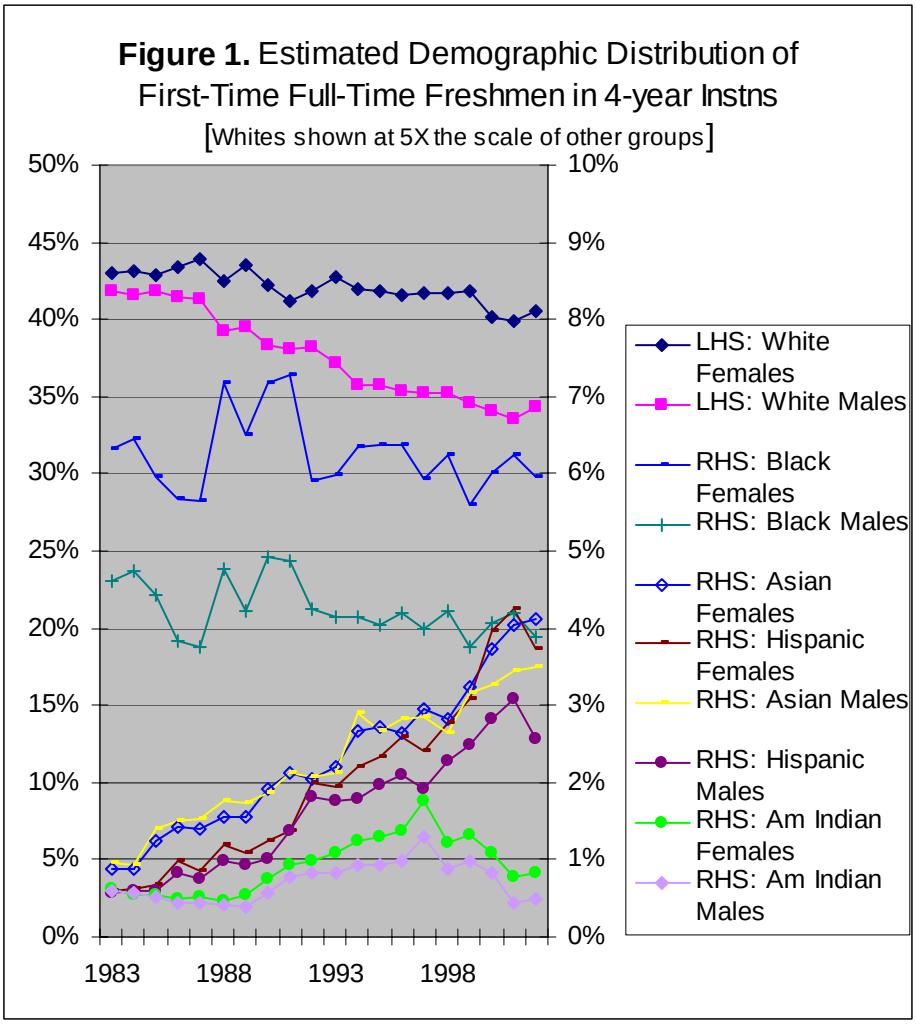
A cautionary note is that these data are self-reported and thus not as reliable as independently verified data for some variables, such as "high school grades." Nevertheless, studies of self-reported data in other surveys that could be independently verified have not found significant aggregate bias in reported data covering factual information, such as sex or high school grades. For example, on the "High School and Beyond" longitudinal panel studies of high school students in the early 1980s, students were as likely to under-report as over-report their course grades.

Some of the HERI data are available in published (paper) form in the annual HERI publication of "The American Freshman: National Norms." The electronic tabulations used in this analysis were provided to the National Science Foundation by HERI for use in the latest (2004) National Science Board biennial report "Science and Engineering Indicators."

I. Diversity: What are the demographic characteristics of students entering 4-year institutions as freshmen?

Engineering is not an egalitarian undergraduate discipline. Freshmen intending to major in engineering and computer science are drawn from different population subgroups (defined by sex and race/ ethnicity) at substantially different rates.

This paper starts by examining the demographic composition of successive freshmen classes across all disciplines over the last 20 years. **Figure 1** illustrates that considerable changes have occurred. Abstracting from yearly fluctuations, there has been a large decline in the proportion of white (non-Hispanic) males from 42% to 34% and smaller reductions in the proportions of white females and black males. There has been no trend in the proportion of black females.



On the other hand, there have been substantial increases in freshmen from the other minority groups. The percentage drawn from each group rose from under 1% in 1983 to as high as 4% each for Asian and Hispanic females. American Indian females grew from about ½% to nearly 2% of the total in 1997 but have since dropped back to under 1%

again in 2001 and 2002. The pattern for American Indian males is similar at a lower scale. Within each racial or ethnic group, the number of female students has outnumbered the number of male students. In 2002, female freshmen exceeded male freshmen by 17% among Asian students, 18% among white (non-Hispanic) students, 45% among all Hispanic students, 53% among black students, and 70% among American Indian students. Overall, females exceeded males by 23% in 2002 in this population.

Figure 2 examines the changes in the total proportion of first-time, full-time freshmen who are considered under-represented minorities (a category that excludes Asian students), showing the underlying proportions in six categories. [Because the data in this paper refer consistently to first-time full-time freshman in 4-year institutions (i.e. 4-year colleges and universities) these full descriptors will not be used in the remaining text.]

Total under-represented minorities rose from 12% to 19% of all freshmen during 1986-2001 (or less dramatically from 13% to 17% during 1983-2002). Hispanic students accounted for most of this proportional growth. The falloff in 2002 may reflect growing restrictions in affirmative action due to a rising number of legal challenges.

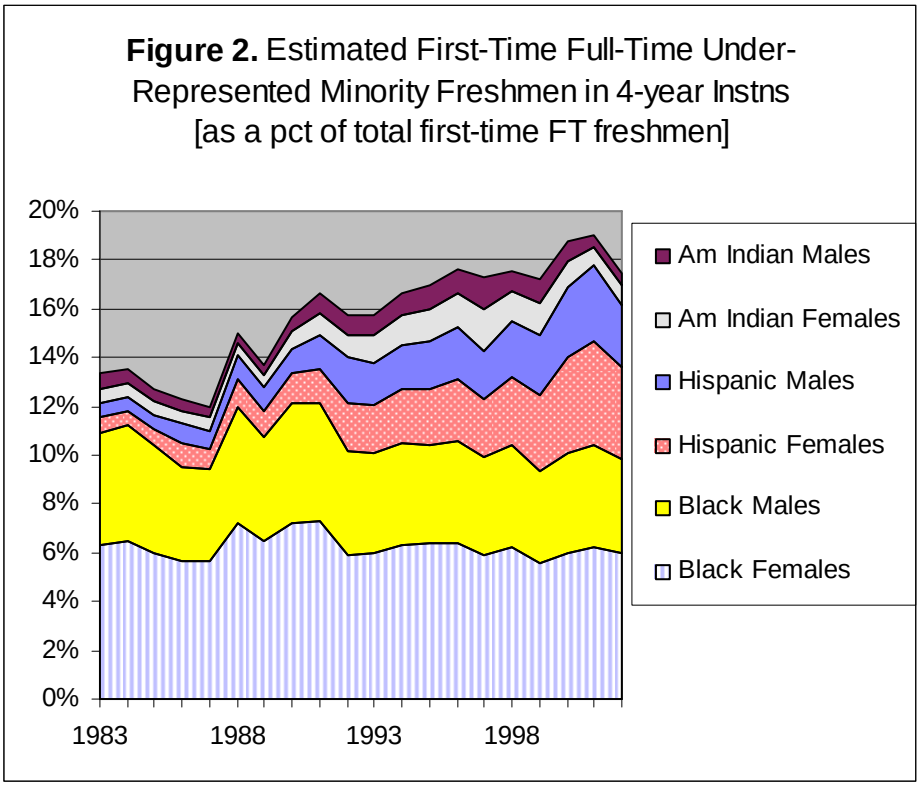
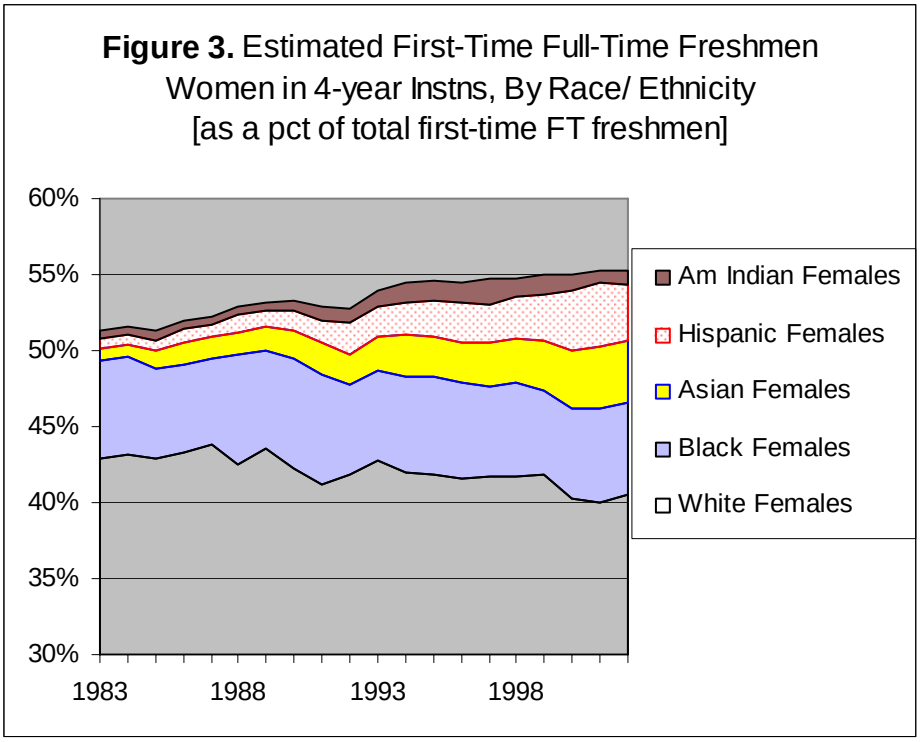


Figure 3 provides a picture of the growing proportion of women. The proportion of white (non-Hispanic) females declined from 43% to about 40% during 1983-2002 and the proportion of Black females started and finished this 20-year period at 6%. Yet, the overall proportion of women grew from 51% to 55% during the last 20 years as a consequence of strong growth in American Indian, Hispanic, and Asian female freshmen.



II. Diversity: What are the differences between males and females from different races and ethnic backgrounds in choosing to major in engineering?

Overall, the diversity of preferences by demographic subgroup is enormous, ranging from a low of 2% to a high of 35% planning to major in engineering. There is clear higher preference by males for engineering compared to females in any of the 5 racial / ethnic subgroups. **Figure 4a** indicates that all of the male subgroups are above the "all students" line and all the female subgroups are below it. The variation across subgroups of males and females is also high. Nearly 35% of Asian male freshmen in 1985 indicated they were planning to choose engineering majors. At the other extreme, as little as 2% of women from white, American Indian, and Chicano/ Mexican American/ Puerto Rican backgrounds have indicated they planned to major in engineering at some points during the last 20 years.

In male subgroups there was a large decline during 1983 - 2002 in the percentage Asians planning to major in engineering, a smaller decline in interest by whites, and a large rise followed by a large drop in interest by blacks.

Figure 4a. Pct of Freshmen Intending to Major in Engineering by Sex & Race/Ethnicity

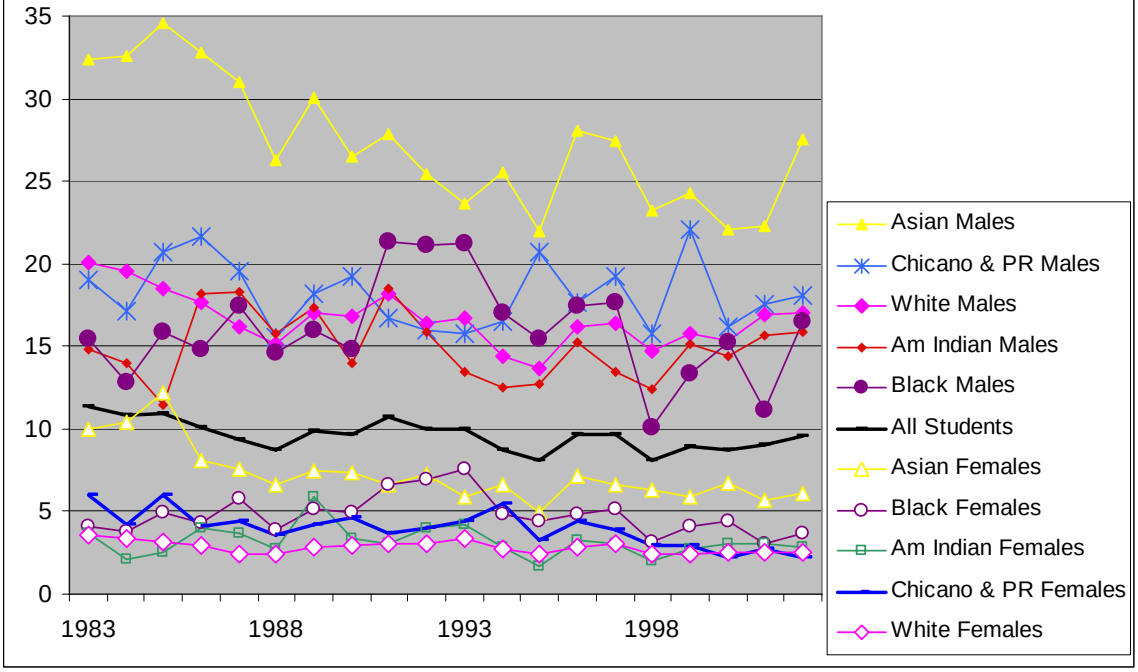


Figure 4b. Pct of Freshmen Women Intending to Major in Engineering by Race/Ethnicity

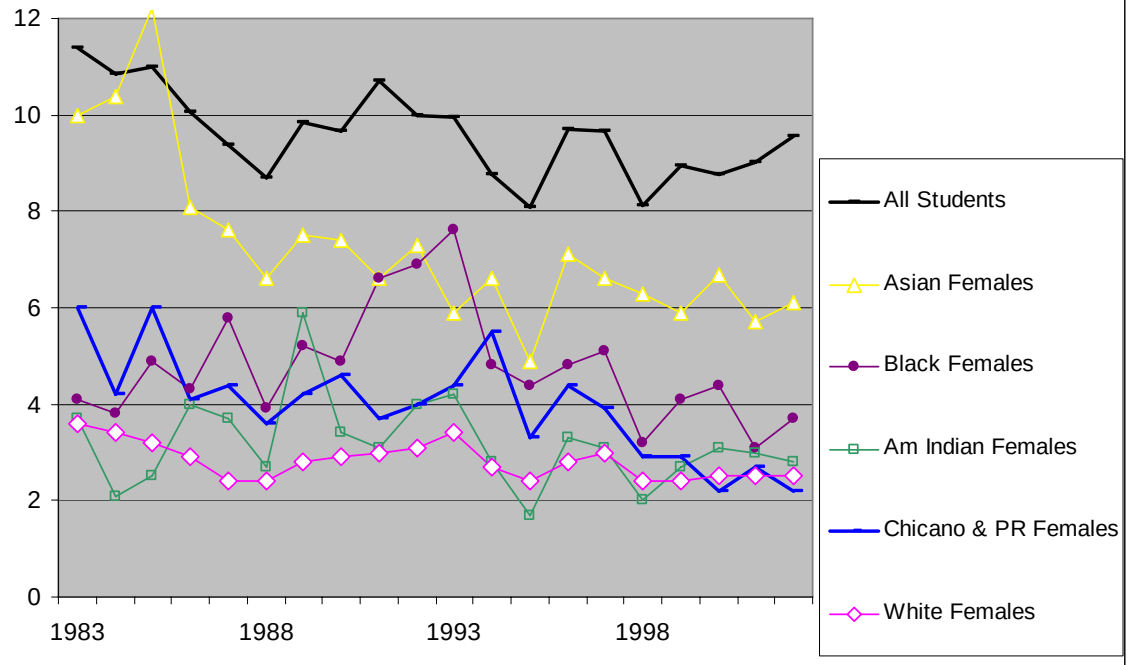
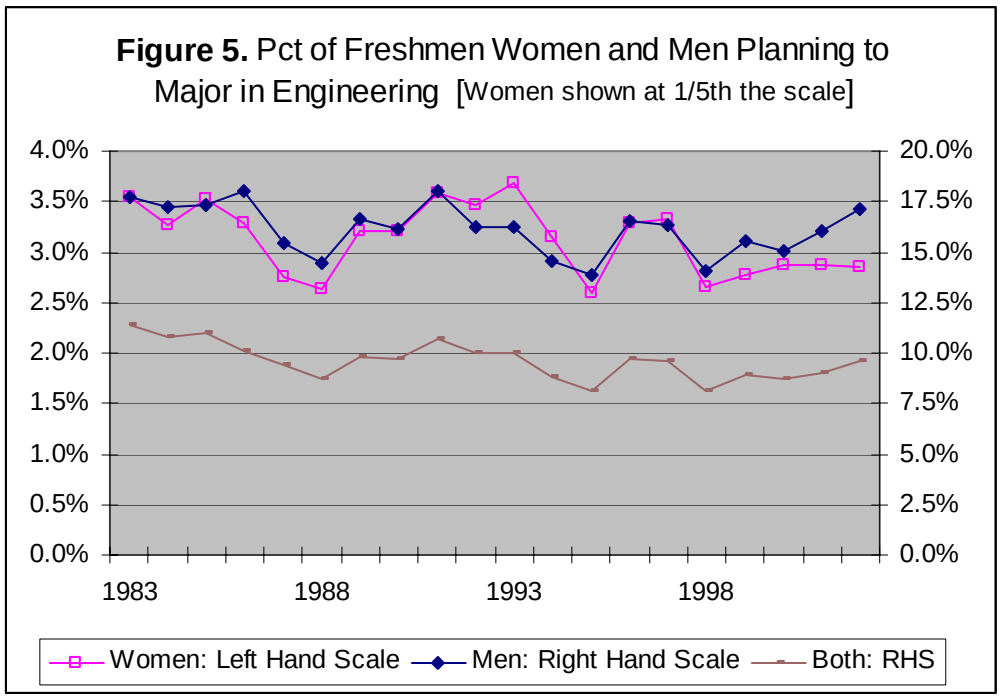


Figure 4b focuses on the bottom part of **Figure 4a** and covers female subgroups. There have been declines in the proportion of every female subgroup planning to major in

engineering, particularly since the early 1990s. The rise and fall in interest among black males noted above also occurred among black females and was sizable, increasing from 4% in the mid-1980s to the 7% - 8% range in the early 1990s, only to drop back to the 3% - 4% range during 1998 – 2002. The drop in interest among Chicano/ Mexican American/ Puerto Rican females was also quite severe from 1993 – 94 to 2000 – 2002.

The net result of changing preferences and proportions within each of the five demographic groups defined by race and ethnicity is illustrated in **Figure 5**, which

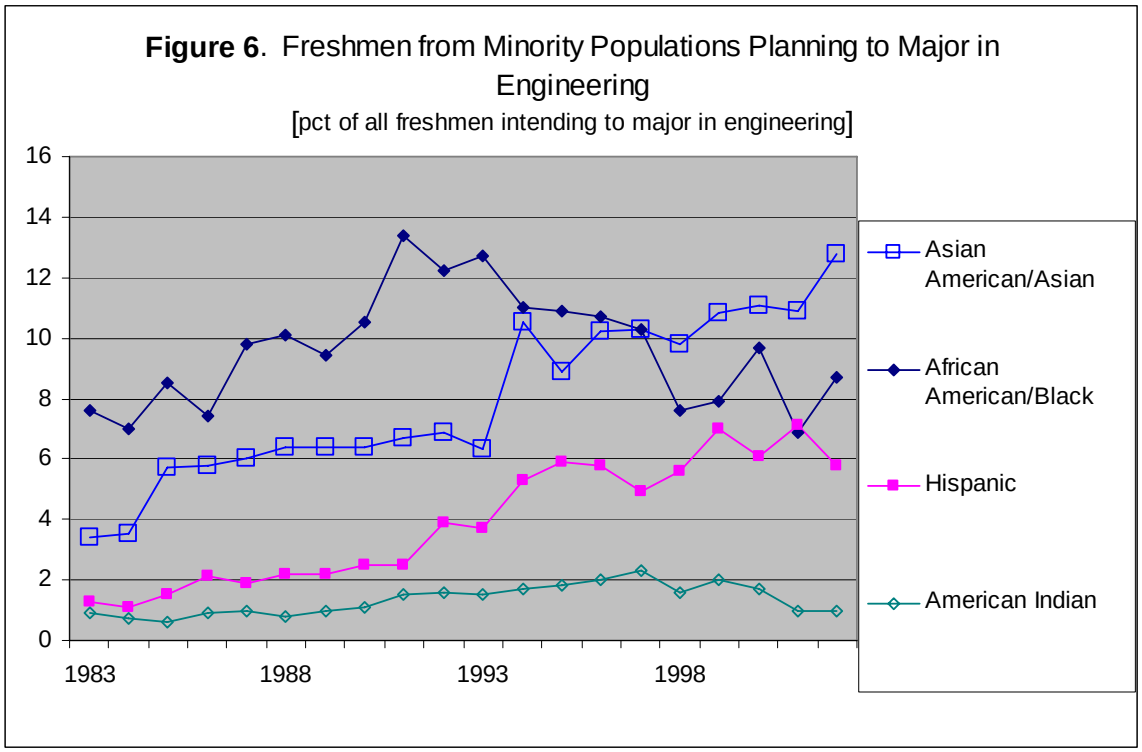


focuses on sex differences. It is remarkable that women exhibit largely the same changing preferences for studying engineering as men -- at one-fifth the scale of male preferences. The rise in the percentage of male freshman planning engineering majors after the year 2000 was not mirrored by women, however.

The reduction in female interest after 1993, coupled with the fact that the proportion of freshmen women in 4-year institutions grew by almost 2.5 percentage points during 1992 - 2002 (as shown in **Figure 3**), had the net effect of holding down the proportion of all freshmen intending to major in engineering. For example, from 1992 to 2002 men preferring engineering increased from 16.2% to 17.1% of males, but engineering-preferring women dropped from 3.7% to 2.9% of females, and thus engineering-preferring freshmen dropped from 10.0% to 9.6%.

Thus, at the national level, it is clear that efforts to increase female representation in engineering are not succeeding at the front end of the process, namely attracting college freshmen. The female percentage of freshmen planning engineering majors rose slowly from 17% to 21% during 1983 – 1993 only to fall back to 17% during 1993 – 2002.

However, due to the growth in minority populations, there have been significant gains in minority freshman planning to major in engineering. This can be seen in **Figure 6**. During 1983 – 1993 there was strong growth in the percentage of putative engineering majors drawn from minority populations, from about 13% to 28%. During 1993 – 2002, however, this growth ceased and minority groups have accounted for 26% to 28% of the

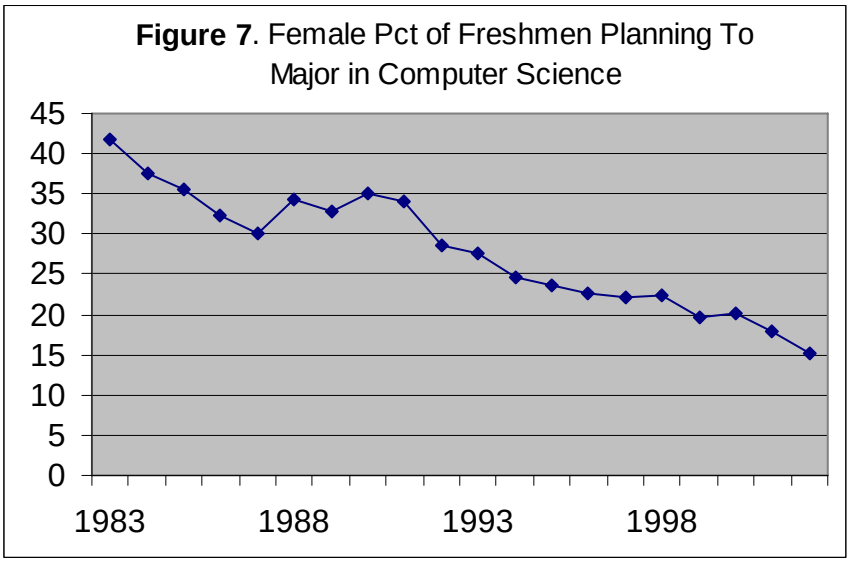


total (with no discernable trend). The continued growth in Asians and Hispanics has been offset by reductions in blacks and American Indians after 1993. The combined percentage of freshman planning engineering majors who were black, Hispanic, or American Indian (i.e. came from under-represented populations) actually dropped during 1994 – 2002, from 18% to 16%. By 2002, Asian Americans accounted for more than 12% of the engineering majors.

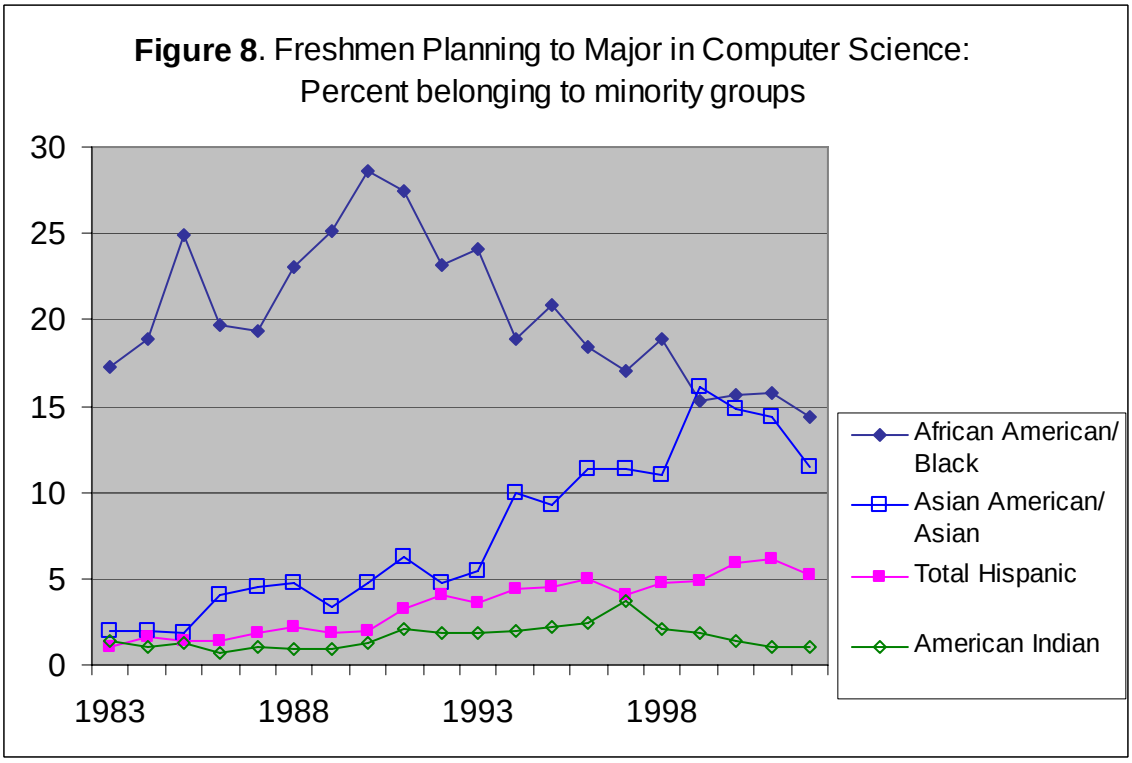
III. Patterns in Computer Science.

Student preference patterns for computer science have many parallels with engineering, particularly with respect to the enormous diversity of proportions of different subgroups planning to major in computer science. There are three large differences, however. One is that 20 years ago women were nearly as likely as men to enter college planning to major in computer science. However, female proportion of students planning to major in computer science in 1983 was already declining and continued to do so for the next four years, as indicated in **Figure 7**. It dropped from 42% to 30% in 1987, recovered to 35% during 1988 – 1991, then fell steadily to 15% in 2002, putting it below the proportion of freshmen women choosing engineering as a major in that year.

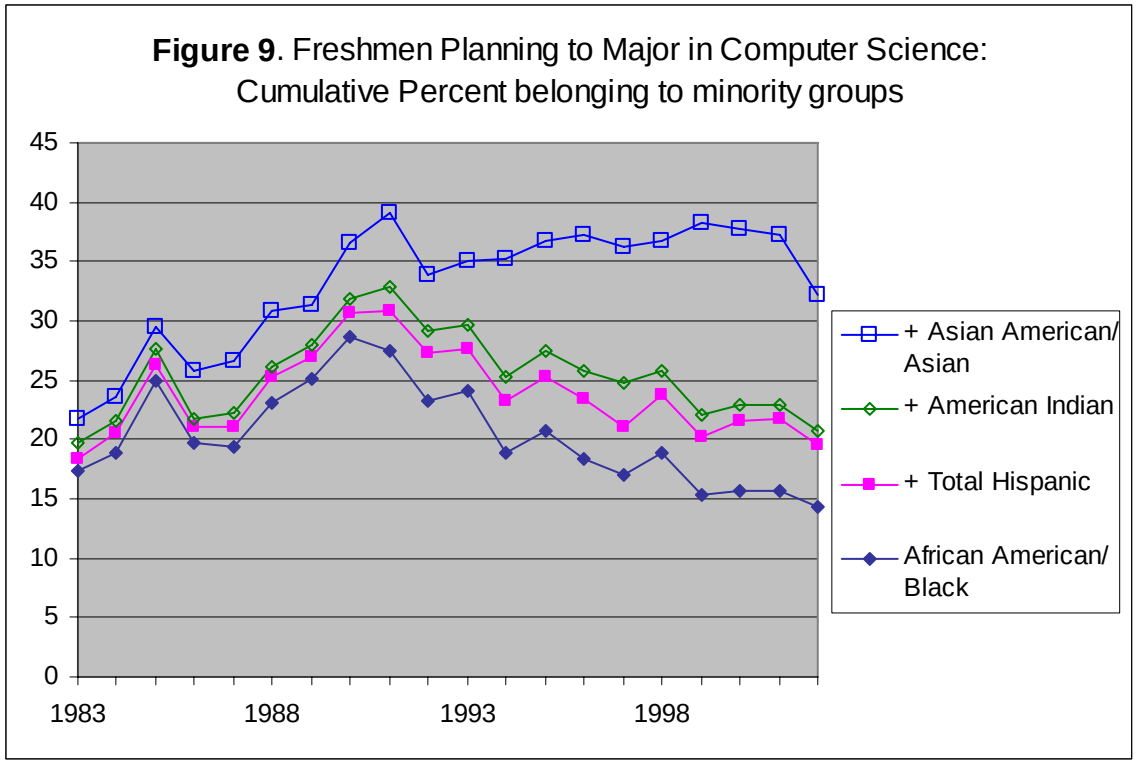
A second major difference is that under-represented minority groups were relatively more attracted to computer science (compared to non-Hispanic whites) than to engineering.



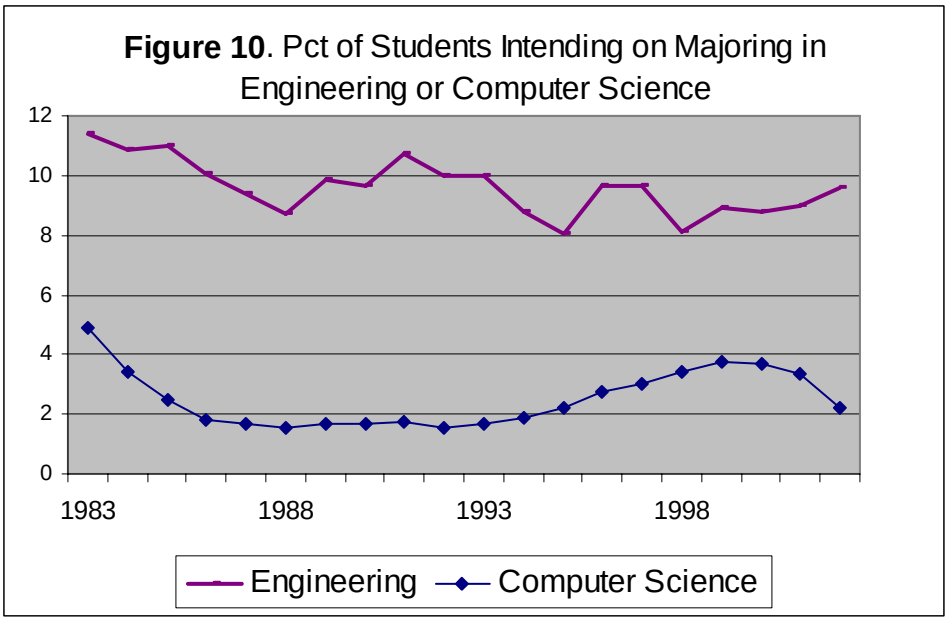
This is particularly true for black students, as illustrated in **Figure 8**. Notice that change in proportions of each minority group over time is similar to those for engineering in **Figure 6**, except for the much greater proportions of blacks and American Indians. From its peak value of 28% in 1990, the black proportion has since dropped to 14% in 2002. In fact, every minority group reached a peak before 1990.

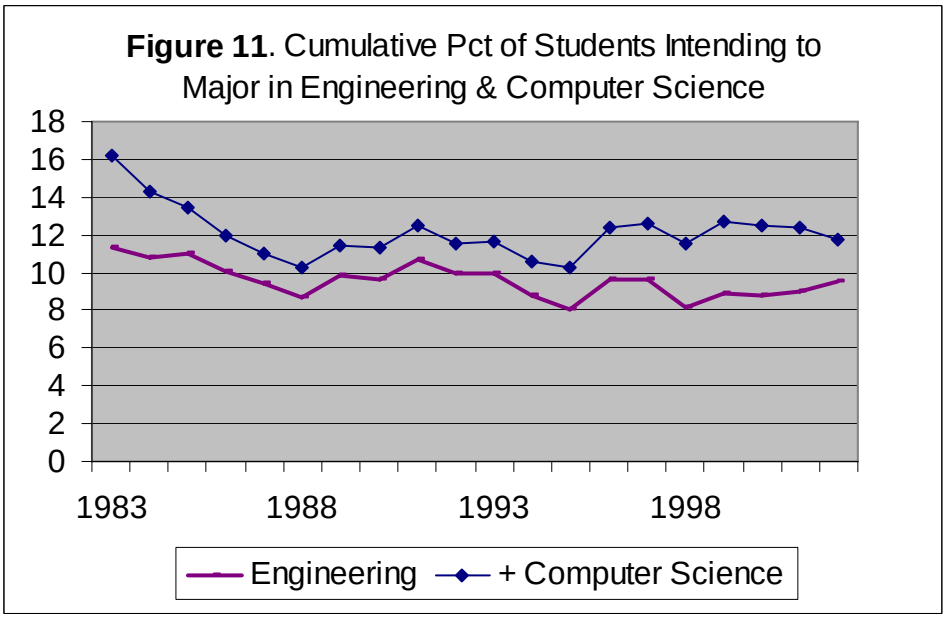


However, rising proportions of Asians planning to major in computer science offset declining proportions of blacks during 1989 – 1999, as illustrated in **Figure 9**. Removing Asian students from the equation, the proportion of under-represented minority students intending to major in computer science has declined considerably from its 1991 peak of 33%, reaching 21% in 2002. This is a much steeper decline than occurred in engineering, but the proportion in 2002 was still higher than in engineering. When contrasted against the rising proportions of underrepresented minority students and females among all freshmen, these are very disappointing findings.



A third difference is that student interest in majoring in computer science has been much more cyclical than in engineering, as shown in **Figure 10**. This Figure also indicates that after new undergraduate interest in both disciplines dropped during the mid-1980s, student interest in these two areas was somewhat countercyclical – when one was down the other was up. The result is that when students planning to major in these two disciplines are combined (in **Figure 11**) there is not a discernable long-term trend after 1988. From 1989 to 2002, the proportion of new freshmen intending to major in either engineering or computer science has fluctuated between 11% and 13% in all years except 1994 and 1995.





III. Characterizations and Comparisons of Men and Women Intending to Major in Engineering: Personal Attributes

There is a stereotypical image of undergraduate engineering majors as studious and able but also socially awkward and relatively unskilled at oral and written communication and effective teamwork. The HERI data provide an opportunity to characterize engineering students on these dimensions using self-reported data and compare them by sex. This paper also compares freshmen preferring engineering to those preferring other undergraduate majors.

I chose five attributes to examine:

- **Intellectual self-confidence** (which also correlates highly with "academic ability" on the HERI survey),
- **Social self-confidence**, which I perceive is an indicator of a student's ability to work with peers on teams and their likelihood for taking advantage of opportunities to do so,
- **Writing ability**,
- **Public speaking ability**, which is the closest indicator of oral communication skills, and
- **Popularity**, which could be measuring a variety of factors, including attractiveness to male and female peers, early leadership potential, and the potential for engaging in effective teamwork. (Of course it may be an indicator of negative attributes, too, such as narcissism, self-delusion, and frivolous values.)

Each of these attributes was scored as the combined percentage of students rating themselves either "above average" or "in the top 10%." In the following comparison tables, the average scores and any trends are noted. If there is a 5 point or greater difference, the box of the higher scoring sex is shaded.

Table 1. Comparing Women and Men on Five Attributes (Engineering)

Attribute	**Women** - Engineering	**Men** - Engineering
Intellectual self-confidence	Ave = 65, no trend	Ave = 70, no trend
Social self-confidence	Ave = 47, slightly up	Ave = 50, no trend
Writing ability	Ave = 45, slightly down	Ave = 40, slightly down
Public speaking ability	Ave = 33, no trend	Ave = 31, slightly up
Popularity	Ave = 35, down: 41→ 29	Ave = 43, down: 51→ 39

Comparing women to men within engineering indicates they are remarkably similar in their self-ratings on these five attributes. Except for "popularity," the ratings are fairly stable over the 1985-2002 time period. Both men and women rate themselves quite high on "intellectual self-confidence," very low on "public speaking ability," and below average on writing ability, although this is one attribute on which women score significantly better. The low scores for "popularity" are striking, including the huge drop of 12 points during the 17 year time period for both men and women.

In considering these gender differences, one should factor in that women tend to rate themselves lower on these scales than men rate themselves. The very low scores for public speaking ability and popularity suggest a need to involve students in a variety of experiences that will strengthen and enrich their interpersonal and communication skills. Adding in the low scores for writing ability, especially among men, confirms that the current concerns of engineering educators with improving so-called "soft skills" are well founded.

Figure 12a. Self-Rated Attributes of Freshman Women Planning Engineering Majors [Pct. either above average or in top 10%]

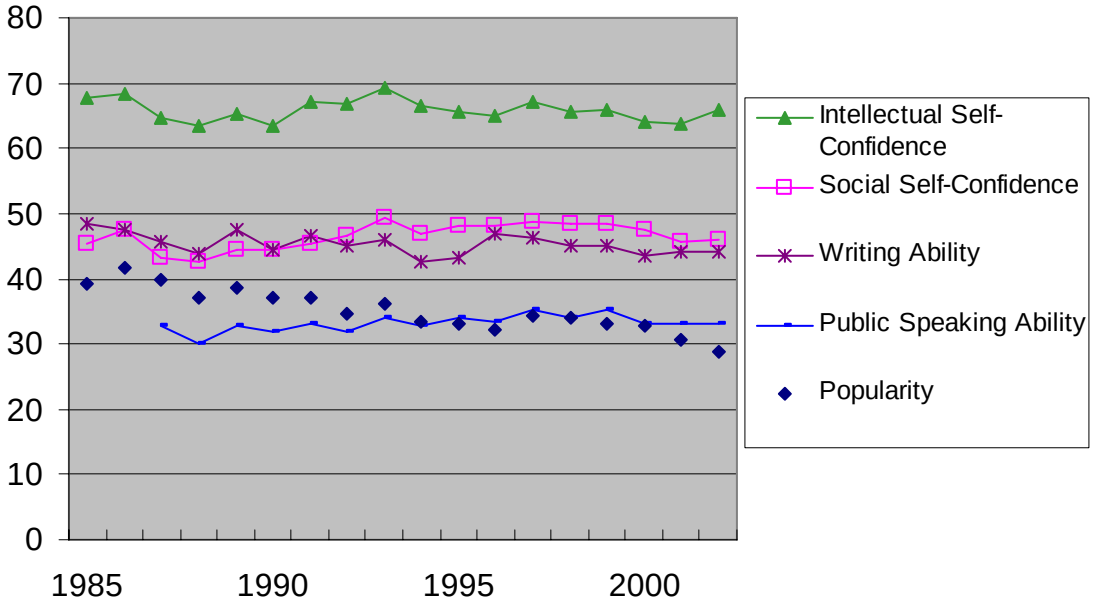
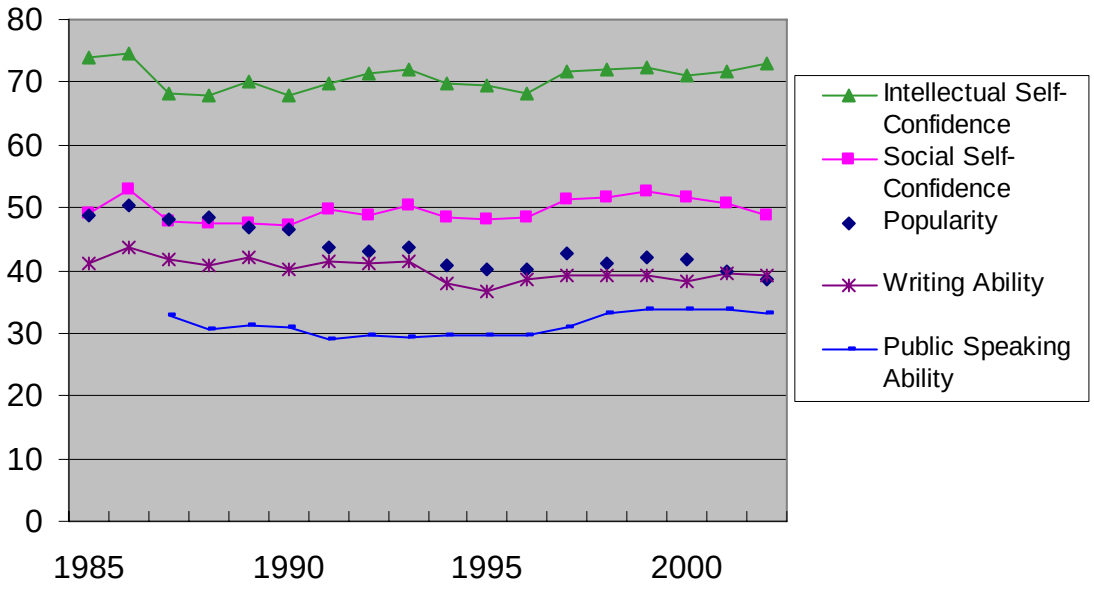


Figure 12b. Self-Rated Attributes of Freshman Men Planning Engineering Majors [Percent either above average or in top 10%]



IV. Comparisons of Student Attributes by Intended Major: Engineering Versus Others

It may be useful to explore whether freshmen who are planning on other majors are significantly different on these attributes. The first comparison was made with freshmen women and men intending to major in computer science, shown in **Figures 13a** and **13b**.

Figure 13a. Self-Rated Attributes of Freshman Women Planning Computer Science Majors [Pct above average or in top 10%]

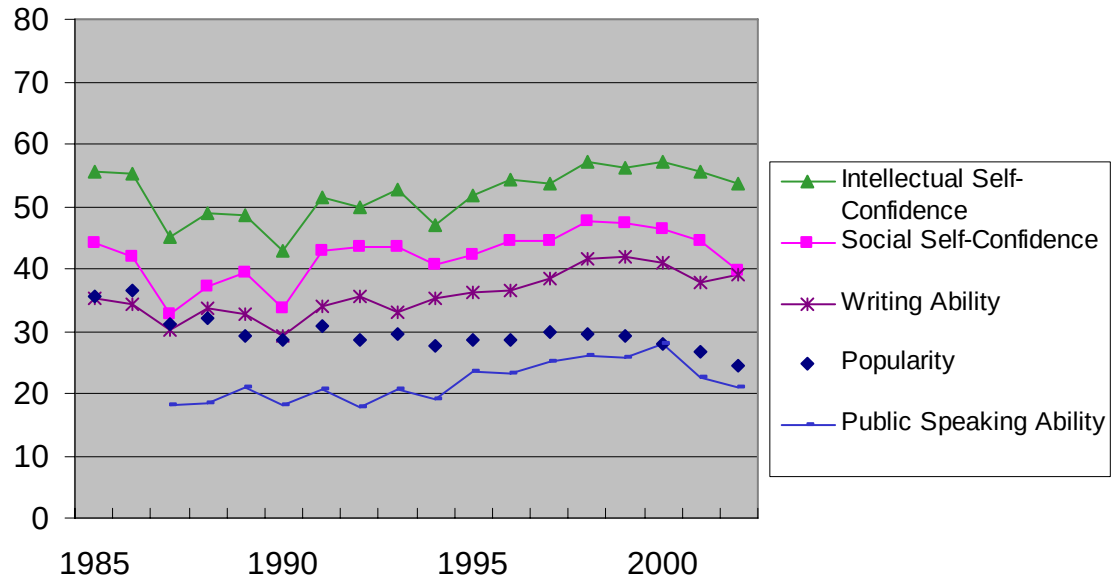
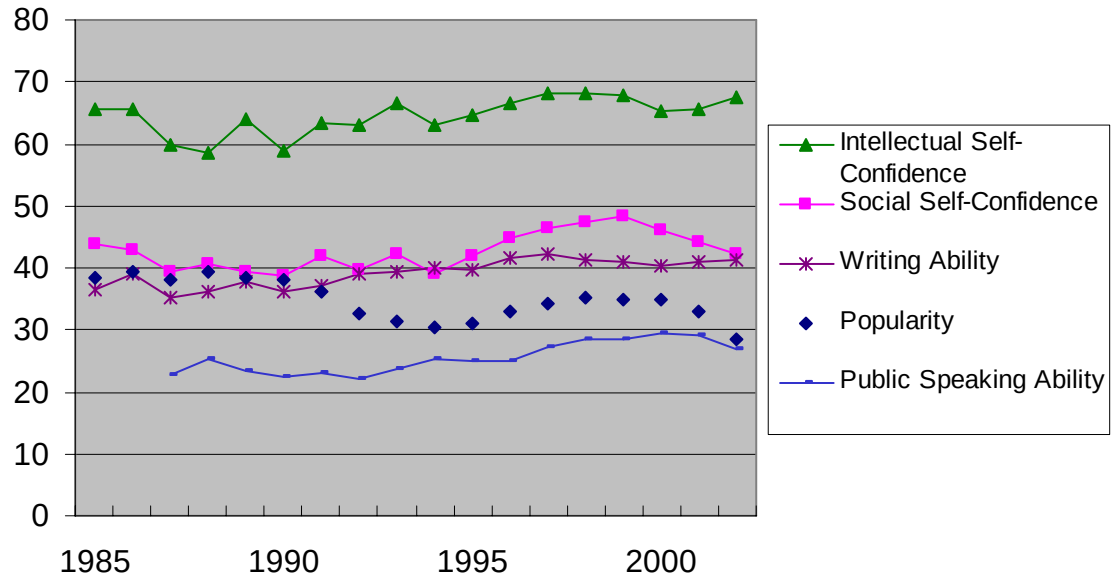


Figure 13b. Self-Rated Attributes of Freshman Men Planning Computer Science Majors [Pct above average or in top 10%]



The attribute scores of freshman planning to major in computer science have not been stable over time, unlike those of engineering-preferring freshmen. The variability over time is particularly evident for women. It is also evident that the average score on each attribute for women and men in computer science has tended to rise and fall with the proportion of students planning to major in it, suggesting that stronger students were drawn into computer when it rose in popularity and vice versa. For each sex and each attribute (except "popularity") these ups and downs were around a rising trend line.

Table 2 indicates that men have tended to score higher on all five attributes, particularly "intellectual self-confidence" and "public-speaking ability." The male-female differences were more pronounced here than in engineering. Women caught up on "social self-confidence" and "writing ability" by 2002, as the percentage of females in the computer science-preferring group dropped steadily to 15%. This suggests a deliberate winnowing process may have been taking place which discouraged lower scoring females from considering computer science as viable major field.

Table 2. Comparing Women and Men on Five Attributes (Computer Science)

Attribute	**Women** - Comp Sci	**Men** - Comp Sci
Intellectual self-confidence	Ave = 52, down-43/up-57	Ave = 65, down-59/up-69
Social self-confidence	Ave = 42, down-32/up-48	Ave = 45, up-49/down-42
Writing ability	Ave = 35, down-30/up-42	Ave = 40, up: 35→ 42
Public speaking ability	Ave = 22, up-28/down-20	Ave = 25, up: 22→ 29
Popularity	Ave = 30, down: 37→ 24	Ave = 35, down: 40→ 29

Turning to a comparison of engineering to computer science (**Tables 3a and 3b**) note that the gross ranking of the 5 attributes is similar in most years for both sexes and both undergraduate disciplines. In general, engineering-preferring freshmen claim higher scores than computer science freshmen -- both within male and female subgroups. The engineering scores exceeded computer science scores by the widest margins in the mid-1980s. Computer science scores for the attributes of "social self-confidence" and

Table 3a. Comparing Women on Five Attributes (Engineering to Comp. Sci.)

Attribute	**Women** - Engineering	**Women** - Comp Sci
Intellectual self-confidence	Ave = 65, no trend	Ave = 52, down-43/up-57
Social self-confidence	Ave = 47, slightly up	Ave = 42, down-32/up-48
Writing ability	Ave = 45, slightly down	Ave = 35, down-30/up-42
Public speaking ability	Ave = 33, no trend	Ave = 22, up-28/down-20
Popularity	Ave = 35, down: 41→ 29	Ave = 30, down: 37→ 24

Table 3b. Comparing Men on Five Attributes (Engineering to Comp. Sci.)

Attribute	**Men** - Engineering	**Men** - Comp Sci
Intellectual self-confidence	Ave = 70, no trend	Ave = 65, down-59/up-69
Social self-confidence	Ave = 50, no trend	Ave = 45, up-49/down-42
Writing ability	Ave = 40, slightly down	Ave = 40, up: 35→ 42
Public speaking ability	Ave = 31, slightly up	Ave = 25, up: 22→ 29
Popularity	Ave = 43, down: 51→ 39	Ave = 35, down: 40→ 29

"writing ability" had caught up to engineering by 2002 for both males and females, as noted above, as did the male score for "intellectual self-confidence." In Section V below another perspective for these disciplinary differences is given.

Engineering and the Social and Behavioral Sciences

How do the attribute scores of engineering-preferring freshmen compare to scores of freshmen planning to major in the social and behavioral sciences? Folklore has long held that many students who do not persist in their engineering majors shift to a majors in the social and behavioral sciences or business. Thus it may be surprising to discover that freshmen intending to major in the social and behavioral sciences tend to score much higher than their engineering-preferring counterparts.

Table 4a. Comparing Male Freshmen on Five Attributes (Engineering to Social & Behavioral Sciences)

Attribute	**Men** - Engineering	**Men** - Social & Behavioral Sciences
Intellectual self-confidence	Ave = 70, no trend	Ave = 75, up slightly
Social self-confidence	Ave = 50, no trend	Ave = 60, up slightly
Writing ability	Ave = 40, slightly down	Ave = 60, no trend
Public speaking ability	Ave = 31, slightly up	Ave = 53, up: 51→ 56
Popularity	Ave = 43, down: 51→ 39	Ave = 53, down: 61→ 49

The comparison over the 1985 – 2002 period is facilitated by the stability of attribute scores over time (except for "popularity") for both males and females in these two disciplines. (The 12-point drop in "popularity" scores for engineering freshmen also occurred in the social and behavioral sciences.) Also, similar to engineering, the female proportion of new freshmen preferring the social and behavioral sciences has been relatively stable, albeit at a much higher level – approximately 67%.

Men preferring the social and behavioral sciences have consistently scored significantly higher during 1985-2002 on all 5 attributes compared to their engineering counterparts. The differences in "public speaking" and "writing" are huge. These findings define a large challenge to engineering educators who are seeking to improve the "soft skills" of their undergraduate students. The average freshman planning to major in engineering is already in a sizable deficit position when he enters higher education.

Table 4b. Comparing Female Freshmen on Five Attributes (Engineering to Social & Behavioral Sciences)

Attribute	**Women** - Engineering	**Women –** Social & Behavioral Sciences
Intellectual self-confidence	Ave = 65, no trend	Ave = 55, no trend
Social self-confidence	Ave = 47, slightly up	Ave = 50, no trend
Writing ability	Ave = 45, slightly down	Ave = 55, no trend
Public speaking ability	Ave = 33, no trend	Ave = 40, up slightly
Popularity	Ave = 35, down: 41→ 29	Ave = 40, down: 48→ 37

Women preferring the social and behavioral sciences are significantly higher on "public speaking," "writing," and "popularity" than those preferring engineering. The differences in "public speaking" and "writing" are large but only about one-half the size of male differences. Women preferring engineering are significantly higher on "intellectual self-confidence."

Finally, unlike the situation in engineering, men intending to major in the social and behavioral sciences score much higher than women on all 5 attributes except "writing" where they are only moderately higher. This is likely because freshmen men and women prefer different sub-disciplines within the social and behavioral sciences, which is a broad category covering economics, psychology, sociology, political science, anthropology, archaeology, geography, and linguistics.

V. High School Grade Point Average and the Choice of Undergraduate Major.

Another perspective is gained by examining freshmen preferences for engineering, computer science, and other undergraduate majors in subgroups differentiated by high school achievement. In the HERI survey, high school achievement is measured by "high school grade point average" (HS GPA). The survey asks students to report their overall high school grades in one of the following nine categories:

A & A+	B +	C +
A	B	C
A -	B -	D

Freshman intending to major in engineering are predominantly in the four highest GPA categories, much less in the B, B -, and C + ranges, and virtually not at all in the C and D

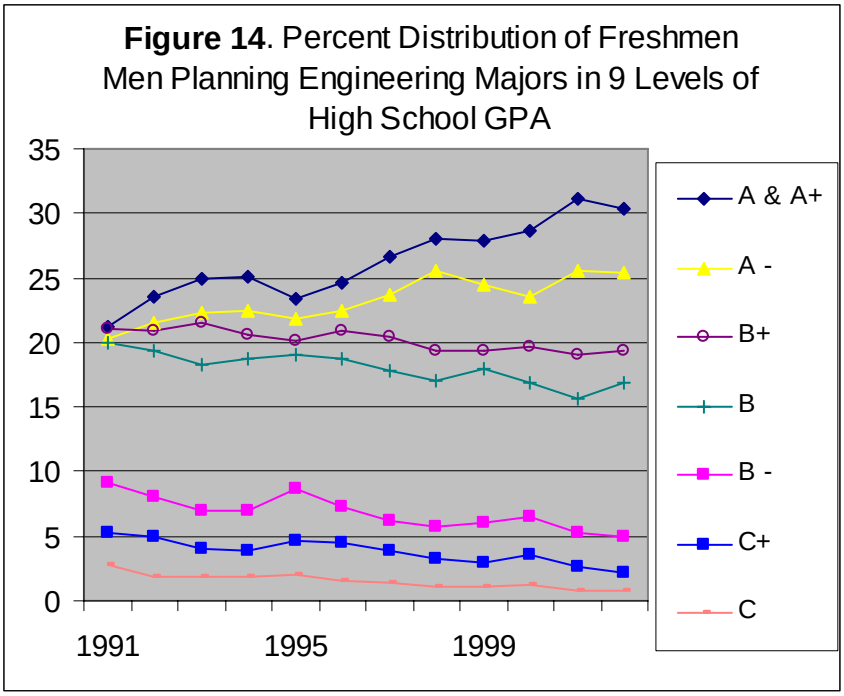
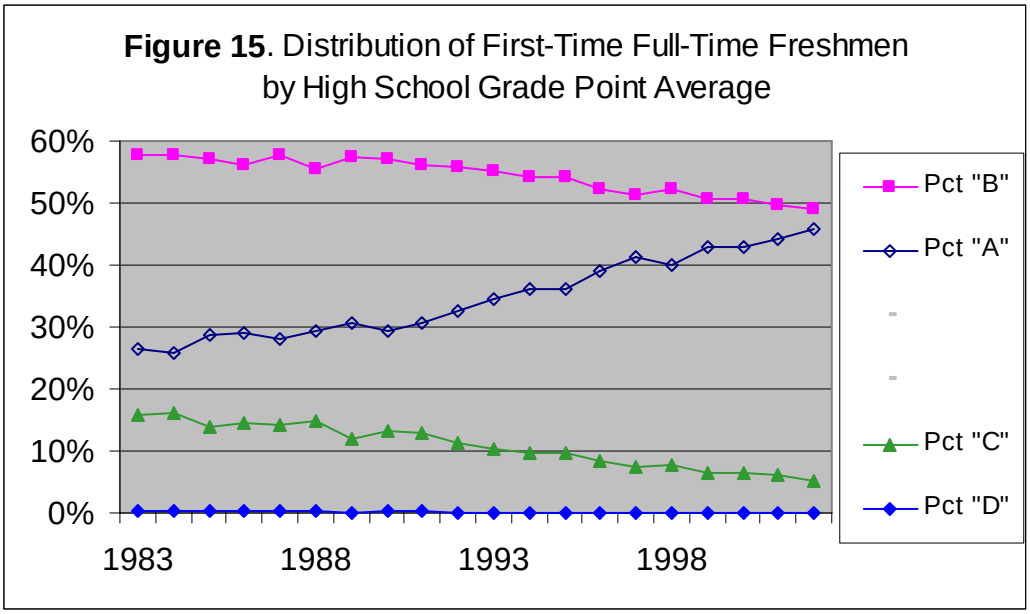


Figure 14. Percent Distribution of Freshmen Men Planning Engineering Majors in 9 Levels of High School GPA

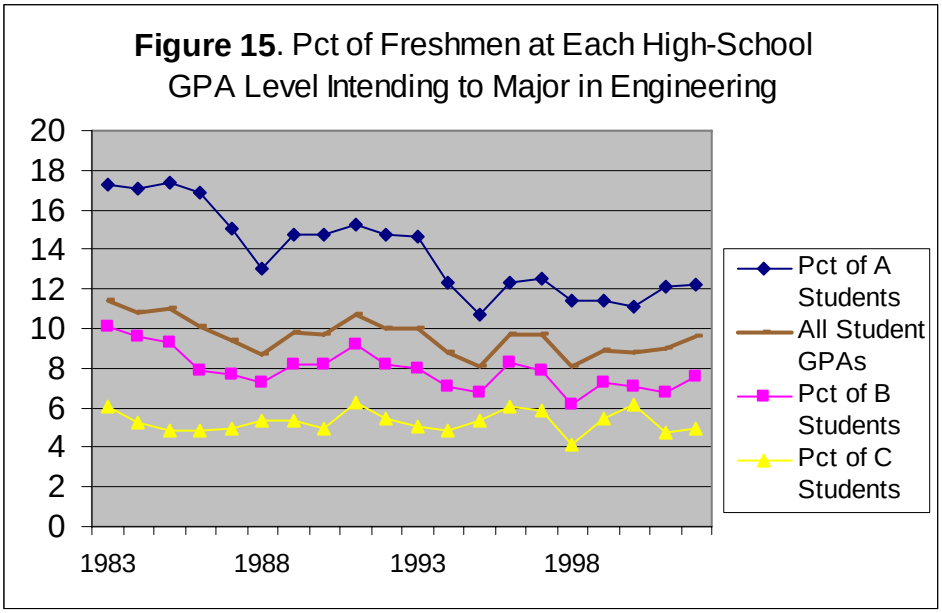
ranges. Except in **Figure 14** these 9 grade point averages have been collapsed into 4: A, B, C, and D. **Figure 14** indicates that the HS GPA distribution of males planning engineering majors improved steadily after 1991. New male freshmen were increasing reporting grades in the A+/A and A- ranges and less frequently in the C, C+, B-, and B ranges. Virtually none reported a HS GPA below C. The calculated average GPA for these males rose from 3.32 in 1991 to 3.50 in 2002 on a 4-point scale.

However, this rosy picture overstates the real gain, due to grade inflation. To examine the extent of grade inflation, **Figure 15** examines changes in the distribution of all entering freshmen by HS GPA. The fraction of freshmen claiming they were "A" level students has risen dramatically -- from 26% in 1984 to 46% in 2002. This gain was balanced by a 9 point drop in "B" level students and an 11 point drop in "C" level students. This is equivalent to an increase in the average GPA from 3.12 in 1983 to 3.15 in 1991 and 3.35 in 2002. The 1991 – 2002 gain is slightly larger than the gain found for men planning engineering majors during the same period. Much of this rise is likely due to grade inflation, because it is not matched by rising test scores on the SAT or ACT, or improvements on the 12th grade National Assessment of Educational Progress (NAEP) assessment.

The presence of grade inflation complicates the interpretation of gains over time in "A" students in a particular major field. However, there is still useful information in these data that is developed by comparing differences in the preferences of "A" students, "B" students, and "C" students for selecting various undergraduate majors.

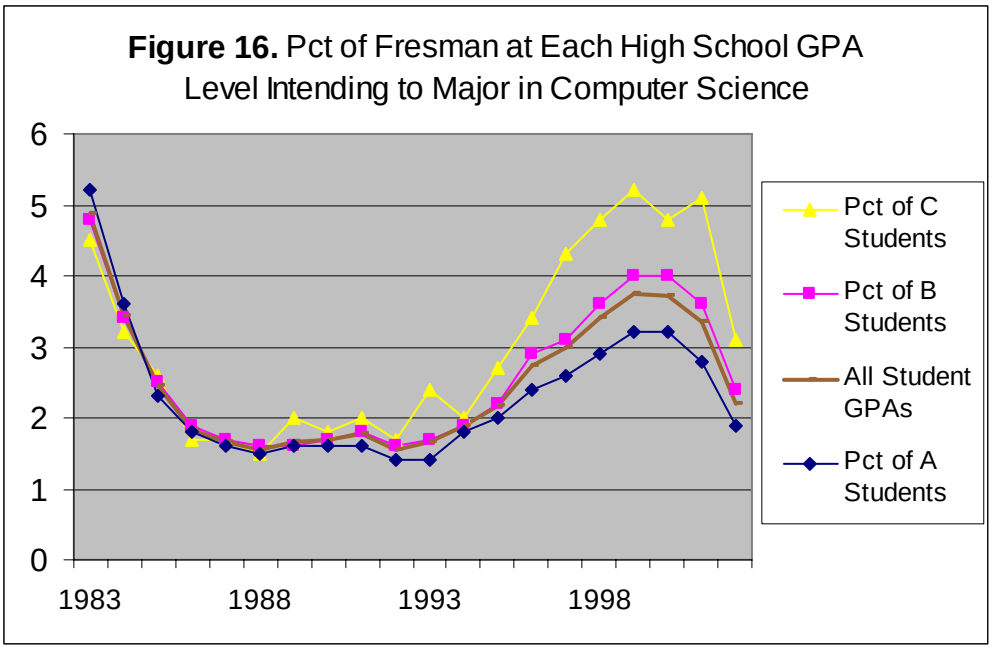


In fact, this analysis yields one clear set of results. Higher proportions of A students than B students in each of the last 20 years have planned to major in engineering and, similarly, higher proportions of B students than C students have planned to major in engineering. See **Figure 15**. The same picture holds for the biological sciences. This paper calls these disciplines "%A>%B>%C disciplines."



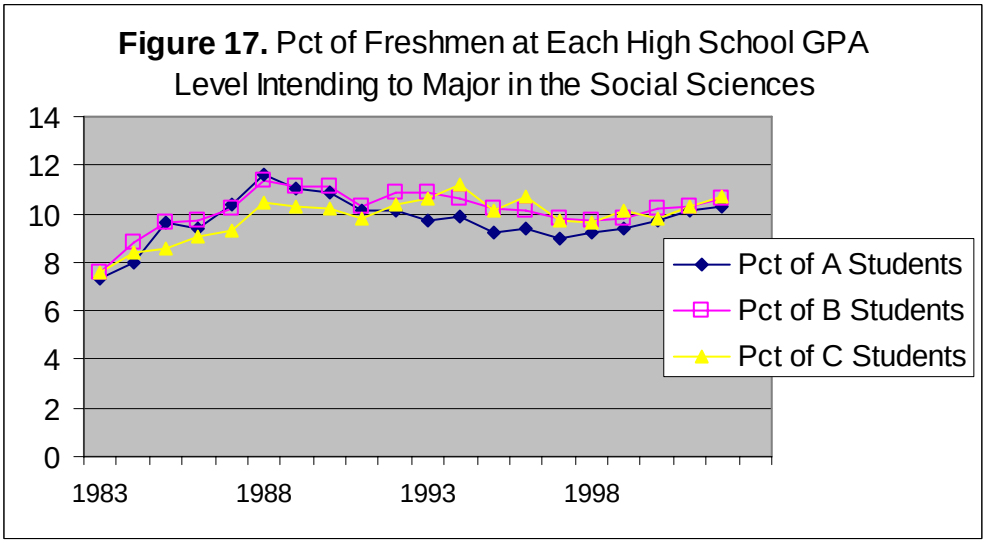
Less obvious is how to interpret the decline over time in the proportion of "A" students preferring engineering. It overstates the decline over time in the fraction of students of fixed, uniformly high quality picking engineering, because due to grade inflation the "A" category increasingly includes students who would have been "B" students in earlier years. For the same reason, the true underlying academic quality of the "B" students picking engineering has probably declined over time as the "B" category increasingly loses its best students to the "A" category and increasing picks up "C" students. However, there has still been some decline in the interest of the best high school students embodied in the "A" proportion. The proportion of "A" students planning engineering majors dropped from a high of 17.5% during 1983-85 to12% during 2001-2002. This is a greater relative decline (of 30%) than occurred in the interest of "B" students (from 10% to 7.8% - drop of 22%).

For some undergraduate majors, the proportions of students at each grade level preferring that major are very close. This has been the case for the social and behavioral sciences (illustrated in **Figure 16**) and was also approximately characteristic of computer science during 1983-1992. These are "%A=%B=%C disciplines." However, in the last decade computer science has evolved to a choice that is preferred by greater percentages of "C" students than "B" students, and lower percentages of "A" students than "B" students, as shown in **Figure 17**. It has become a "C&>B%>A% discipline" – just the reverse of engineering. This change in computer science happened as the proportions of women and under-represented minorities planning computer science majors were shrinking steadily, suggesting their best students were leaving computer science and being attracted to other majors (excluding engineering).



Another example of a C%>B%>A% discipline is business, shown in **Figure 18**. Other patterns are also possible. For example, students planning to study elementary education fit the pattern C%=B%>A%, as illustrated in **Figure 19**.

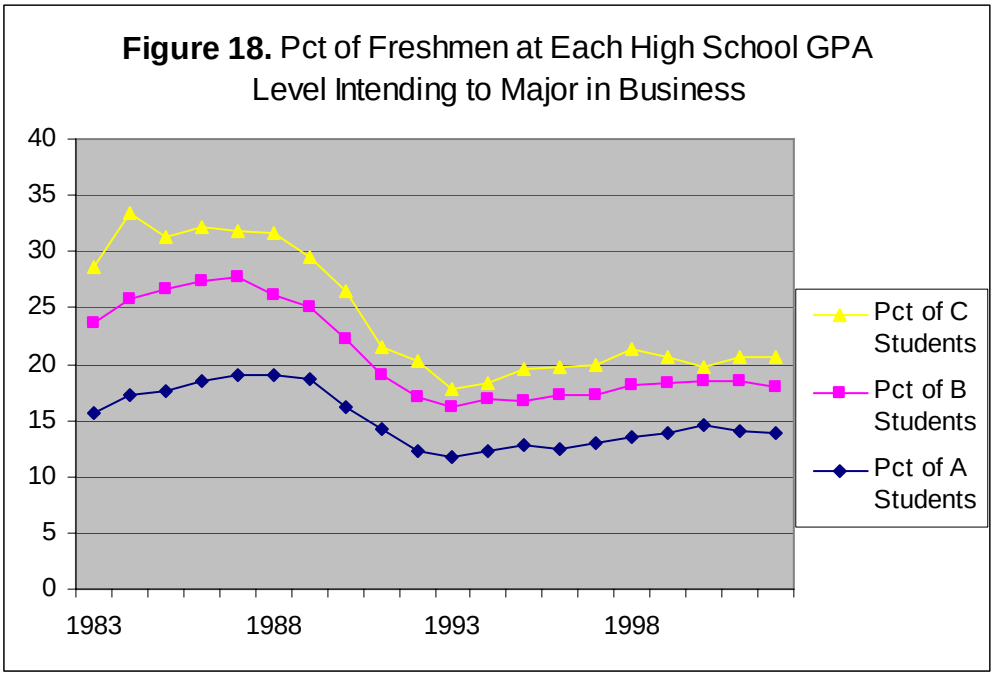
Considering both the student-attribute and the HS GPA achievement comparisons of engineering with the social and behavioral sciences, ponder the findings that show engineering-preferring students typically have higher high school GPAs while social and behavioral science students consider themselves to be intellectually better, superior writers and public speakers, and more at ease in social situations.

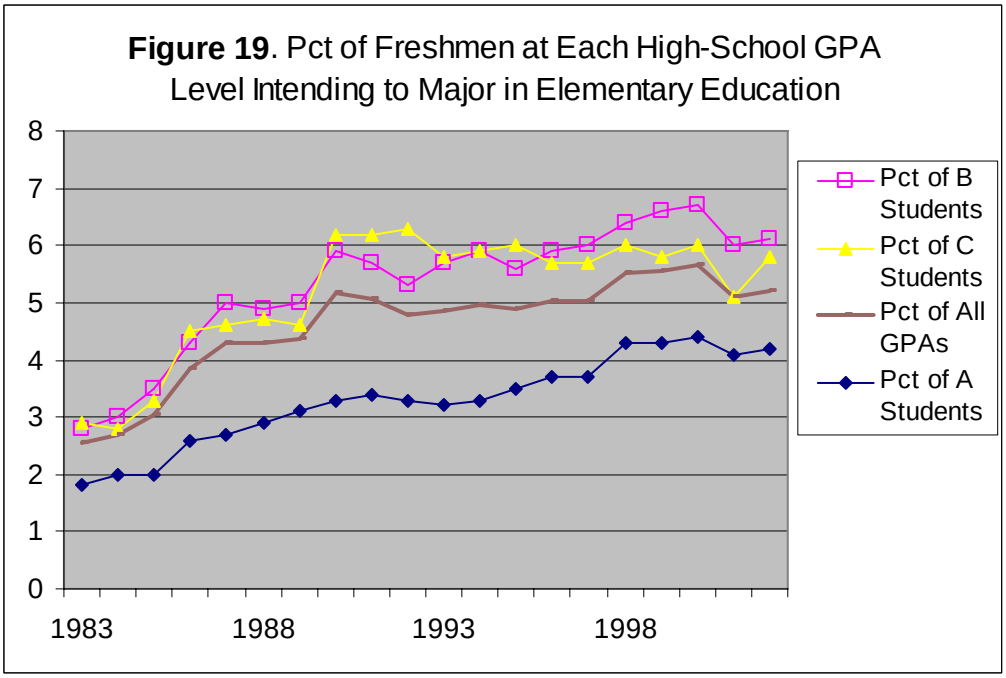


The answer will not be forthcoming from analysis of HERI data. However, the high achievement in mathematics and sciences courses typically emphasized by high school

students who major in engineering, computer science, or the natural sciences are only reflected strongly in one of the 5 attributes – "intellectual self-confidence." High school courses that develop writing skills and speaking skills are often more compatible with teaching and learning practices in the humanities and social sciences.

Further, as pointed out by Seymour and Hewitt in their analysis of why college students drop out of natural science and engineering majors, the atmosphere of basic courses in





these disciplines is often more competitive and less cooperative than found in courses in English, foreign languages, and the social sciences. There is also undoubtedly some self-selection reflected in these findings. Students who feel ill-at-ease socially and are worried about their writing skills often seek career paths where these traits are less important to immediate success. Males who are academically able but socially ill-at-ease will not have to deal with many females if they choose engineering or computer science majors.