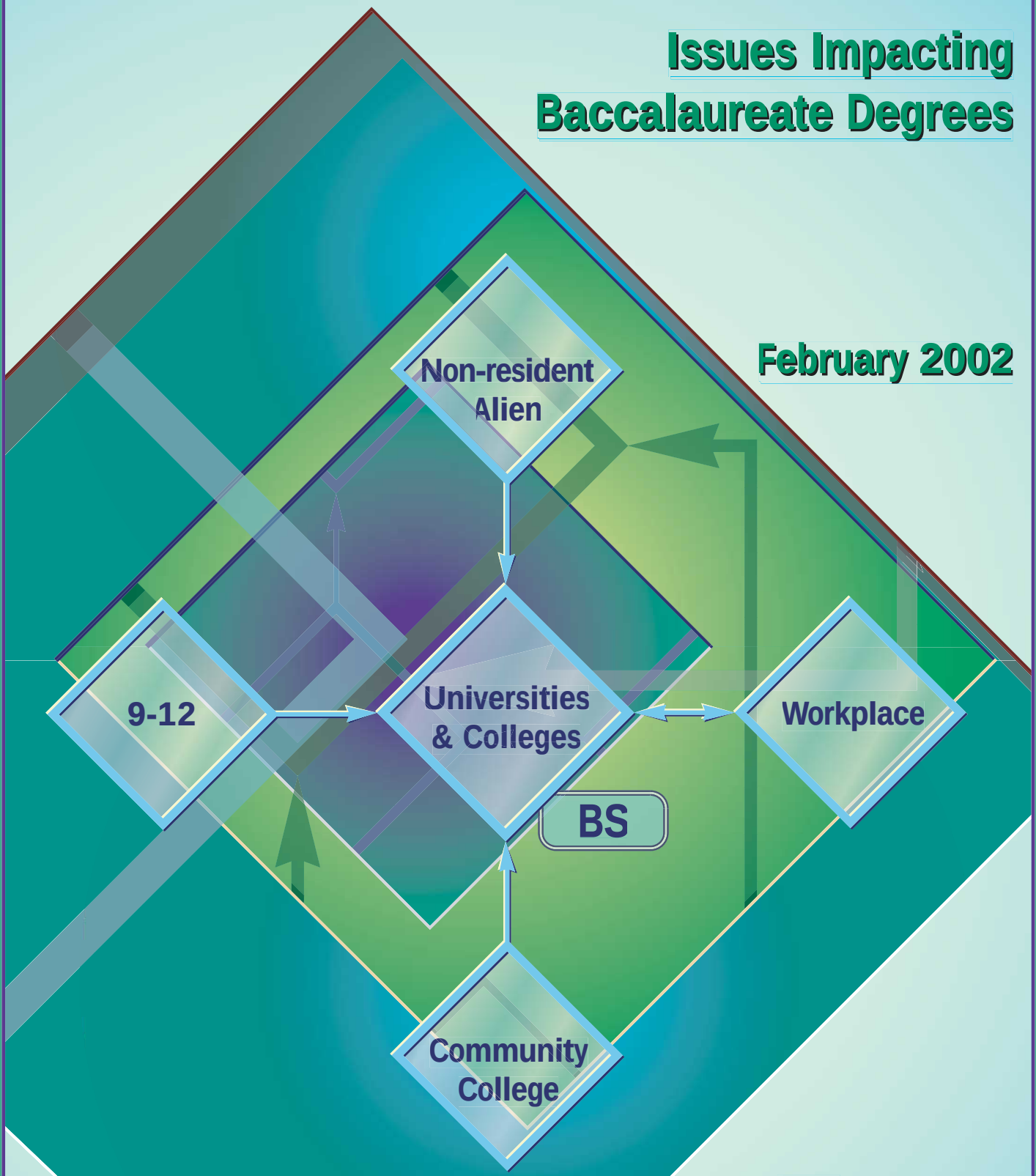
Critical Path Analysis of California's S&T Education System:

Issues Impacting Baccalaureate Degrees

February 2002



CALIFORNIA COUNCIL ON SCIENCE AND TECHNOLOGY

Issues Impacting Baccalaureate Degrees in Science and Engineering

A Report Prepared by

The California Council on Science and Technology

April 2002

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The California Council on Science and Technology is a nonprofit organization established in 1988 at the request of the California State Government and sponsored by the major post secondary institutions of California, in conjunction with leading private-sector firms. CCST's mission is to improve science and technology policy and application in California by proposing programs, conducting analyses, and recommending policies and initiatives that will maintain California's technological leadership and a vigorous economy.

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1. EXECUTIVE SUMMARY

To understand how the state should respond to the changing technology environment, the California Council on Science and Technology (CCST) two years ago commissioned a comprehensive evaluation of California's high-tech infrastructure. The California Report on the Environment for Science and Technology (CREST) analyzed the state's science and technology infrastructure to determine if California has the people, capital investment and necessary state policies to maintain California's leadership in the face of increasing worldwide competition.

A major finding of the CREST report was that California is not producing the science and engineering workforce needed to continue meeting industries' growing requirements for skilled workers.

The Critical Path Analysis Project was initially comprised of five sub-projects being conducted by seven principal investigators. CCST initiated this additional project aimed at collecting primary data on the supply of undergraduate scientists and engineers. This sixth project looks at a range of issues specific to the state's universities and colleges and assesses their impact on the production of baccalaureate degrees in science and engineering. These issues include application and enrollment trends in science and engineering programs; rates of retention/graduation of science and engineering students; and impediments to student success and progress to receiving a degree.

Data Gathering Methodology

A review of reported data on application rates, enrollment, and graduation trends for the State of California was performed. The two major sources of public data are the California Postsecondary Education Commission (CPEC) (http://www.cpec.ca.gov), and the California Department of Education (http://www.cde.ca.gov). Each site is constrained by the data they have collected and the data they then make available to the public. Enrollment and degree trends were tracked for mathematics, engineering, computer science, biology and physical sciences.

In addition, a survey was designed focusing on engineering. This survey was sent to University of California (UC), California State University (CSU) and independent schools with engineering colleges. Quantitative data were requested on applications, enrollment, and drop-out rates. In addition, qualitative data were requested on application and enrollment trends, retention rates, impediments to success, and education support and resources.

Quantitative Data Trends

State Overview

Despite the fact that more of the best-paying jobs are in S&E, fewer students are opting for S&E disciplines. S&E enrollment is up somewhat statewide, although the production of baccalaureate degrees in S&E in California increased at a slower rate overall (12.3%) than the general trend in degrees granted (13.8%). Most of the overall increase in S&E degrees has been in biology, and all of the increase occurred at UC and the Independents – S&E degrees at CSU actually declined from 1990 to 2000.

Most significantly, Latino S&E degrees are very low compared to the size of the population. Latinos comprise the state's most rapidly growing population segment (32% in 2000), yet the percentage of degree recipients graduating in S&E disciplines was no higher than 10% by 1999.

Individual disciplines

Biology and computer science saw increases in enrollment. The 85% rise in computer science enrollment at CSU has been more recent (since 1997) and has not yet translated

into a rise in degrees at CSU, though statewide computer science baccalaureates rose by 26% from 1990 to 2000. Mathematics and physical science enrollment and degrees were stagnant from 1990-2000, and engineering degrees declined a sharp 25% at CSU and 10% at the Independents.

Gender

UC has the highest ratio of female graduates in S&E overall, while CSU trails. Female degrees rose most sharply at the Independents from 1990-2000. However, while female degrees dominate in biology, they trail in engineering. Moreover, while the overall percentage of female S&E degrees is rising, it is still a distinct minority.

Ethnicity

Latinos saw the largest improvement in degrees received relative to 1990 numbers (88%), but the overall percentage of Latino S&E degrees still trails far behind the increasingly dominant numbers they show relative to the California population. Asians and Blacks saw modest increases of 5 to 15% in S&E degrees from 1990-2000, mostly in biology. Blacks, although they comprise a relatively small percentage of S&E degrees overall, have the best male/female ratio in overall S&E enrollment of any ethnic group, especially at UC where female enrollment comprised 55% of the total.

Qualitative Data (Survey Results)

Application and enrollment trends

The vast majority of students apply to several universities or colleges. Applicants are admitted to more than one institution and can then decide which of those to attend. Most "take rates" generally range between 20% and 30%. The increase in applications across the years reflects growth in applicants, as well as applicants applying to more than one institution. In addition, transfer students from the community college system have a significant impact on CSU.

Retention and graduation

Retention of students who enroll in S&E programs is roughly comparable to overall student retention, although many student switch majors and most who change majors leave S&E altogether rather than switching to a related subject. Data on what happens to students who drop out or transfer is not readily available and was not obtained for this report.

Impediments to student success

Entry-level courses are an unintentional barrier for unprepared students. In addition, there is limited availability of some entry-level courses due to various resource and scheduling issues. Consequently many students get frustrated with S&E requirements and end up switching majors. Most campuses which responded to the survey deemed academic advising resources adequate, though chronically underused by students.

2. INTRODUCTION

Two years ago, the California Council on Science and Technology (CCST) commissioned a thorough evaluation of California's science and technology infrastructure, in order to understand how the state should respond to the changing high-tech environment. The California Report on the Environment for Science and Technology (CREST) was intended to determine whether California has the people, capital investment, and state policies necessary to maintain its leadership in the face of increasing worldwide competition.

A major finding of the CREST report was that California is not producing the science and engineering workforce needed to continue meeting industries' growing requirements for skilled workers. Although some immediate shortages can be met by attracting skilled labor from elsewhere, California's ability to produce skilled labor from within will be a critical factor for the future performance of California high-tech companies. Furthermore, a decline in the production of a skilled workforce is beginning to be a problem throughout the U.S. with ensuing competition for those critical resources.

In October 2000 CCST initiated a project to conduct a Critical Path Analysis for the production of a science and technology workforce by our schools, colleges and universities. The project provides data on the trends in science and engineering education at the high school, associate, baccalaureate, masters, and doctoral level, taking into account population growth, demographics and changes in California's employment. For the first time, this study brings together data from multiple sources and integrates them into a single model. Through this critical path model, policy makers will have insight into factors that influence and control inputs, outputs, and linking mechanisms throughout the state's education system. The William and Flora Hewlett Foundation provided funding for the Critical Path Analysis project. The Semiconductor Industry Association and Hitachi Ltd. provided matching support.

The Critical Path Analysis Project was initially comprised of five sub-projects being conducted by seven principal investigators. CCST initiated this sixth project aimed at collecting primary data on the supply of undergraduate scientists and engineers. This sixth project looks at a range of issues specific to the state's universities and colleges and assesses their impact on the production of baccalaureate degrees in science and engineering. These issues include application and enrollment trends in science and engineering programs; rates of retention/graduation of science and engineering students; and impediments to student success and progress to receiving a degree. The three issues and the associated data are discussed in the following sections.

3. DATA GATHERING METHODOLOGY

In addition to analyzing the workforce supply and demand there are other factors, more difficult to quantify, that affect the production of baccalaureate degrees in science and engineering. These factors include analysis of the application and enrollment trends in science and engineering programs; rates of retention/graduation of science and engineering students; and impediments to student success and progress to receiving a degree. In addition to using state and national data sources, information of this type needs to be supplemented by working directly with the student affairs officers of each academic institution. Often these data are not required to be reported and therefore are not recorded on a regular basis.

3.1 GENERAL

A review of reported data on application rates, enrollment and graduation trends for the State of California was performed. The two major sources of public data are the California Postsecondary Education Commission (CPEC, http://www.cpec.ca.gov) and the California Department of Education (http://www.cde.ca.gov). Each site is constrained by the data they have collected and the data they then make available to the public.

Enrollment trends and graduation rates are available on each site, but that data is not easily broken down by area of study. Special requests were made to CPEC for data broken down by "science and engineering" categories. Two-digit Classification of Instructional Program (CIP) codes were defined to include: mathematics, engineering, computer science, biology and physical sciences.

CPEC is designated by the National Center for Education Statistics (NCES) to coordinate California's response to the Integrated Postsecondary Education Data System (IPEDS). CPEC provided CCST with ten years of data on total enrollments and degrees awarded for five of the two-digit CIP IPEDS codes. Those two-digit codes and name of degree area are listed in Table 2.

It was determined that statewide data was available by 2 digit CIP code for:

- Enrollment by UC, CSU, and other
- Graduation rates by UC and CSU
- Degrees awarded

Statewide data was not found to be available for:

- Applications
- Drop out rates

As a result of the limited data available CCST developed a survey instrument to ask specific quantitative and qualitative questions to academic institutions that the available data could not provide. However, this would have been a monumental task, even if only requesting for the five "science and technology" areas. It was determined that an approach of focusing on engineering would provide insight into the application and drop out rates that could be used to express a relationship to the overall picture.

3.2 QUANTITATIVE DATA REQUESTED

Each engineering college was asked to provide the following data broken down wherever possible:

- By all engineering programs
- By individual engineering programs
- By gender
- By ethnicity

2. Application data for the last 10 years

3. Enrollment data

- Number of freshmen (first year), sophomores (second year), juniors (third year), seniors (fourth year) and

fifth year and higher undergraduates enrolled in engineering programs for each of the last ten academic years.

- Average length of time to graduate with undergraduate engineering degree.
- For how many enrolled freshman is the engineering program the student's 1st, 2nd or 3rd choice?

4. Drop-out rate
   - How many students dropped out of engineering programs and enrolled in science programs and what science programs were they?
   - How many students dropped out of engineering programs and enrolled in a program other than engineering or science and what programs were they?
   - How many students dropped out of engineering programs and transferred to a community college?
   - How many students dropped out of engineering programs and transferred to another four-year university or college?

3.3 QUALITATIVE DATA REQUESTED

2. Application and enrollment trends in engineering programs:

In addition to assessing the changes in applications and enrollments, there is a need to determine what happens to students applying to engineering programs who are not accommodated at the state's engineering impacted four-year institutions (e.g. UCB, UCLA, CSU Cal Poly). Are they accommodated elsewhere in the state? Do they go out of state? Or do they abandon the goal of studying science and engineering disciplines?

3. Retention/graduation of engineering students:

Data from the California State University system suggest that rates of retention/graduation of science and engineering students do not deviate markedly from those of students in other programs. At the same time, from Cal Poly San Luis Obispo data, many students appear to change majors. Is this phenomenon widespread? At the same time, many students appear to change major and this phenomenon warrants further study. What do the data show? Data that would provide insights into where students go after they drop out of engineering or science programs would be of interest.

4. Impediments to student success and progress to degree. For example:
   - To what extent are lower division engineering courses being used to perform a weeding out function that results in attrition of otherwise qualified and promising students?
   - Do we have evidence that those who fail academically might otherwise have gone on to be successful?
   - To what extent is out of class academic advising and support adequate in terms of the magnitude of the effort, its targeting of demonstrated need and its effectiveness in fostering student success?
   - To what extent do present policies discourage and frustrate student transfer from one science and engineering program to another or from non-science/engineering programs into a science and engineering program?
   - To what extent do present general education and science and engineering program curricular requirements frustrate student progress to degree?
   - To what extent does class availability deter progress to degree or cause attrition?

5. Education support and resources. For example:
   - For the public academic institutions, is there an erosion of budget support for science and technology programs, due to overall reductions in budget support, elimination of mode/level distinctions in institution funding methodology,

escalation of unfunded mandates (such as financial aid)?

- What is the impact of escalating industry competition for qualified faculty and technical staff - in a time when mass retirements are predicted to occur and what are the constraints of existing compensation policies?
- What is the impact of deferred maintenance/renewal of laboratory spaces, scientific equipment, information technology and other instructional resources?
- What is the impact of insufficient capital funding on ability of universities to renew/expand science and engineering instructional facilities?

3.4 SURVEY INSTRUMENT

A survey questionnaire was devised to collect quantitative and qualitative data on applications, enrollment and retention for baccalaureate S&E students. The survey was sent to private and public institutions throughout the State of California (Appendix A). AICCU forwarded the survey to the CEO's of the private institutions and CCST contacted the deans of the colleges of engineering for the University of California campuses and the Chancellor's office for the California State University system.

Two Digit CIP	Degree Area
11	Computer and Information Sciences
14	Engineering
26	Biology
27	Mathematics
40	Physical Sciences

Table 3.1 -- S&E CIP codes

4. QUANTITATIVE DATA

4.1 STATE OVERVIEW

Profile: California State University (CSU)

CSU is the largest component of the California baccalaureate educational system, and the majority of students enrolled in S&E in California are at a CSU school. However, it produces less than 39% of the state's S&E baccalaureates. According to the Master Plan for Higher Education,[1] CSU is required to accept the top one-third of graduating high school seniors.

Profile: University of California (UC)

UC is the largest producer of S&E baccalaureates in California, granting over 43% of these degrees. It has a strong national reputation, containing nine schools listed among the nations' top 100 research universities (Berkeley, Davis, Irvine, Los Angeles, Riverside, San Diego, San Francisco, Santa Barbara, and Santa Cruz). The Master Plan for Higher Education requires UC to accept the top 12.5% of graduating high school seniors.

Profile: Independent Institutions

California has 105 independent four-year colleges and universities accredited by the Western Association of Schools and Colleges (WASC). They produce approximately 18% of total S&E baccalaureates in the state. At least three of these schools (California Institute of Technology, Stanford University, and the University of Southern California) are counted among the nation's top research universities.

What are the trends?

4.11 S&E enrollment up somewhat

Enrollment trends in S&E disciplines have been generally positive in the 1990s, with the exception of engineering. The number of students who enrolled in California colleges and universities increased by approximately 14% from 1990 to 2000. From fall 1990 to 2000, the number of students enrolled in science and engineering disciplines at California's public universities rose by 17% (Figure 5.1).

Significance: The rise in enrollment has not led to a corresponding rise in degrees (see Figure 5.2). Some gains in S&E enrollments, particularly computer science, have been registered since 1997, are too recent to be reflected in degree data.

4.12 S&E degrees not keeping pace with overall rise in baccalaureates

The production of baccalaureate degrees in S&E in California increased at a slower rate overall than the general trend in degrees granted. Baccalaureate degrees awarded in all subjects at all California colleges and universities increased 14% between 1990 and 2000 while the science and engineering component of that increased only 12% (Figure 5.2).

Significance: Despite the fact that more of the best-paying jobs are in S&E, fewer students are opting for S&E disciplines. This indicates that they are either not capable of pursuing these disciplines due to poor math and science preparation in the K-12 system, or they are not adequately informed of the opportunities that careers in S&E can offer.

4.13 CSU, once the leader in S&E degrees, falls behind UC

In 1990, CSU produced the most S&E degrees (41%); however, by 2000 it was producing fewer S&E degrees (35%) than UC and saw a net decline in degrees despite an overall increase statewide. This change was due to stagnant CSU totals, which declined by nearly 5%, and steady growth at UC, which saw a 35% increase in the number of S&E degrees granted and

[1] Liaison Committee of the Regents of the University of California and the California State Board of Education. *A master plan for higher education in California, 1960-1975*. Assembly of the State of California [1960]

produced the most S&E baccalaureate degrees in 2000 (46% of the total). (Figure 5.3)

Significance: The fact that CSU enrollment and degree numbers are not only failing to keep up with the increases seen in other sectors but actually declining slightly from 1990 totals raises alarm signals.

4.14 Biology degrees up, at expense of other S&E disciplines

Nearly all of the increase in S&E degrees was concentrated in biology, which showed a 75% increase in the number of degrees awarded in 2000 versus 1990 (Figure 5.3). Computer science and the physical sciences experienced modest 12 and 13% increases respectively. Mathematics, and engineering had net decreases of 10 and 5% respectively between 1990 and 2000, although mathematics enrollment did increase in 2000.

Significance: The concentrated rise in biology degrees masks stagnant or negative growth trends in a number of key disciplines. This is a potentially serious distortion of the overall picture, which prevents the true urgency of the S&E decline from gaining as much attention as it deserves.

4.15 Percentage of S&E degrees earned by women is rising, but still a minority

Women earned 39% of S&E degrees in 2000, up from 31% in 1990 (Figure 5.5). Most of the increase in female S&E enrollment has been in life sciences (e.g. biology), which saw a 50% increase from 1990 to 2000, mostly at UC and the Independents. Non-life sciences S&E degrees earned by women at CSU have actually declined over the past decade.

Significance: The ratio of male to female graduates has improved over the last ten years. However, women are still seriously underrepresented in S&E, particularly when disciplines other than biology are considered. It is also important to note that this is true despite the fact that women make up more than half (55%) of high school graduates who completed the a-g[2] requirements.

4.16 The Latino population is rising significantly, but Latino degree recipients are not

Latinos comprise the state's most rapidly growing population segment, yet the percentage of degree recipients graduating in S&E disciplines changed from 6% to 10%, while the percentage of Latino students enrolled in these disciplines changed from 8% to 11.5%. The Latino percentage of the population in California was over 32% according to the 2000 census.

Significance: The K-16 system is failing to capture the Latino population adequately. If Latinos continue to be underrepresented in the baccalaureate system at these percentages, and continue to grow into the dominant demographic component of the state, the number of baccalaureates received will slip even further relative to the population as a whole.

4.2 INDIVIDUAL DISCIPLINES

What are the trends?

4.21 Engineering degrees decline sharply at CSU and the Independents…

Despite an overall rise in S&E enrollment of 12% from 1990 to 2000, CSU engineering degrees dropped by over 25% from in the same

[2] These are a specific series of classes considered a prerequisite for admission to the University of California and the California State University. They include history, English, math, laboratory science, foreign language, and college preparatory electives. A similar set of courses is required for admission to many private institutions, especially those that are highly selective.

period (Figure 5.6). A slight increase in new undergraduate enrollments was offset by a sharp drop in first-time freshmen applicants and undergraduate transfers. Engineering enrollment levels were actually 4,500 lower in 2000 than they were in 1990, a drop of 17% from the 1990 total of 25,426. The number of first-time freshmen enrolling in engineering dropped by 40% during this period of time, from over 20,000 to 12,000. The latter number however does represent an improvement over the lows recorded in 1995-1996 (when enrollment bottomed out at less than 8,000).

Although S&E degree totals at independent institutions fluctuated between 1990 and 2000, net S&E degrees in 2000 were down 17% from 1990 totals (Figure 5.7).

4.22 …but have increased at UC

S&E enrollment increased at UC at a more robust rate of 24% during this period, and engineering enrollment kept pace with the overall increase, making up 33% of the total in both 1990 and 2000. Beginning in 1997, there have been significant annual increases in applications, resulting in a slightly lower acceptance rate. The number of UC engineering degrees increased by over 8.6% from 1990 to 2000.

> **Significance**: In spite of the fact that both CSU and the Independent sector boast individually well-respected engineering programs which have seen gains in enrollment (e.g. Cal Poly San Luis Obispo and Stanford University), the net totals for both systems decreased from 1990-2000. The sustained decline at the CSU is more concerning than the fluctuating totals at the Independents.

4.23 At CSU, computer science enrollment up by 85%, but degrees decline

The proportion of computer science enrollees relative to overall enrollment jumped from 11,300 to over 20,000, comprising most of the rise in S&E enrollment from 1990 to 2000 at CSU. Enrollment first increased significantly in 1996 and has been rising annually. UC and the Independents both saw substantial rises of computer science baccalaureates by 2000, but this raised the statewide total by only 26%

> **Significance:** This rise in enrollment has been fueled by the information technology and telecommunications boom of the late 1990s. However as noted above, there has not yet been a corresponding rise in the number of degrees received at CSU. This is of concern because UC and the Independent institutions both saw significant increases by 2000. Possible reasons contributing to the absence of a corresponding increase at CSU could include the higher S&E attrition rate at CSU overall and longer average time to degree at CSU (since the enrollment increase dates only to 1996/1997, this would mean that CSU might begin seeing corresponding increases in degrees by 2001 or 2002).

4.24 Mathematics and physical science enrollment stagnant or declining

Physical science enrollment at CSU dropped by over 20%, and mathematics enrollment declined by nearly 3%, from 1990 to 2000. Combined, these two disciplines make up only 11% of total 2000 S&E enrollment, down from 15% in 1990. UC saw less dramatic declines, but physical science still dropped by 2% and mathematics by 11%.

In addition, a cohort study of first-time freshmen at CSU starting in 1994 indicates that, at CSU at least, retention of mathematics and physical science students is relatively poor compared to other disciplines; after six years, only a quarter of the original mathematics and physical science students who graduated actually received degrees in their original majors. Of those graduates who originally majored in mathematics, 60% took a non-science degree altogether.

> **Significance:** These disciplines are likely less popular because they do not translate as readily into the high-paying

S&E career opportunities which other disciplines offer.

4.25 All S&E disciplines suffer significant attrition at CSU

The 1994 cohort study indicates that of 5,262 entering freshmen who declare S&E majors, less than 25% receive a related degree within six years. Some (8%) are still pursuing related degrees after six years, but nearly half of this cohort (2,565) had left the CSU system altogether.

The graduation percentages obtained from CPEC are somewhat better, but still show attrition rates of 40% to 60% depending on the discipline.

Significance: This is a major attrition rate which suggests that entering freshmen are not adequately prepared to pursue a baccalaureate degree. The cohort study loss of nearly 50% (75% within original S&E major) is significantly higher than the national undergraduate six-year attrition rate of 22% reported by the National Science Foundation, and merits serious attention.

4.4. BREAKDOWN BY GENDER

What are the trends?

4.31 UC has highest ratio of female graduates in S&E overall…

Women earned over 42% of S&E degrees at UC in 2000, up from 36% in 1990. UC has consistently granted the highest percentage of S&E degrees to women. However most of the increase in female S&E enrollment has been in life sciences (e.g. biology).

4.32 …while CSU trails

Female degree recipients earned 34% of CSU's S&E baccalaureates in 2000, up from 28% in 1990. However, this increase was almost entirely due to a rise in biology. Although biology degrees earned by women rose by 71% at CSU from 1990-2000, S&E degrees actually declined over the past decade in computer science (down 16%) and engineering (down 14%; Figure 5.17), and were virtually flat in mathematics and physical science. If biology is excluded from the total, the number of female S&E degree recipients at CSU actually dropped by 9% from 1990 to 2000.

4.33 The percentage of female degree recipients rose most sharply at the Independents

By 2000, the percentage of S&E degrees granted to women at the Independents was close behind that of UC, at 40%. This represents a 43% increase over the 1990 degree total and is the single largest improvement registered.

Significance: Although more women are enrolling in S&E disciplines, they are still outnumbered by male students by a factor of almost two to one. The fact that female engineering enrollment has not declined nearly as much as male enrollment in the discipline is encouraging, but clearly more effort is necessary to bring female enrollment numbers into line with male enrollment numbers, particularly in the CSU system. The rise at the Independents is also encouraging, but the effect on overall numbers is limited due to the relatively small number of total S&E degrees granted by this sector (less than 20%).

4.34 Female degree recipients dominant in biology, trail in engineering

CSU, UC and the Independents all saw increases of over 70% in degrees awarded to women in biology between 1990-2000. This phenomenon had the greatest relative impact on overall female degree percentage at UC, because UC grants more than twice as many biology degrees as either CSU or the Independents. However, aside from biology, female enrollment and degree trends were stagnant, with the exception of a 40% spike in physical science degrees at UC (however the actual difference was less than 200 degrees).

Female engineering enrollees experienced a smaller decline (6%) than overall engineering enrollment (19%) from 1990-2000, and the total number of female engineering degree recipients remained approximately constant, resulting in a net relative increase of only 2%. Ratios at UC and CSU remained the same (19% and 15% respectively) in 1990 and 2000. The Independents saw a jump from 15% to 25% during this period, but this only represents a change of 50 degrees.

Significance: The sharp increase in female biology degree recipients masks a failure to bring more women into S&E overall. UC may have the best overall percentage of female S&E degree recipients, but it grants more degrees in biology to women than it does in engineering, physical science, computer science, and mathematics *combined.* The relatively small and unchanging numbers of female engineering baccalaureate recipients shows that virtually nothing has changed to improve female participation in this important field

4.5. BREAKDOWN BY ETHNICITY

What are the trends?

4.41 Latinos show large improvement in degrees received, but still trail population percentage

The number of Latino S&E degree recipients increased by 79% from 1990 to 2000, the second largest percentage increase of any ethnic group (after Filipinos). However, this increase is small relative to the original size of the Latino contingent, and the 2000 totals only comprise 10% of total S&E degrees. CSU saw larger percent increases in computer science (50%), physical science (55%) and biology (40%) than UC did (10%, 12% and 8%, respectively).

Significance: The overall number of Latinos in the system remains far too small; the large relative gains are offset by the small total number of degrees involved. The greater increases at CSU suggest that CSU is more accessible and/or effective in reaching out to this population than UC or the Independents.

4.42 Asians and Blacks also show increases, though mostly in biology

The number of Asians who have earned a S&E degree increased by 36% from 1990-2000; African-American degrees increased by 31%. However if biology is excluded from these numbers, the Asian improvement drops to only 5% and African-American to 15%.

The percentage of Asian S&E degree recipients overall (29%) is nearly triple the corresponding Asian percentage of the population. Blacks, on the other hand, comprise 6% of the population and only 3% of the S&E degrees.

Significance: Gains for Asians and Blacks are relatively modest when biology is excluded, which does not bode well for participation in the more critical fields of computer science and engineering. Black representation in S&E degrees is better than Latino representation, but still significantly lower than the population breakdown.

4.43 Blacks have best male/female ratio in overall S&E enrollment, especially at UC

African-Americans had the highest percentage of female S&E enrollment of any ethnic group at both CSU and UC in both 1990 and 2000. At CSU, where Blacks comprise close to 4% of total S&E enrollment, female enrollment was at 44% in 2000, up from 40% in 1990. At UC, where they comprise just over 2% of total enrollment, female enrollment hit 53% in 2000, up from 48% in 1990. These percentages are substantially better than the overall male/female S&E enrollment ratios at CSU and UC (34% and 39% respectively in 2000).

This trend is fairly consistent across disciplines; Black women have higher enrollment percentages than women of any other ethnic group in computer science,

biology, and mathematics at both UC and CSU, and they are near the top in engineering and physical sciences. Female Black enrollment is particularly high in biology, with 69% at CSU and 71% at UC.

Significance: The low overall percentage of African-Americans in the system and in S&E in particular prevents this trend from having more of an impact on the overall male/female ratio. The consistency of high female African-American participation in S&E is encouraging and bears further investigation. It is possible, however, that the higher proportion of Black women actually represents a higher rate of failure in bringing African-American males into the system.

	Population (Census 2000)	Graduates with a-g requirements (1999)	S&E Bachelor's degrees (2000)
Asian	10.80%	19%	29%
African-American	6.40%	5%	3%
Filipino		4%	4%
Latino	32.40%	20%	10%
Native American	0.50%	1%	1%
White American	46.70%	51%	39%
Other		0%	16%

Table 4.1 -- Population, graduates with a-g requirements, and S&E baccalaureates, by ethnicity, 2000

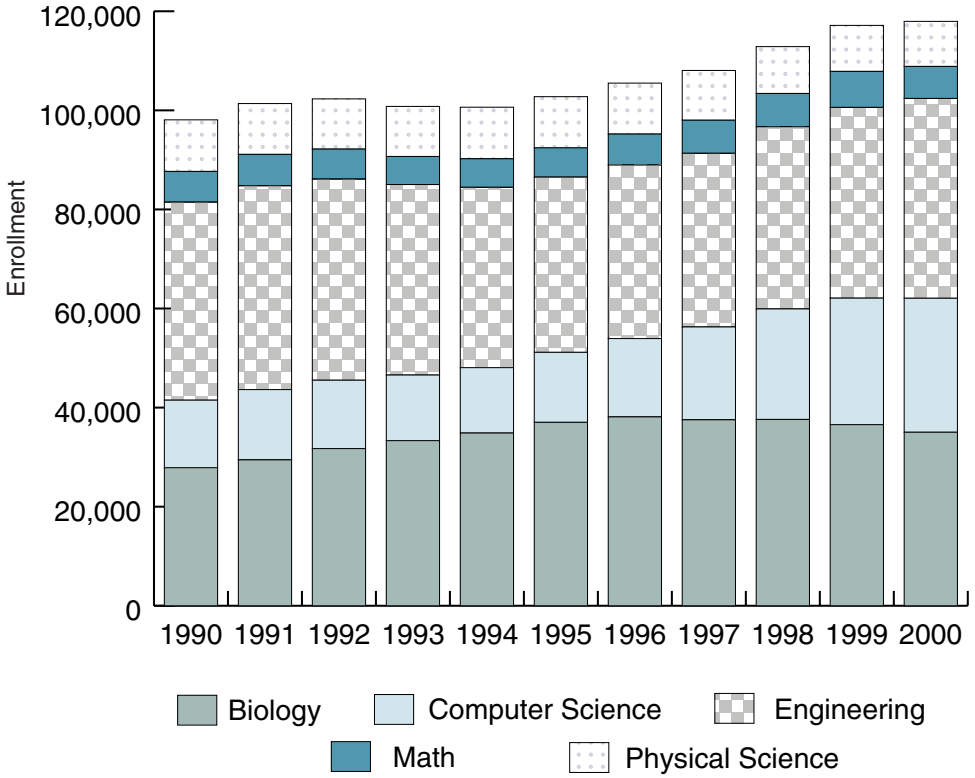

Figure 4.1 -- S&E Enrollment in UC and CSU, 1990-2000

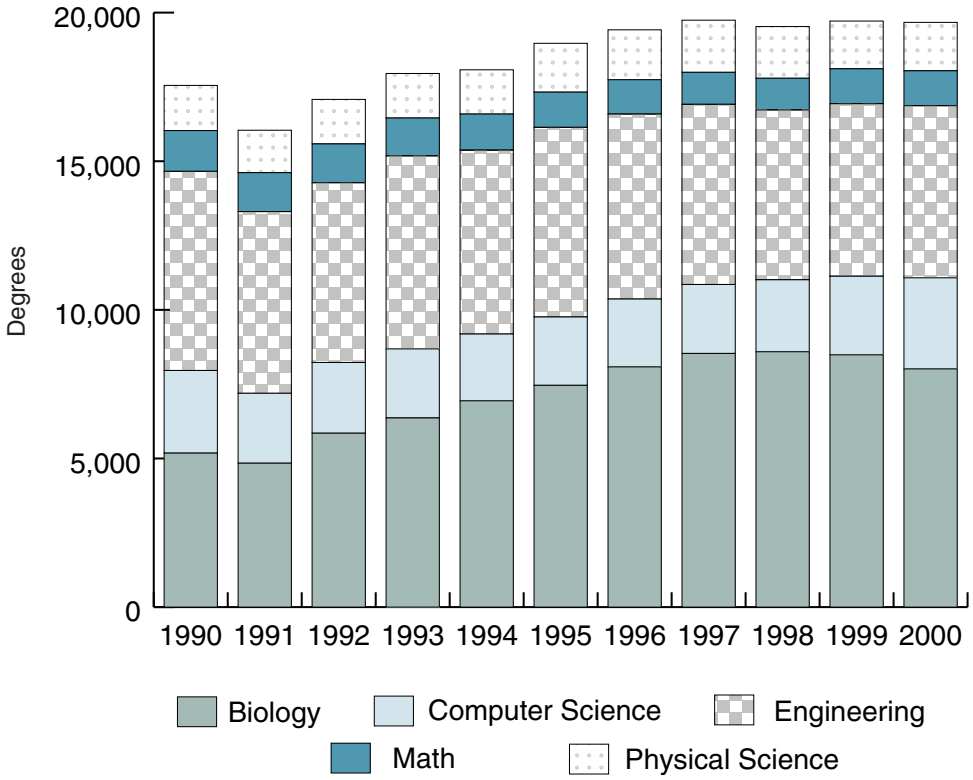

Figure 4.2 -- S&E Degrees, UC, CSU & Independents, 1990-2000

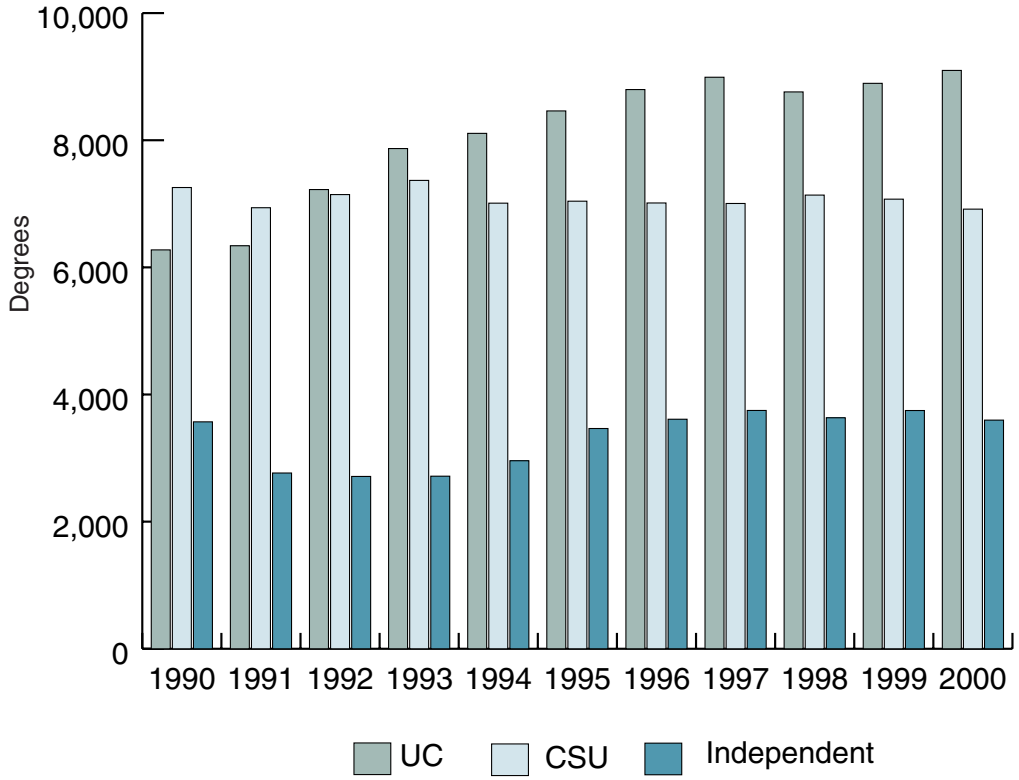

Figure 4.3 -- Degree Trends for CSU, UC and Independents, 1990-2000

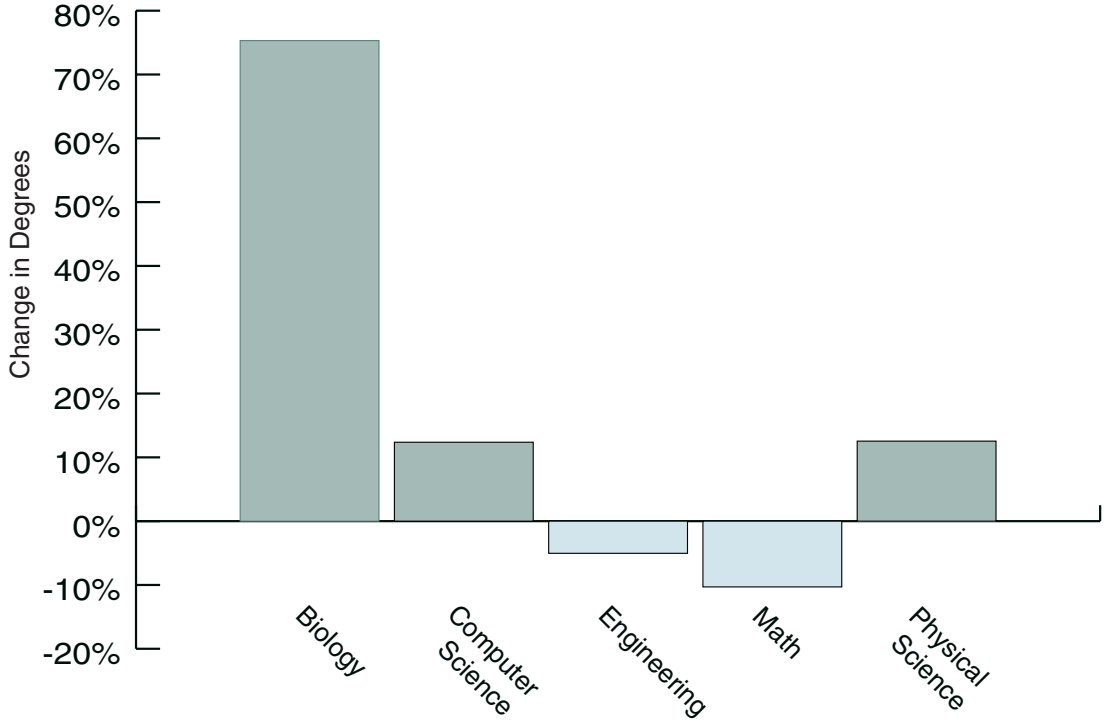

Figure 4.4 -- S&E Baccalaureate Degrees, UC, CSU & Independents, Percentage Change, 1990-2000

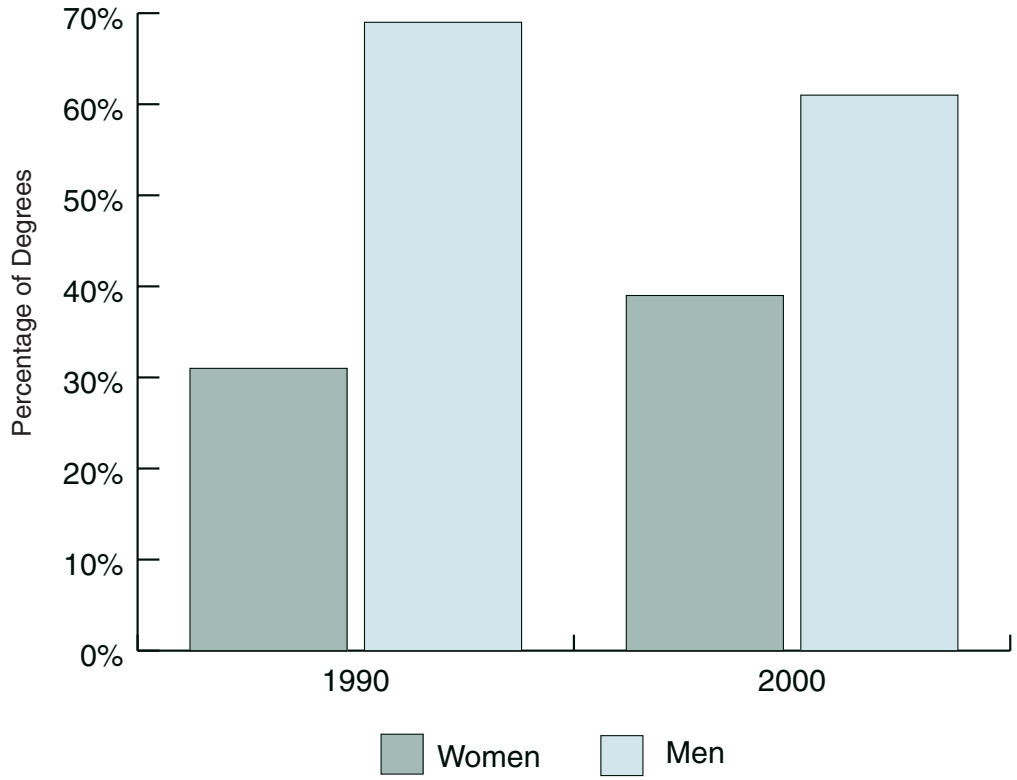

Figure 4.5 -- S&E Degrees by Gender, 1990 & 2000

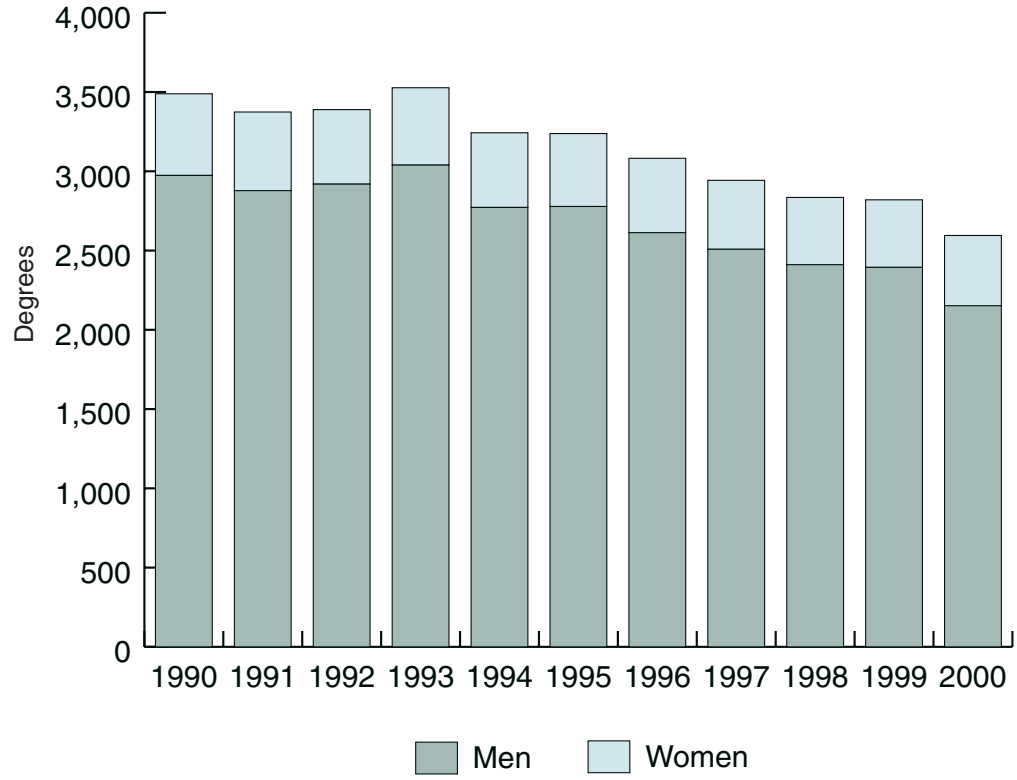

Figure 4.6 -- CSU Engineering Baccalaureate Degrees, 1990-2000

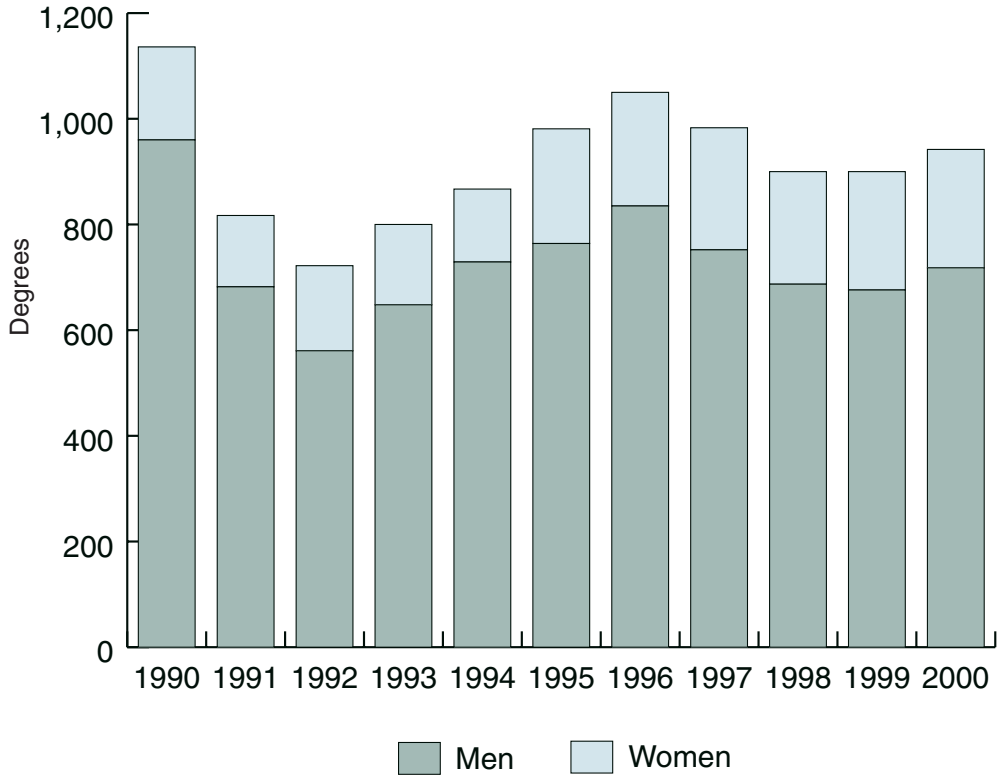

Figure 4.7 -- Independent Engineering Baccalaureate Degrees, 1990-2000

Figure 4.8 -- UC Engineering Baccalaureate Degrees, 1990-2000

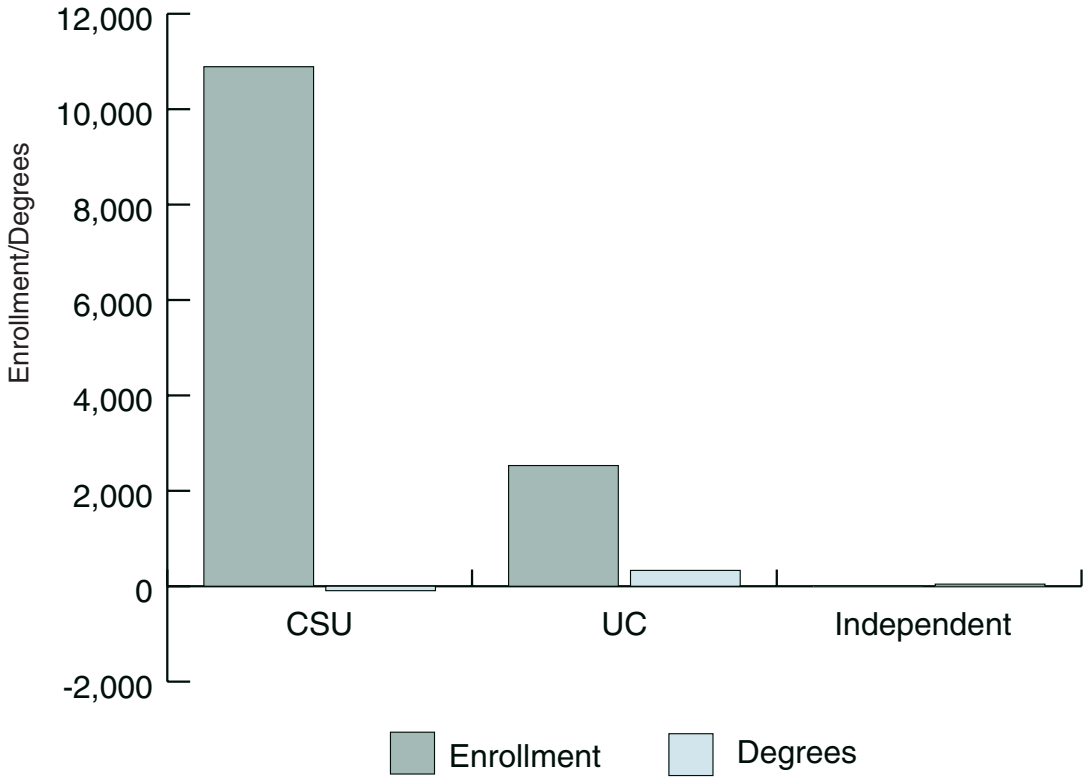

Figure 4.9 -- Computer Science Enrollment and Degrees, UC, CSU & Independents, Change, 1990-2000

Figure 4.10 -- CSU Mathematics Enrollment, 1990-2000

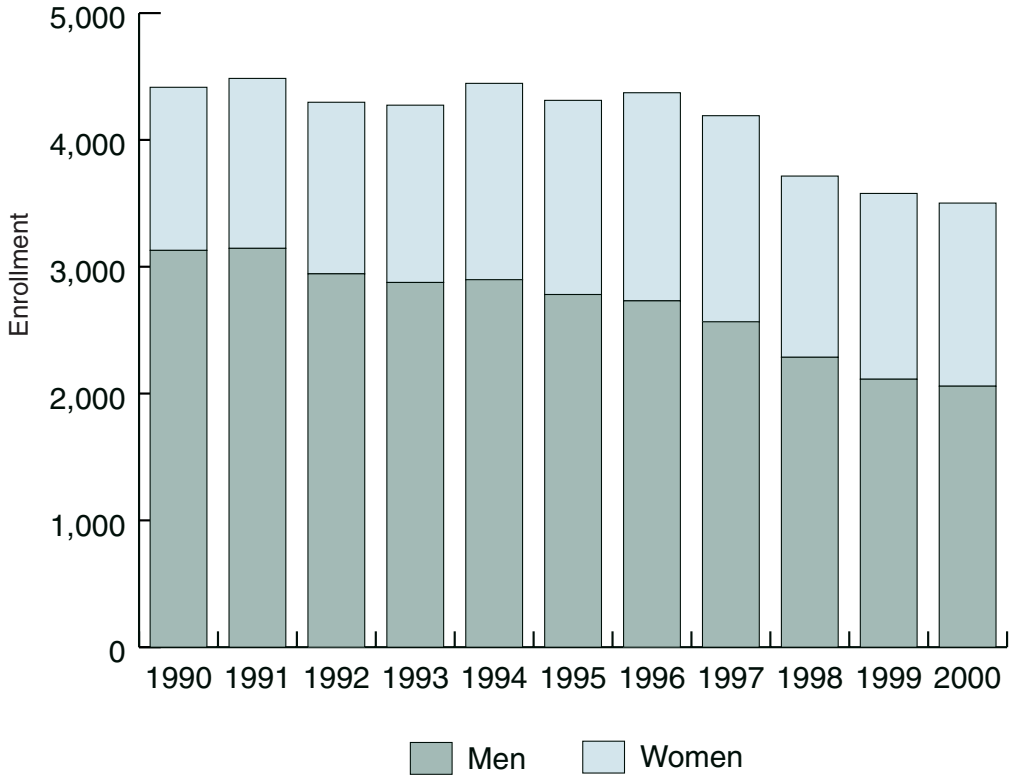

Figure 4.11 -- CSU Physical Science Enrollment, 1990-2000

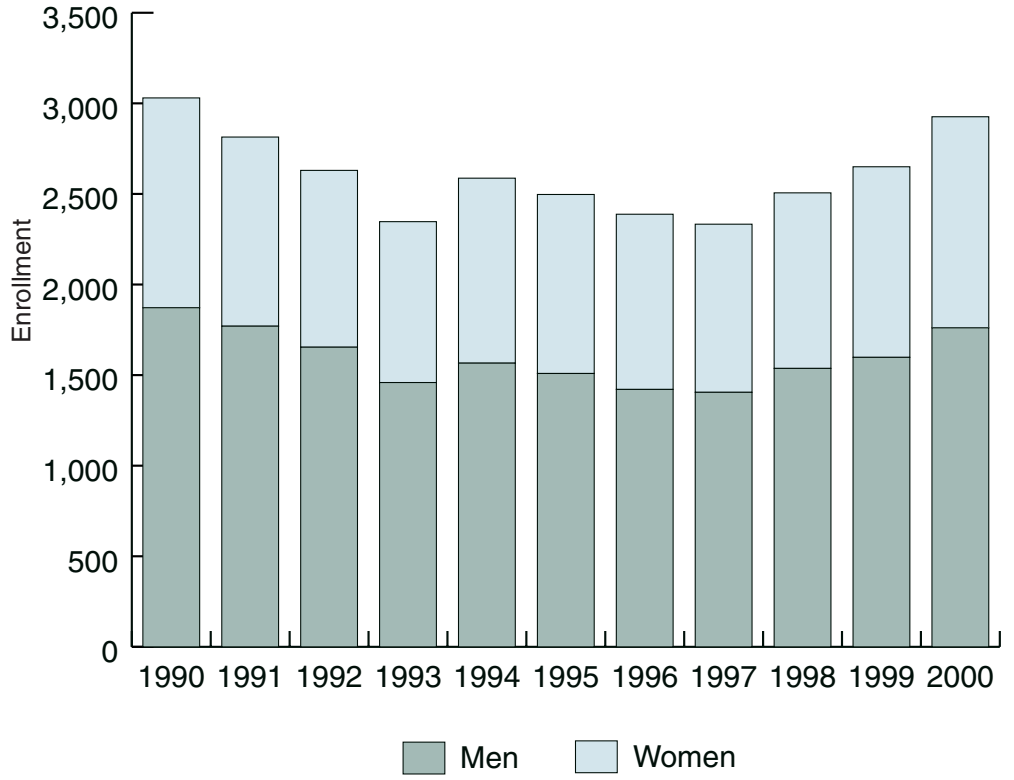

Figure 4.12 -- UC Mathematics Enrollment, 1990-2000

Figure 4.13 -- UC Physical Science Enrollment, 1990-2000

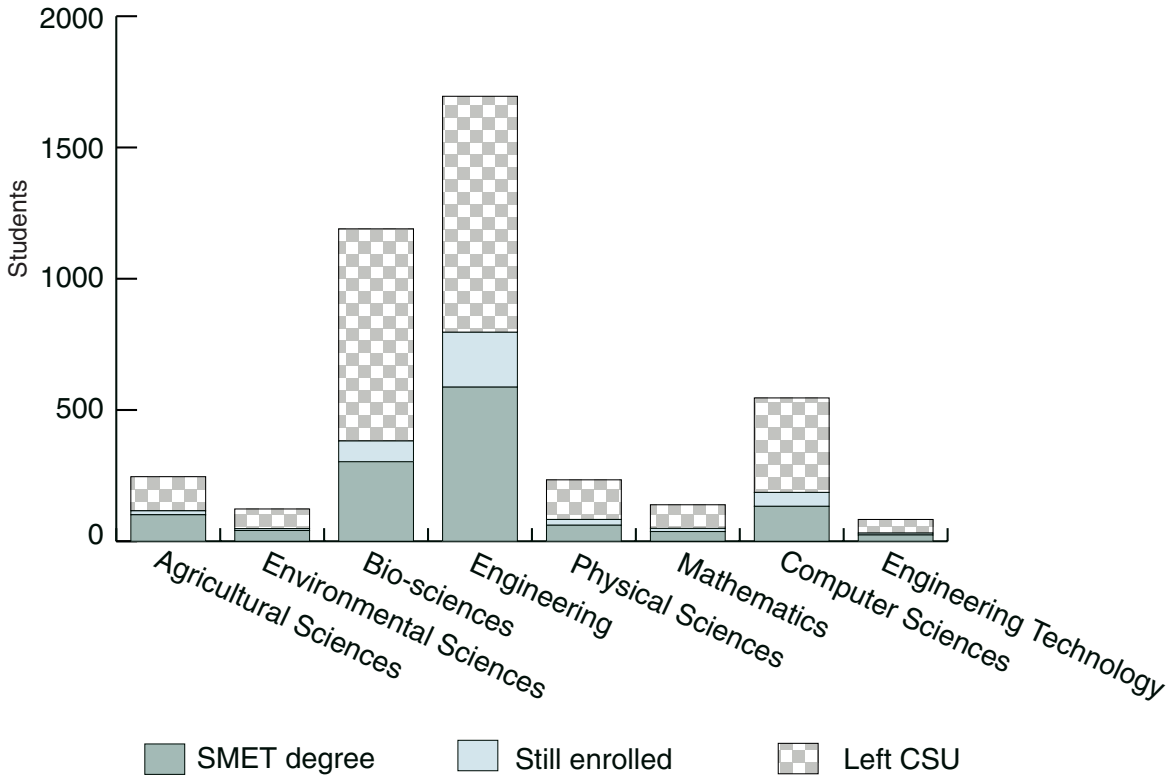

Figure 4.14 -- Summary of CSU 1994 Cohort Study

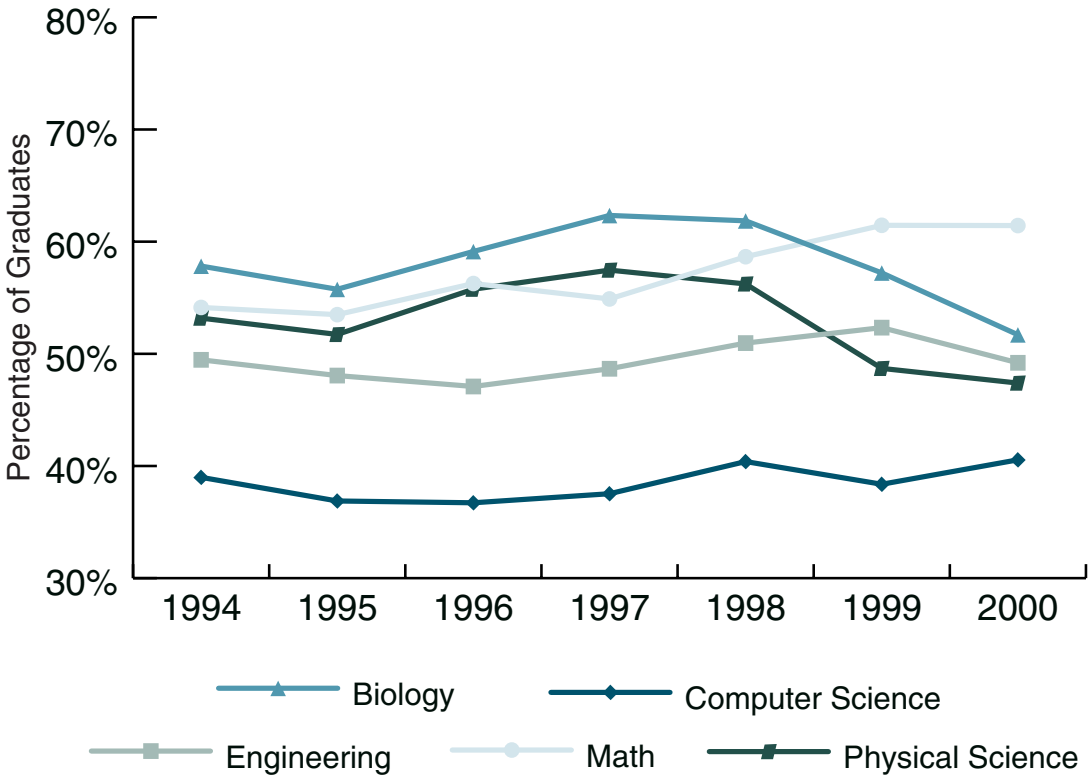

Figure 4.15 -- CSU Graduation Trends by Discipline, 1994-2000

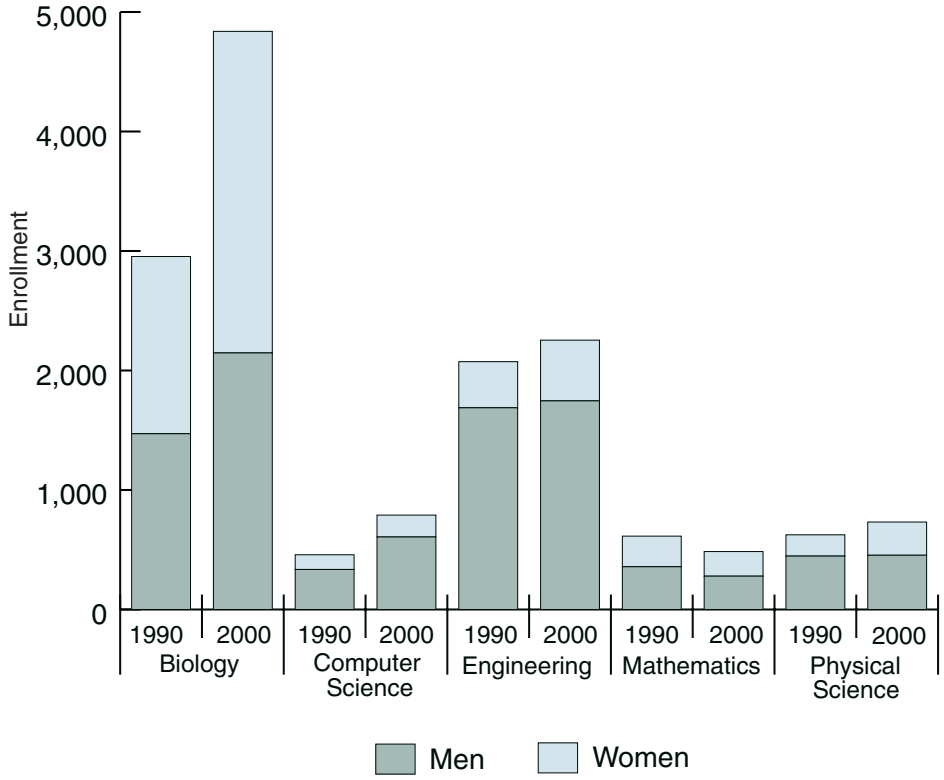

Figure 4.16 -- UC S&E Baccalaureate Degrees by Gender & Discipline, 1990-2000

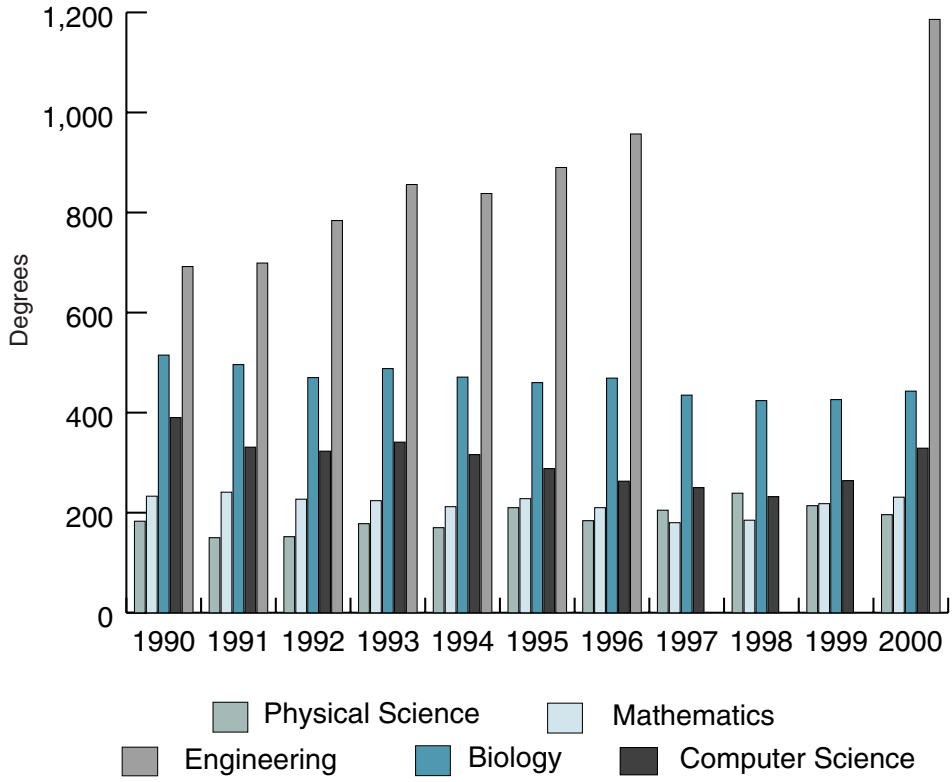

Figure 4.17 -- CSU female S&E Baccalaureate Degree Recipients, by Discipline, 1990-2000

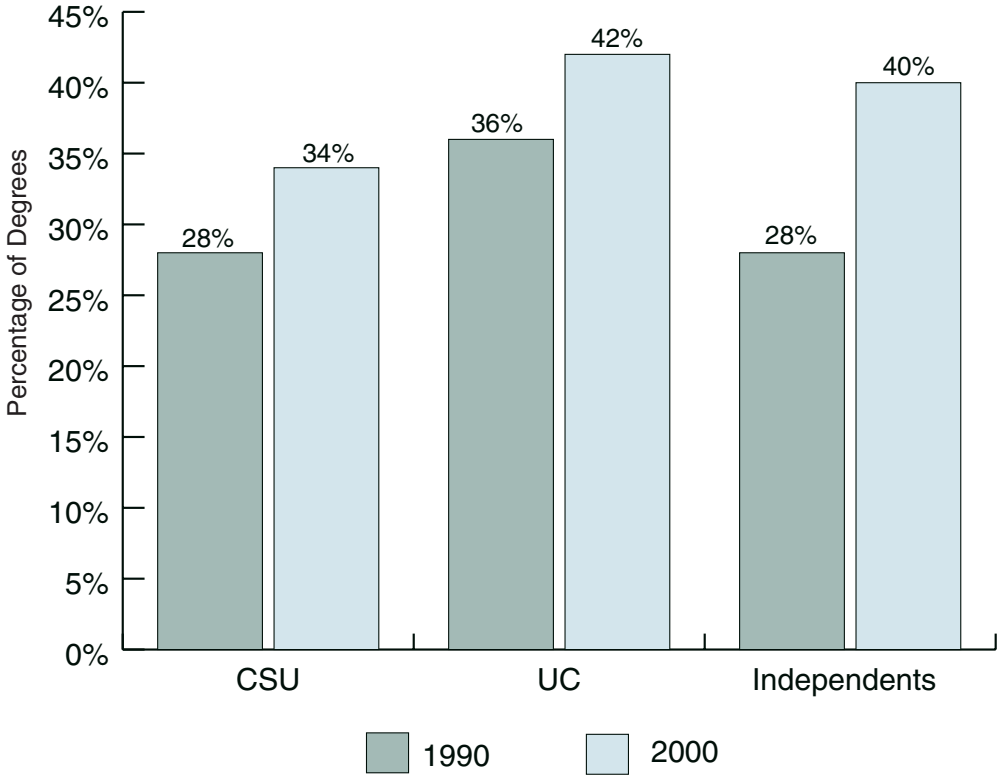

Figure 4.18 -- Percentage of Female S&E Baccalaureate Degrees, UC, CSU & Independents, 1990 & 2000

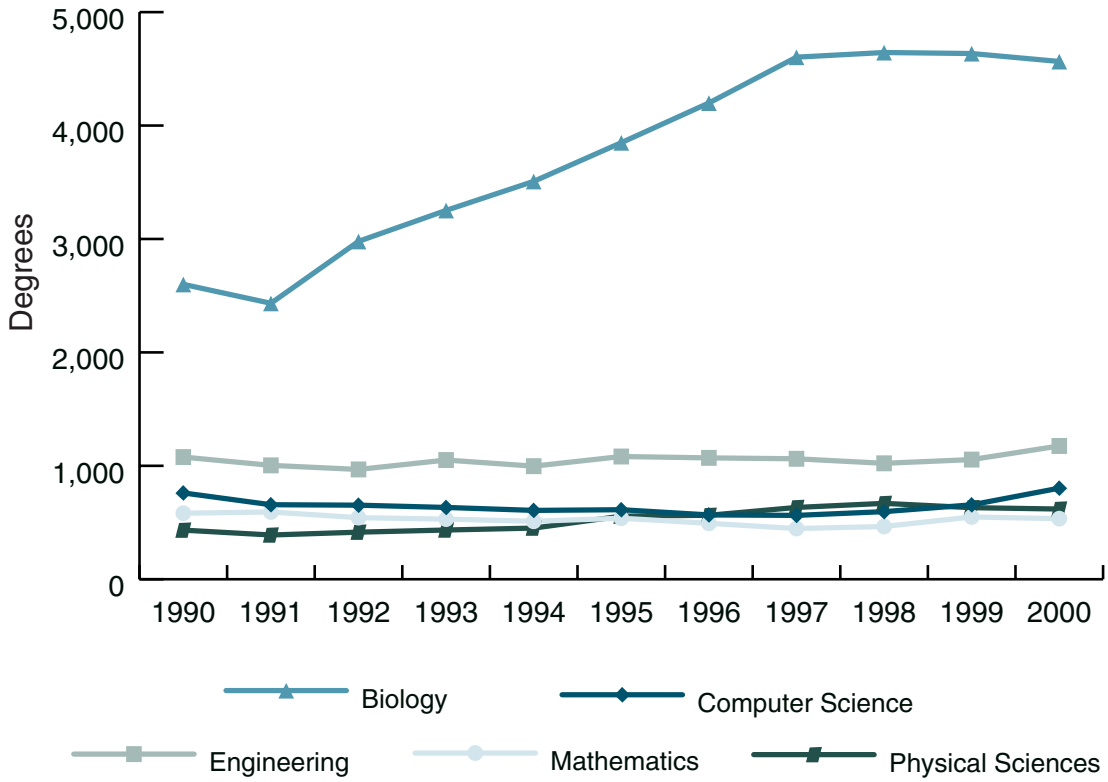

Figure 4.19 -- Female S&E Baccalaureate Degree Recipients, UC, CSU & Independents, by Discipline, 1990-2000

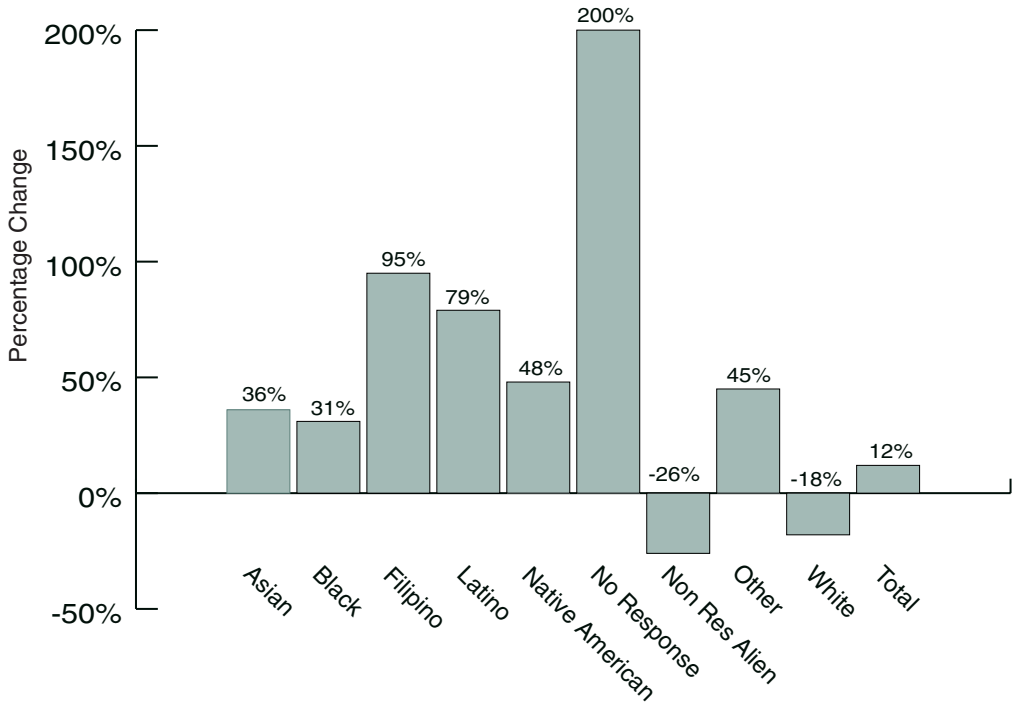

Figure 4.20 -- S&E Baccalaureate Degrees, UC, CSU & Independents, Percentage Change by Ethnicity, 1990-2000

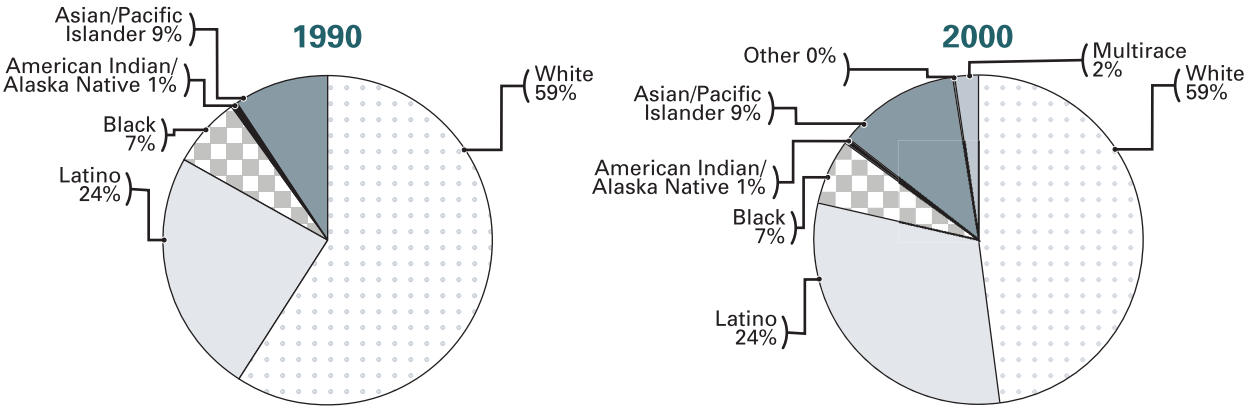

Figure 4.21 -- Ethnic Breakdown of California Population, 1990 & 2000

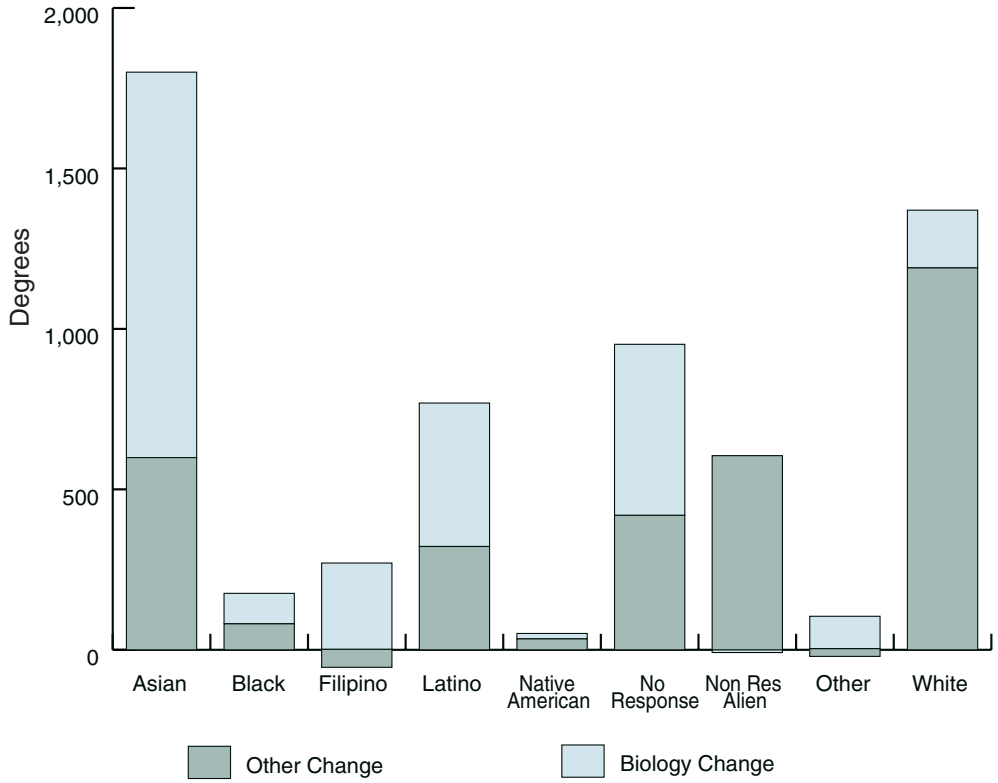

Figure 4.22 -- S&E Baccalaureate Degrees, UC, CSU & Independents, Change by Ethnicity, Biology vs. All Other S&E Disciplines, 1990 - 2000

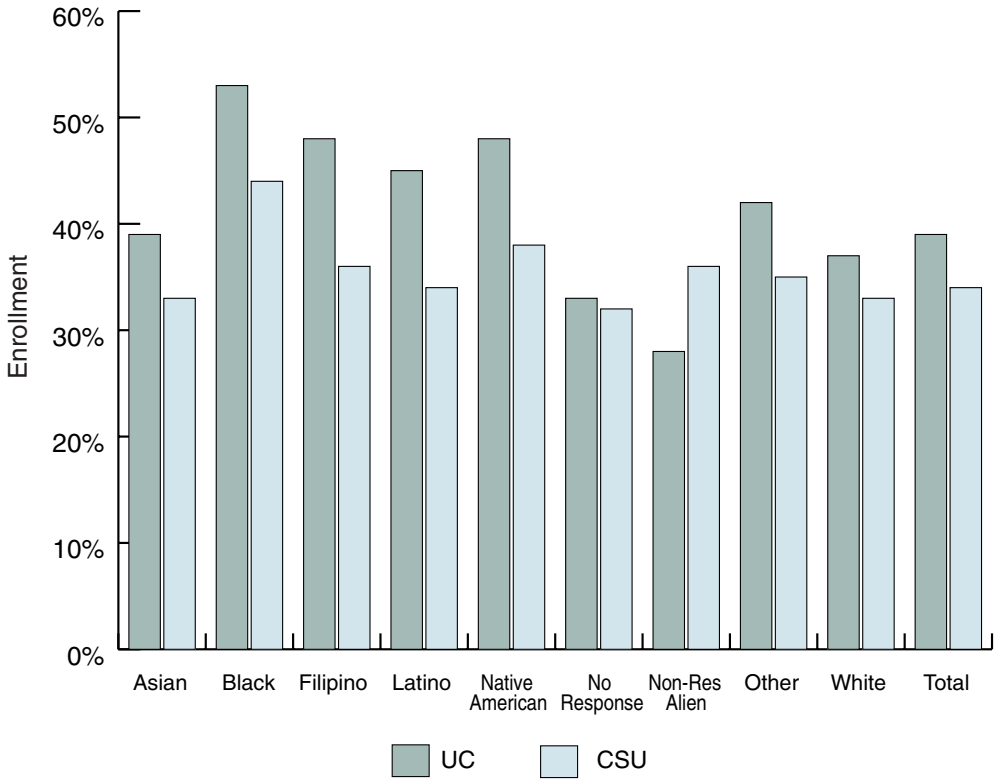

Figure 4.23 -- Female S&E Enrollment Percentages by Ethnicity, UC & CSU, 2000

5. QUALITATIVE DATA

It was hoped that the survey questions regarding enrollment trends, student retention, and potential impediments to student success would help explain the quantitative data examined in Section 4. While the responses we obtained do provide some insight, the overriding theme is that colleges simply don't know what happens to many students who leave the system. There is no universal tracking system that enables different systems (e.g. the California Community College System and the UC system) to monitor completely the student flow between one and the other. The survey instrument used is in Appendix A.

This section contains extracts from the survey results (the list of responding institutions is in Appendix F). Please note that, while we found the information gathered in this survey insightful, we recognize that the answers given are the opinions of the individual respondents and do not represent official statements from their respective institutions, the University of California or the California State University.

5.1 APPLICATION AND ENROLLMENT TRENDS

What are the trends?

5.11 More students apply to more schools

- The vast majority of students apply to several universities or colleges. Applicants are admitted to more than one institution and can then decide which of those to attend. (UC)
- Most "take rates" generally range between 20% and 30%. Campuses base their admit numbers on projected enrollment targets and on "take rates" based upon past experience. (UC)
- The increase in applications across the years reflects growth in applicants, as well as applicants applying to more than one institution. (CSU)
- With the increasing popularity of CSU Mentor and other ways of submitting college applications on-line, we anticipate heightened "multiple applications." (CSU)

5.12 Transfer students have large impact at CSU

- At CSU freshman enrollments are just slightly higher than junior enrollments, while sophomore enrollments are substantially lower. This reflects the fact that the CSU admits a large class of upper-division transfers, even in engineering and other science, mathematics, engineering and technology (SMET) majors. Enrollments notably burgeon at the senior level, reflecting the fact that SMET majors require more than 120 semester (180 quarter) units to complete the degree. (CSU)

5.2 RETENTION AND GRADUATION TRENDS

5.21 Graduation rate of those who enroll in S&E comparable to overall graduation rate, though they don't always earn S&E degrees

- In a nutshell, the systemwide analysis shows that students who entered the CSU in science, mathematics, engineering, and technology (SMET) are retained and graduate from the CSU (at the campus of entry within six years) at about the same rates as students who began as non-SMET.[3] (CSU)

[3] However, students often migrate out of SMET degree programs. The overall graduation rate of students entering as SMET majors is comparable to the overall CSU graduation rate (approximately 38%); however, as discussed in Section 5.25, only two-thirds of these students (25% of the entering total) actually earn a SMET degree.

5.22 A few S&E majors who change departments stay in a related field, but most don't

- Most engineering and computer science students who leave engineering do not change to science or mathematics majors. Probably the two most common new majors are undeclared or business/economics. (UC)
- Engineering "holds onto" the largest proportion of original engineering majors and those who change majors from engineering tend more than other SMET majors to stay in SMET majors.[4] (CSU)
- A principal factor discouraging and frustrating student transfer from one science and engineering program to another… is the uniqueness of the curriculum of the various engineering programs. (CSU)

5.23 Data on what happens to students who drop out or transfer is scarce

- Most campuses have no way of tracking students who leave to transfer to another institution. (UC)
- Since it is believed that the data… are suspect regarding the number of students leaving engineering programs that go on to achieve a degree in another major, no conclusions can be reached regarding the subsequent academic success of these students. (CSU)

5.3 IMPEDIMENTS TO STUDENT SUCCESS

5.31 Entry-level courses are an unintentional barrier for unprepared students

- The material covered in lower division courses serves one of two purposes. They either serve to provide breadth of engineering knowledge needed to interact with engineers in other disciplines, or as prerequisites to upper division courses in the major. Thus, a certain level of competence of the material covered in these classes is essential for continued success. (UC)
- None of the required lower division courses are used for "weeding out" students. The lower-division courses have no quota of passing grades to dole [out], and in fact, are routinely used to permit prospective students to demonstrate their potential in preparation for major change to an engineering major. (UC)
- It is hard to see how someone who fails academically could go on to be successful in a program such as engineering or computer science where the requirements are necessarily very specific in order to meet accreditation (and in some instances, licensing) standards.

  If a student fails academically, then what is the definition of "success"? (UC)
- From an examination of the data presented… it is quite apparent that lower division math and science courses are weeding out many students though this is generally not a conscious function of these courses. (CSU)

5.32 Campuses deem academic advising adequate, if underused

- Academic advising services are adequate for those students who seek advising and those who are required to do so (because they are on academic probation, are not following their curricula, etc.). There are always students who do not take advantage of the advising services available, and

[4] Nevertheless the total remains quite low -- in the cohort study, only 38% of engineering students earned a degree after six years, with 30% staying in SMET and the other 8% (a quarter of the graduating total) leaving SMET altogether.

there are always students who do not follow the advice given. (UC)

- Since [1993] CSU-Alliance for Minority Participation has compiled an impressive record with increases in both the percentage of underrepresented students served and the percentage attaining degrees. From 1993, minority enrollment in SMET fields increased 27%, and SMET degrees granted to minorities increased 84% above the established base figure. (CSU)
- Even with mandatory advising enforced by requiring students to visit with their advisor before becoming eligible for enrolling for the subsequent semesters, many students fail to visit their advisor. Many students state that they have the ability to advise themselves by using their catalog and conferring with their peers. (CSU)

5.33 Students free to change majors, get frustrated with S&E requirements

- Non [SMET] major students are encouraged to enroll in lower division major classes, so they can potentially qualify for the change of major. (UC)
- General education requirements present a substantial frustration to progress to degree. (UC)
- Curricula in science and engineering majors have rigorous requirements. Students in science and engineering programs must work these requirements into their schedules and have less leeway in choosing electives than students in many other majors. (UC)
- Students are frustrated by anything that they see as an impediment to their goal. (UC)

5.34 Limited availability of some courses poses an obstacle to some

- Class availability of science courses presents the first obstacle to students. (UC)
- The availability of classes is as much a function of curricular planning as it is of resources. Physical resources limit the capacity of the campus to respond to the increasing demand for larger lecture halls, as well as the number of laboratory sections that can be conducted in a week's time. (UC)
- Sequences such as physics are primarily taught once per year. Students that fall behind in physics or in calculus (a tight prerequisite to physics) will often be set back by a full academic year. (UC)
- Because of the infrequent offerings, students often rush their studies, take courses out-of-sequence, or avoid remedial courses. This pressures struggling students to press on in their academic program, often resulting in diminishing performance that makes it even more difficult for students to return to good standing and earn a degree. (UC)
- Low enrollment in an engineering discipline leads to some required courses being offered every second, third, or fourth semester thereby increasing the time to degree[…] To this extent class availability does deter progress to degree and causes attrition. (CSU)

APPENDIX A. SURVEY INSTRUMENT

ENGINEERING SURVEY

Critical Path Analysis of California's S&T Education System

March 14, 2001

In October 2000 CCST initiated a project to conduct a Critical Path Analysis for the production of a science and technology workforce by our schools, colleges and universities. The project will provide data on the trends in science and engineering education at the high school, associate, baccalaureate, masters, and doctoral level, taking into account population growth, demographics and changes in California's employment. For the first time, this study will bring together data from multiple sources and integrate them into a single model. Through this critical path model, policy makers will have insight into factors that influence and control inputs, outputs, and linking mechanisms throughout the state's education system. The William and Flora Hewlett Foundation is providing funding for the Critical Path Analysis project. The Semiconductor Industry Association and Hitachi are providing matching support.

From this project a more complete picture of California's education pathway will emerge. As with previous CCST projects, these data will be analyzed and synthesized into a set of policy recommendations and presented to the Governor. CCST will complete the project by June 2001.

The Critical Path Analysis Project was initially comprised of four sub-projects being conducted by six principal investigators. CCST has recently initiated a fifth project aimed at collecting primary data on the supply of undergraduate scientists and engineers. The five projects[5] and Principal Investigators (PIs) are --

Project 1 -- The Science and Technology Sector's Demand for Workers
Cecilia A. Conrad, Associate Professor of Economics, Pomona College
Project 2 -- A Critical Path Analysis of California's K-12 Sector
Julian Betts, Associate Professor of Economics, UCSD
Project 3 -- The Role of Universities and Colleges in California
Michael Darby, Professor of Money and Financial Markets, UCLA
Lynne Zucker, Professor of Sociology and Policy Studies, UCLA
Project 4 -- Alternative Paths to Competency -- Continuing Education And Lifelong Learning
Mary Walshok, Associate Vice Chancellor for Public Programs, UCSD
Carolyn Lee, Director of Research, UCSD CONNECT
Project 5 -- Issues Impacting Baccalaureate Degrees in Science and Engineering
CCST with assistance from UC, CSU, and AICCU

The fifth project of the Critical Path Analysis study will add important data that are not available from data sources the PI's are currently using for the first four projects. The fifth project looks at a range of issues specific to the state's universities and colleges and assesses

[5] NB -- at the time this survey was sent out in March 2001, the Critical Path Analysis consisted of only five projects in the order listed. A sixth project (*The Digital Divide*, edited by Roger Noll) was subsequently added and the order of the projects was modified.

their impact on the production of baccalaureate degrees in science and engineering. These issues include application and enrollment trends in science and engineering programs; rates of retention/graduation of science and engineering students; and impediments to student success and progress to receiving a degree. The three issues and the associated data needs are listed in the following sections.

CCST is requesting your assistance in gathering data for our "Project #5 -- Issues Impacting Baccalaureate Degrees in Science and Engineering." The following pages list the three issues and associated data needs. Please provide as much quantitative and qualitative data as you have and identify those areas for which there is no data currently available.

Project 5 -- Issues Impacting Baccalaureate Degrees in Science and Engineering

Undergraduate Engineering Program Data Needs

ISSUE #1 -- Application and enrollment trends in science and engineering programs

Background -- In addition to assessing the changes in applications and enrollments, there is a need to determine what happens to engineering program applicants who are not accommodated at the state's four-year institutions (e.g. UCB, UCLA, Cal Poly). Are they accommodated elsewhere in the state? Do they go out of state? Or do they abandon the goal of studying engineering disciplines?

Data Needs --

a. Application data

2. Number of applications for engineering programs for each of the last ten academic years.

(a) By all engineering programs
(b) By individual engineering programs
(c) By gender
(d) By ethnicity

a. Enrollment data

For the following seven questions please break out the data where possible --

- By all engineering programs
- By individual engineering programs
- By gender
- By ethnicity

2. Number of freshmen (first year) enrolled in engineering programs for each of the last ten academic years.
3. Number of sophomores (second year) enrolled in engineering programs for each of the last ten academic years.
4. Number of juniors (third year) enrolled in engineering programs for each of the last ten academic years.

5. Number of seniors (fourth year) enrolled in engineering programs for each of the last ten academic years.
5. Number of fifth year and higher undergraduate enrolled in engineering programs for each of the last ten academic years.
6. Average length of time to graduate with undergraduate engineering degree.
7. For how many of your enrolled freshman was your engineering program their --
   (a) First choice
   (b) Second choice
   (c) Third choice

a. Qualitative data

2. Provide any insights into the differences between application and enrollment numbers.

ISSUE #2 -- Rates of retention and graduation of science and engineering students

Background -- CSU System data suggest that rates of retention/graduation of science and engineering students do not deviate markedly from those of students in other programs. At the same time, many students appear to change major (based upon Cal Poly campus data) and this phenomenon warrants further study. Any data that would provide insights into where students go after they drop out of engineering or science programs would be of interest.

Data Needs --

For the following four questions please break out the data where possible --
- By all engineering programs
- By individual engineering programs
- By gender
- By ethnicity

a. How many students dropped out of engineering programs and enrolled in science programs and what science programs were they?

b. How many students dropped out of engineering programs and enrolled in a program other than engineering or science and what programs were they?

c. How many students dropped out of engineering programs and transferred to a community college?

d. How many students dropped out of engineering programs and transferred to another four-year university or college?

ISSUE #3 Impediments to student success and progress to degree

Background -- Present impediments to student success and progress need to be explored. Please provide your insights to as many of the following six questions as possible.

Data Needs --

a. To what extent are lower division engineering courses being used to perform a weeding out function that results in attrition of otherwise qualified and promising students?

b. Do we have evidence that those who fail academically might otherwise have gone on to be successful?

c. To what extent is out of class academic advising and support adequate in terms of the magnitude of the effort, its targeting of demonstrated need and its effectiveness in fostering student success?

d. To what extent do present policies discourage and frustrate student transfer from one science and engineering program to another or from non-science/engineering programs into a science and engineering program?

e. To what extent do present general education and science and engineering program curricular requirements frustrate student progress to degree?

f. To what extent does class availability deter progress to degree or cause attrition?

Again, thank you for your assistance and if you have any questions contact --

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chuck@ccst.ucr.edu

APPENDIX B. CIP CODES

11. Computer and Information Sciences
11.01 Computer and Information Sciences, General
11.02 Computer Programming
11.03 Data processing Technology
11.04 Information Sciences and Systems
11.05 Computer Systems Analysis
11.07 Computer Science
11.99 Computer and Information Sciences, Other

14. Engineering
14.01 Engineering, General
14.02 Aerospace, Aeronautical, & Astronautical Engineering
14.03 Agricultural Engineering
14.04 Architectural Engineering
14.05 Bioengineering and Biomedical Engineering
14.06 Ceramic Sciences and Engineering
14.07 Chemical Engineering
14.08 Civil Engineering
14.09 Computer Engineering
14.10 Electrical, Electronics, & Communications Engineering
14.11 Engineering Mechanics
14.12 Engineering Physics
14.13 Engineering Science
14.14 Environmental/Environmental Health Engineering
14.15 Geological Engineering
14.16 Geophysical Engineering
14.17 Industrial/Manufacturing Engineering
14.18 Materials Engineering
14.19 Mechanical Engineering
14.20 Metallurgical Engineering
14.21 Mining and Mineral Engineering
14.22 Naval Architecture and Marine Engineering
14.23 Nuclear Engineering
14.24 Ocean Engineering
14.25 Petroleum Engineering
14.27 Systems Engineering
14.28 Textile Sciences and Engineering
14.29 Engineering Design
14.30 Engineering/Industrial Management
14.31 Materials Science
14.32 Polymer/Plastics Engineering
14.99 Engineering, Other

26. Biology

27. Mathematics
27.01 Mathematics
27.03 Applied Mathematics
27.05 Mathematical Statistics
27.99 Mathematics, Other

40. Physical Sciences
40.01 Physical Sciences, General
40.02 Astronomy
40.03 Astrophysics
40.04 Atmospheric Sciences and Meteorology
40.05 Chemistry
40.06 Geological and Related Sciences
40.07 Miscellaneous Physical Sciences
40.08 Physics
40.99 Physical Sciences, Other

APPENDIX C. CPEC ENROLLMENT & DEGREE DATA, UNIVERSITY OF CALIFORNIA

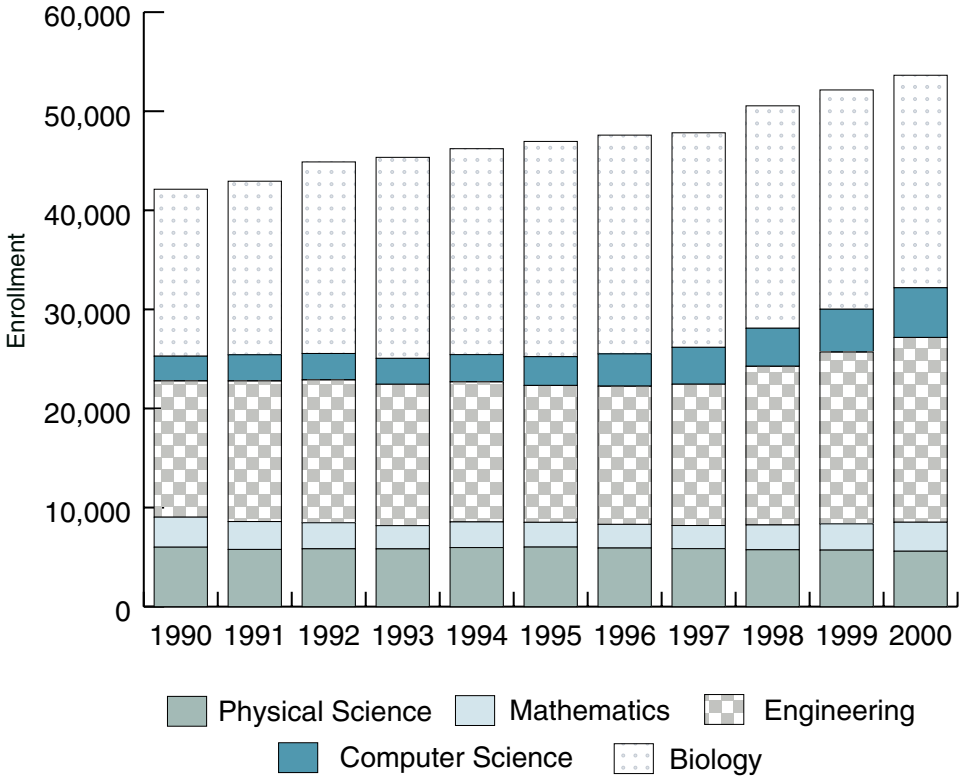

Figure C-1 -- UC S&E Enrollment, 1990-2000

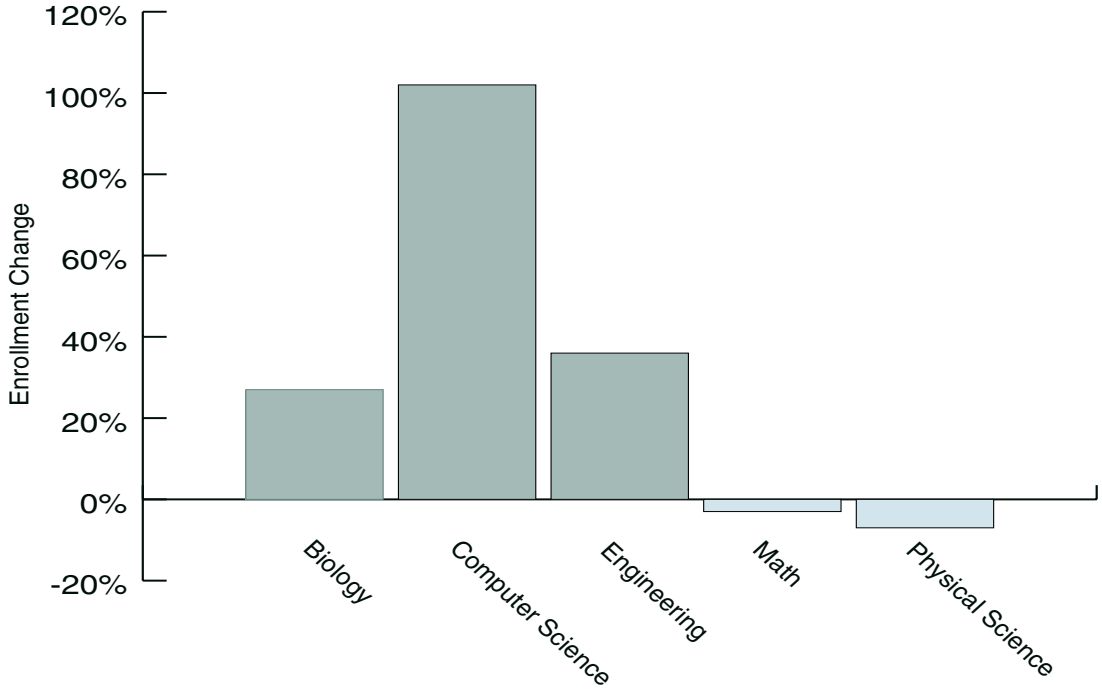

Figure C-2 -- UC Enrollment by Discipline, Percentage Change 1990-2000

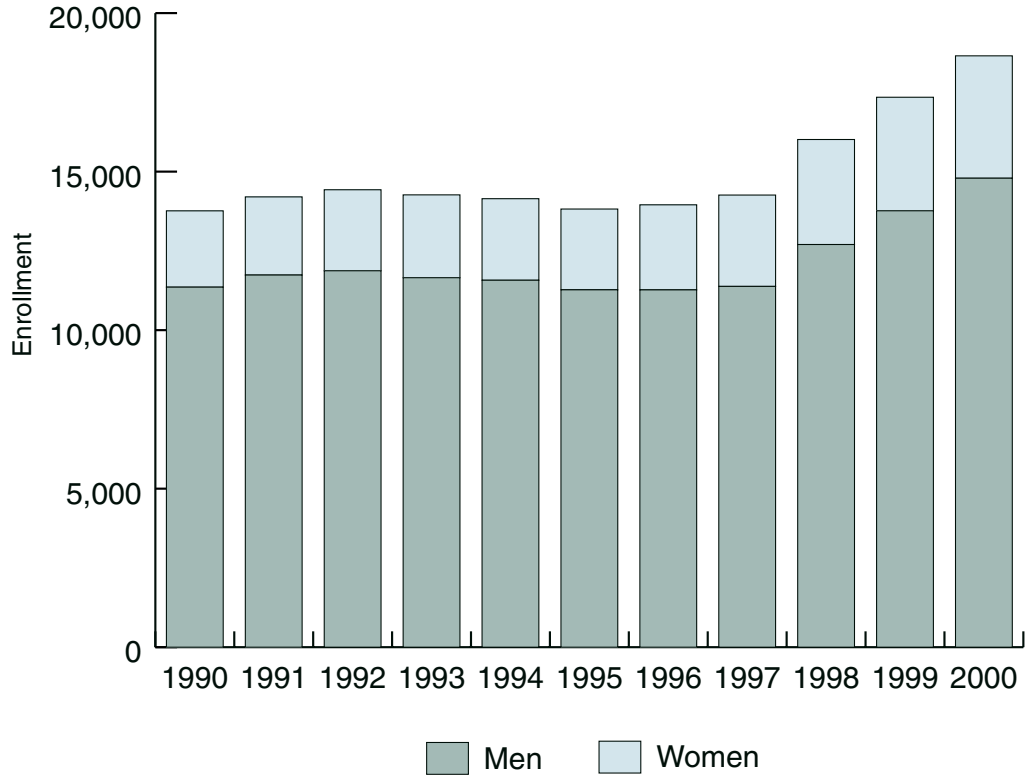

Figure C-3 -- UC Enrollment Trends by Year, Engineering, 1990-2000

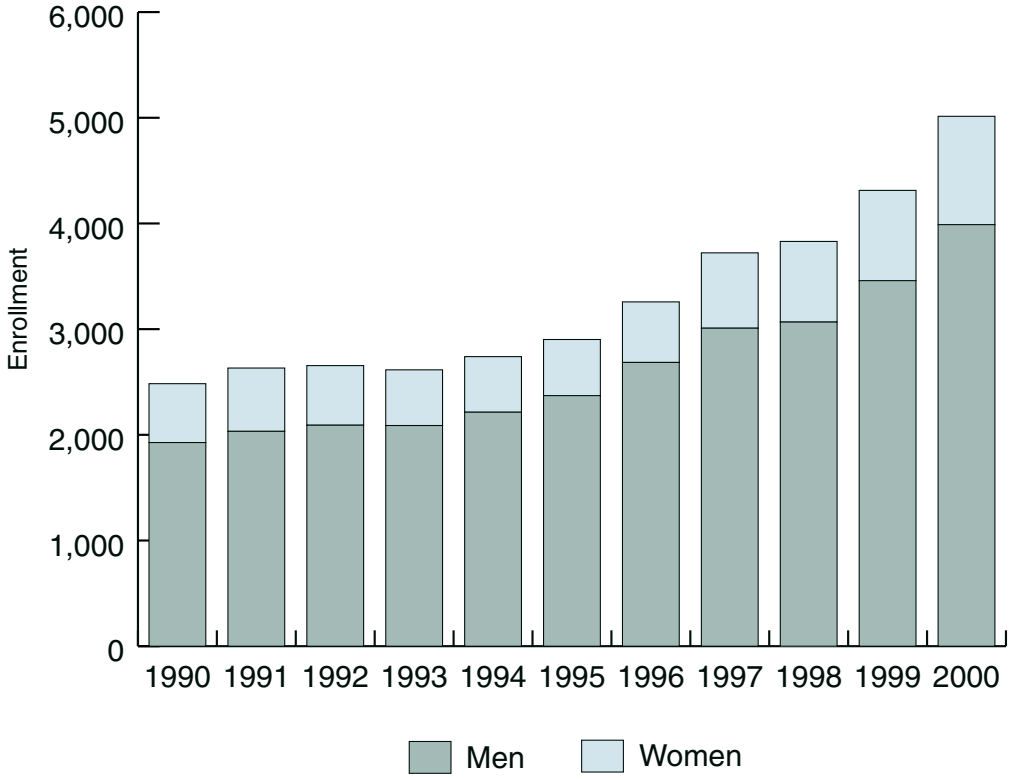

Figure C-4 -- UC Enrollment Erends by Year, Computer Science, 1990-2000

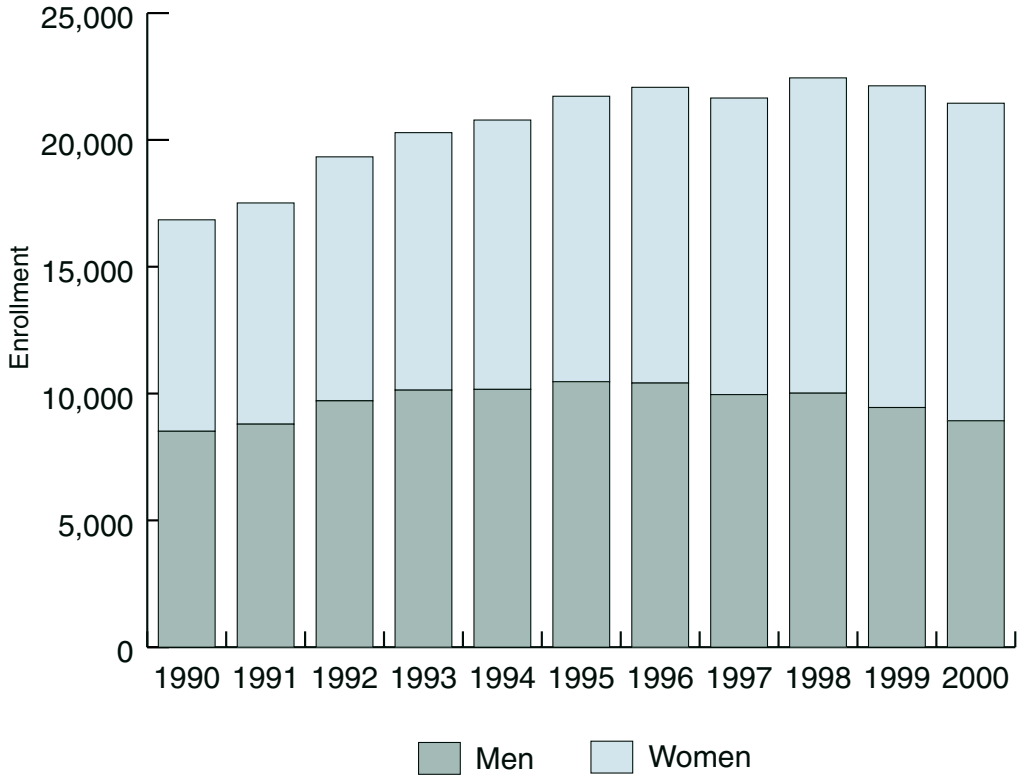

Figure C-5 -- UC Enrollment Trends by Year, Biology, 1990-2000

Figure C-6 -- UC Enrollment Trends by Year, Physical Science, 1990-2000

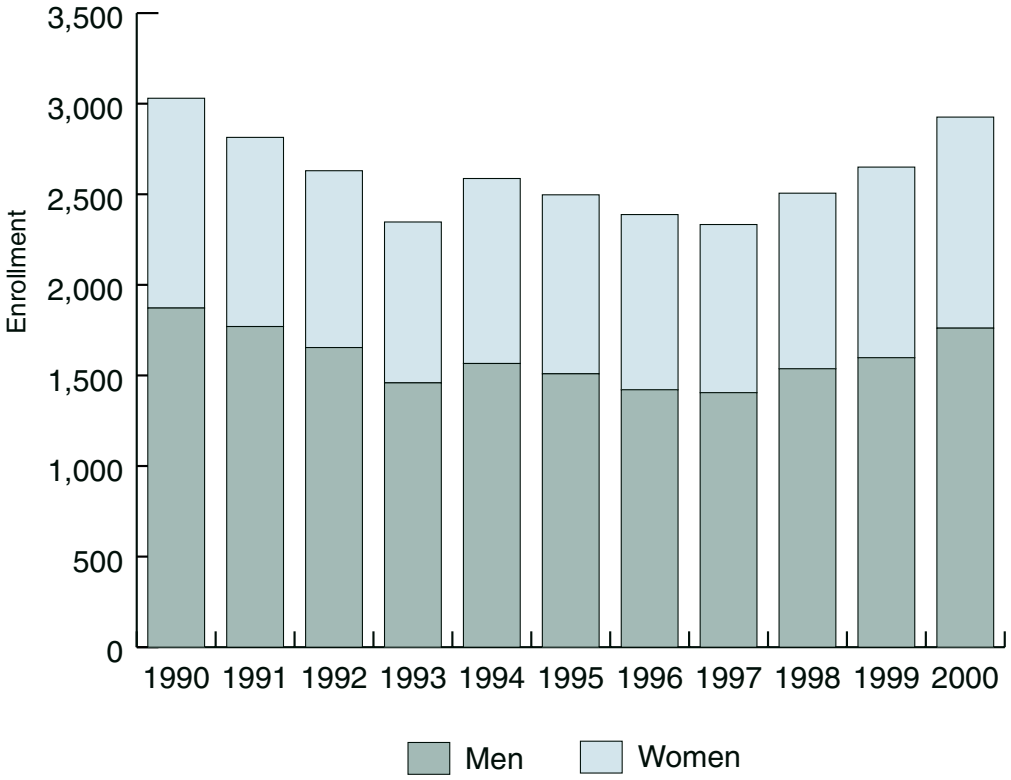

Figure C-7 -- UC Enrollment Trends by Year, Mathematics, 1990-2000

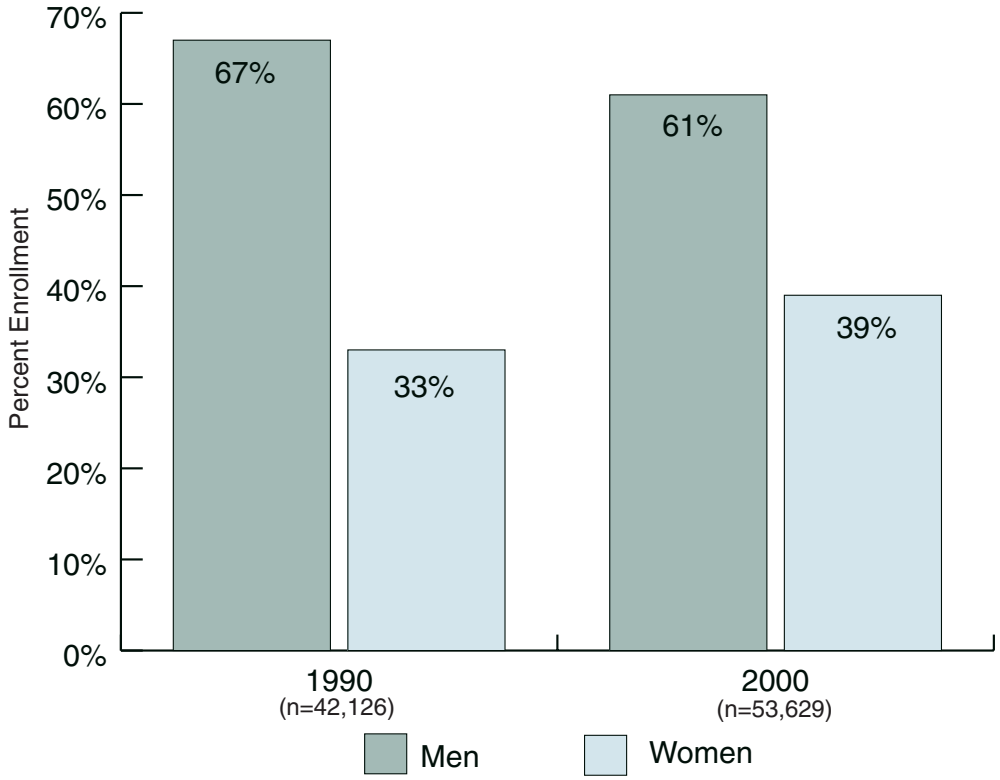

Figure C-8 -- UC S&E Enrollment by Gender, 1990 & 2000

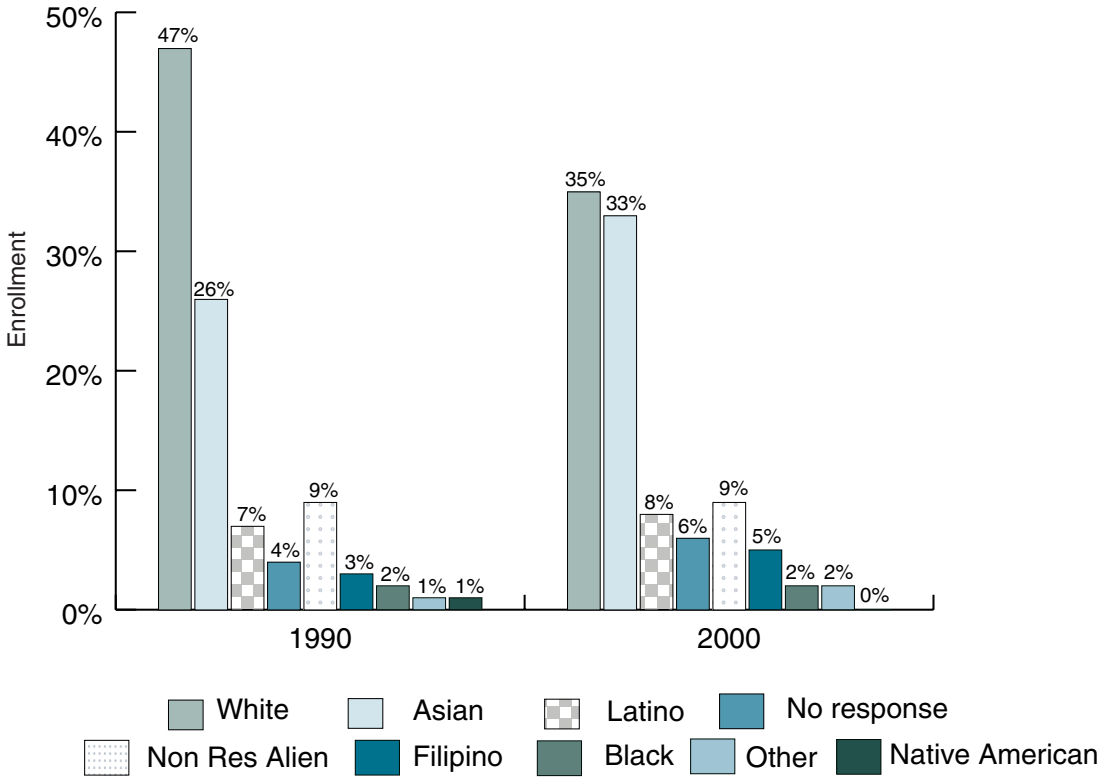

Figure C-9 -- UC S&E Enrollment by Ethnicity, 1990 & 2000

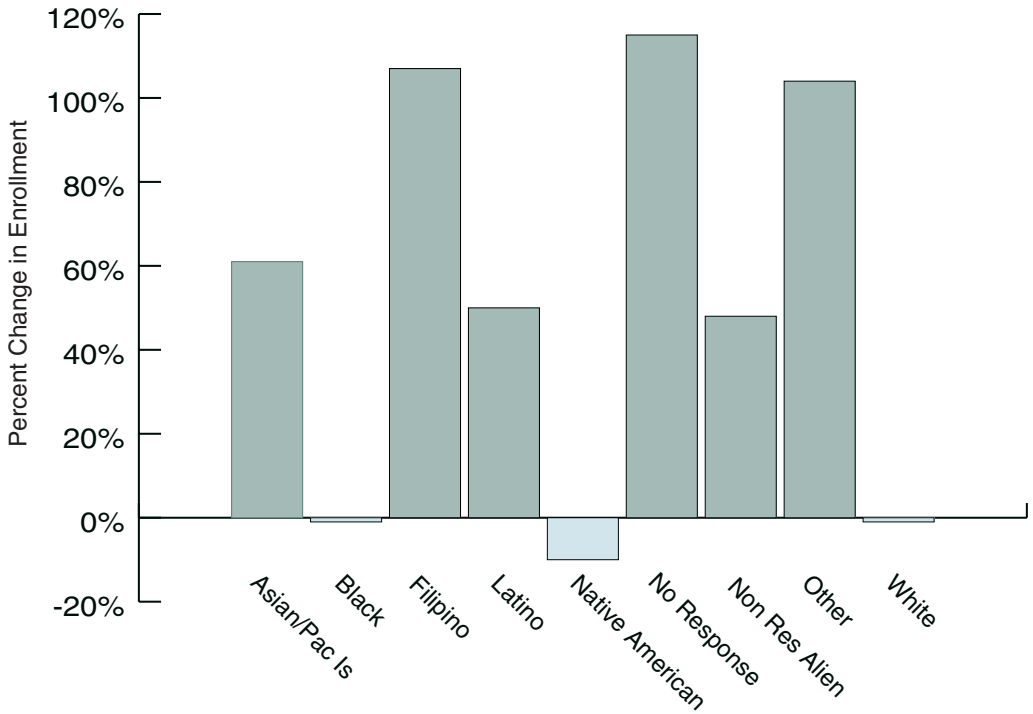

Figure C-10 -- UC Percentage Change S&E Baccalaureate Enrollment by Ethnicity, Engineering, 1990-2000

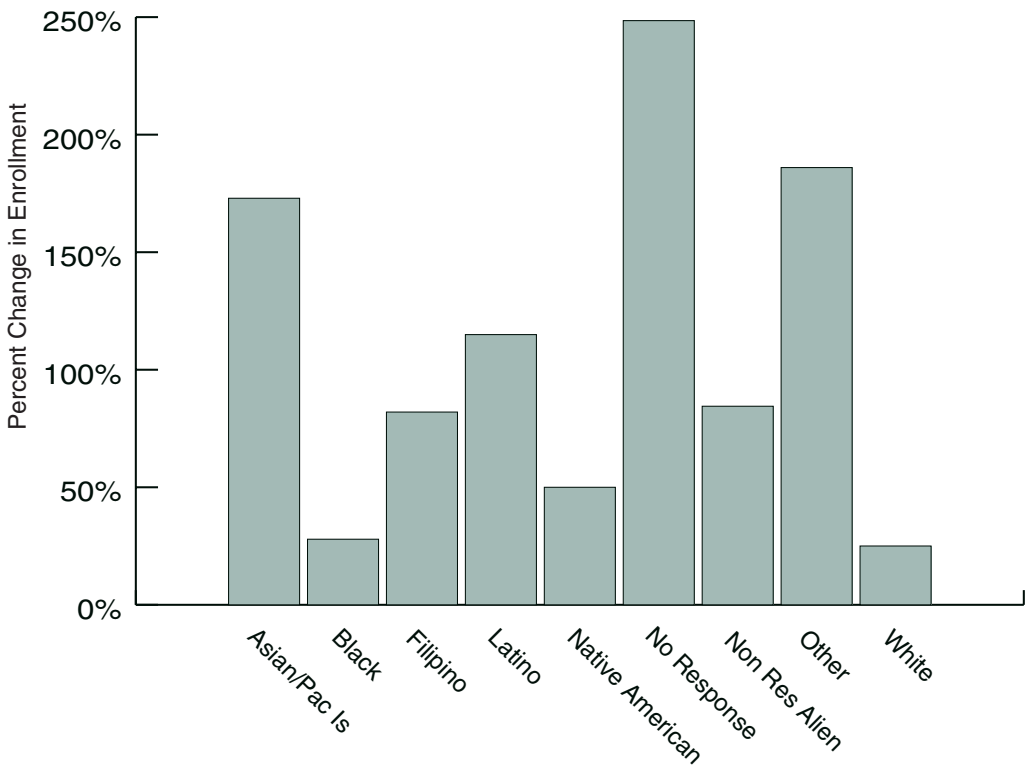

Figure C-11 -- UC Percentage Change S&E Baccalaureate Enrollment by Ethnicity, Computer Science, 1990-2000

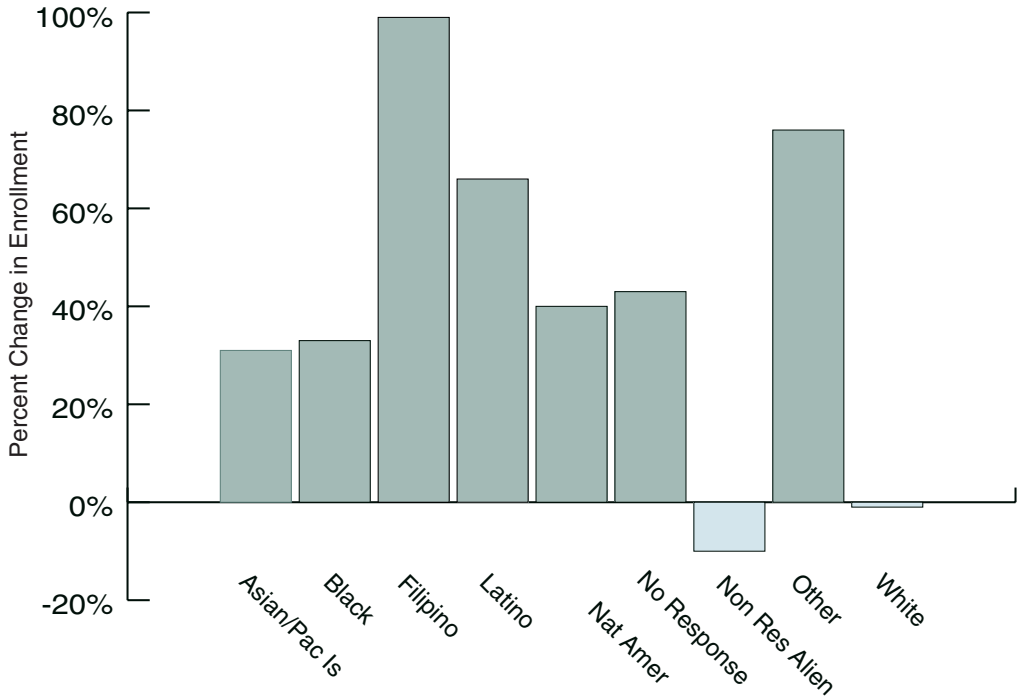

Figure C-12 -- UC Percentage Change S&E Baccalaureate Enrollment by Ethnicity, Biology, 1990-2000

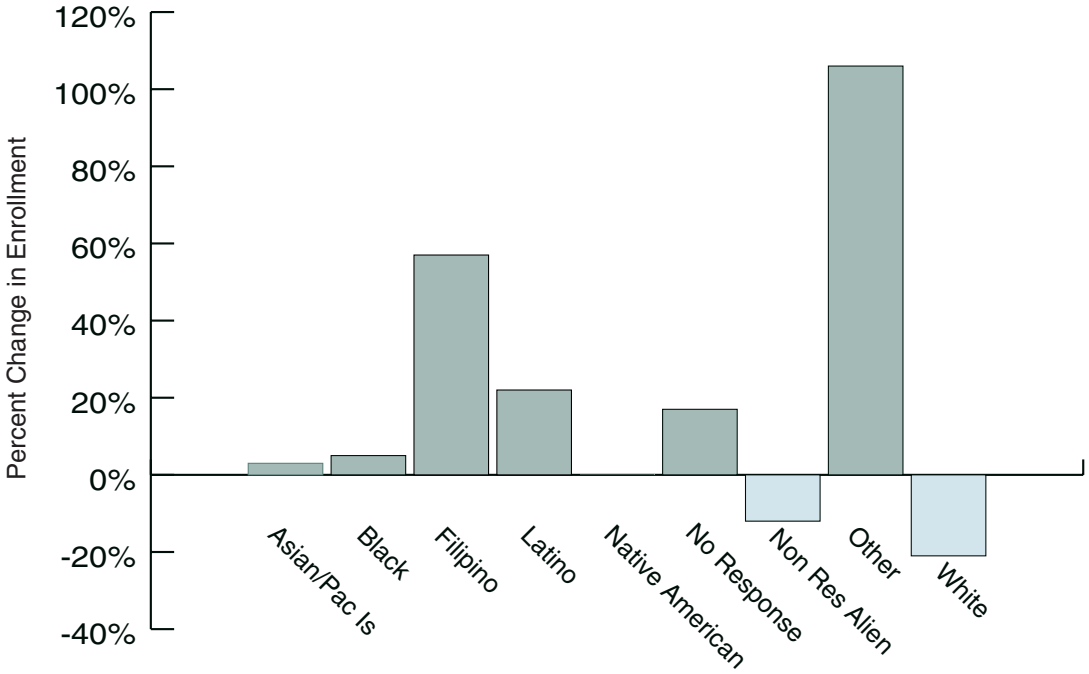

Figure C-13 -- UC Percentage Change S&E Baccalaureate Enrollment by Ethnicity, Physical Sciences, 1990-2000

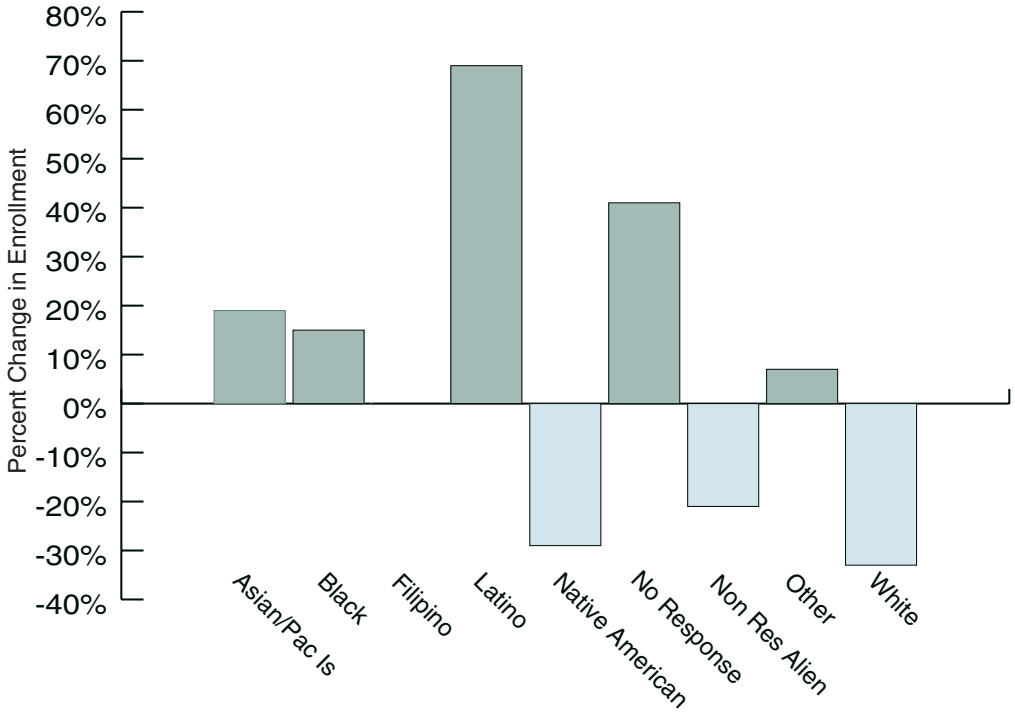

Figure C-14 -- UC Percentage Change S&E Baccalaureate Enrollment by Ethnicity, Mathematics, 1990-2000

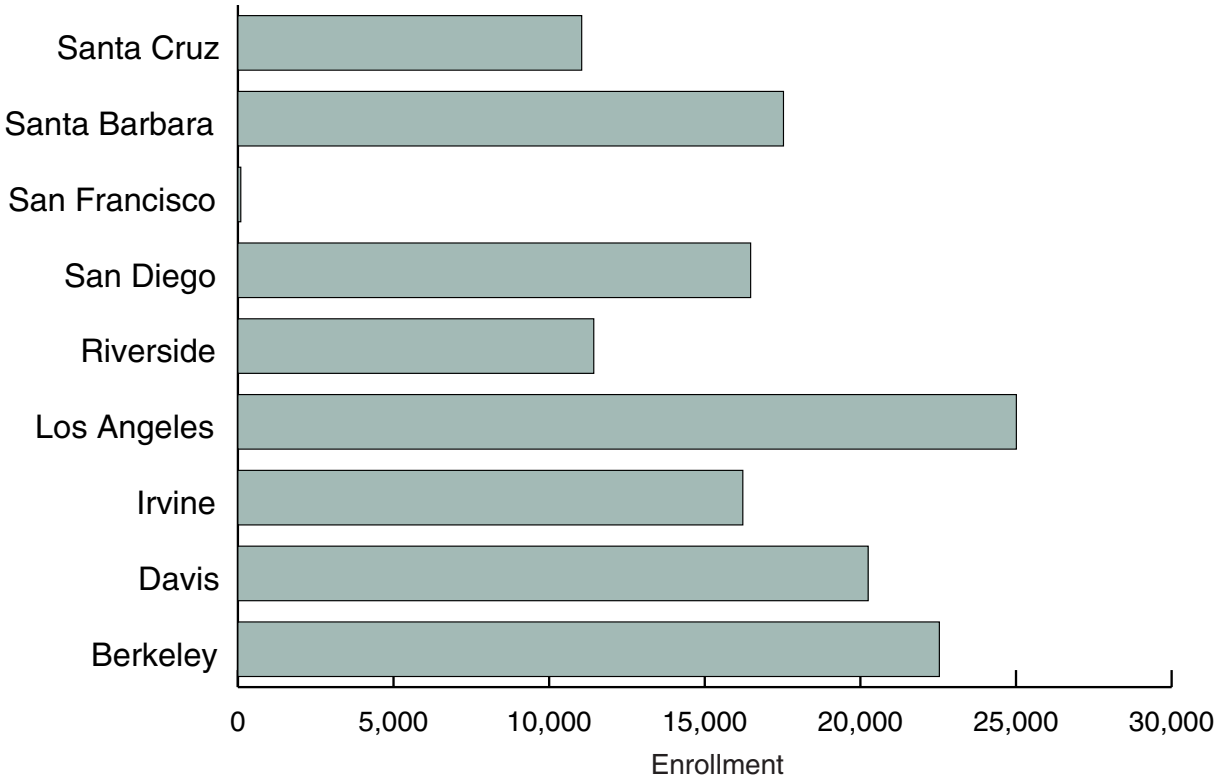

Figure C-15 -- UC Total Undergraduate Enrollment by Campus, 2000

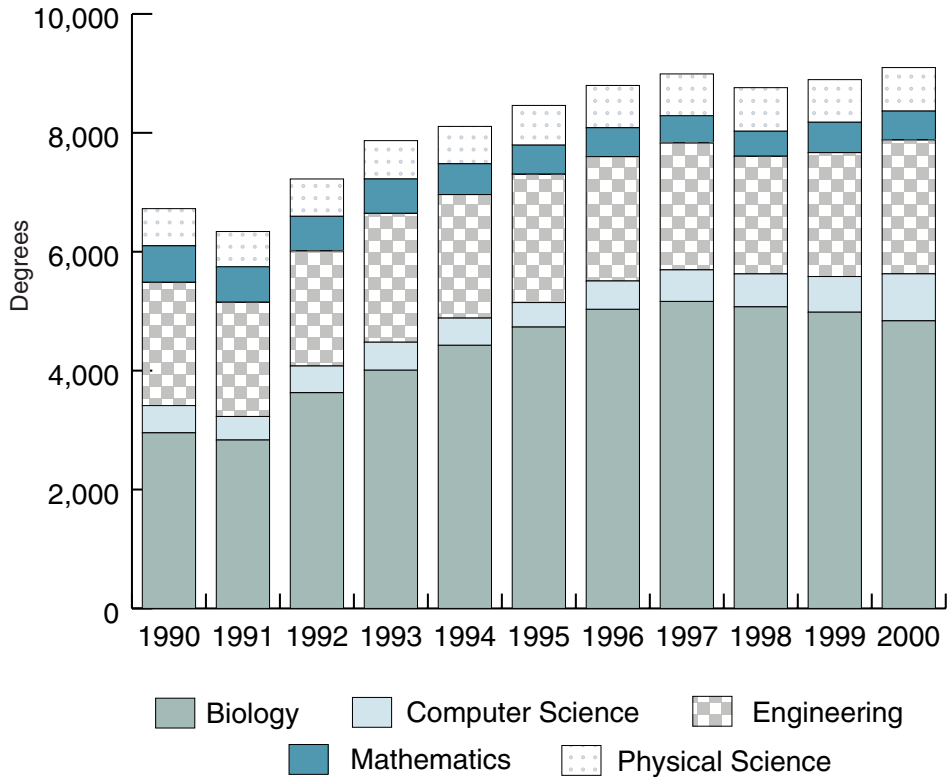

Figure C-16 -- UC S&E Baccalaureate Degree Trends, 1990-2000

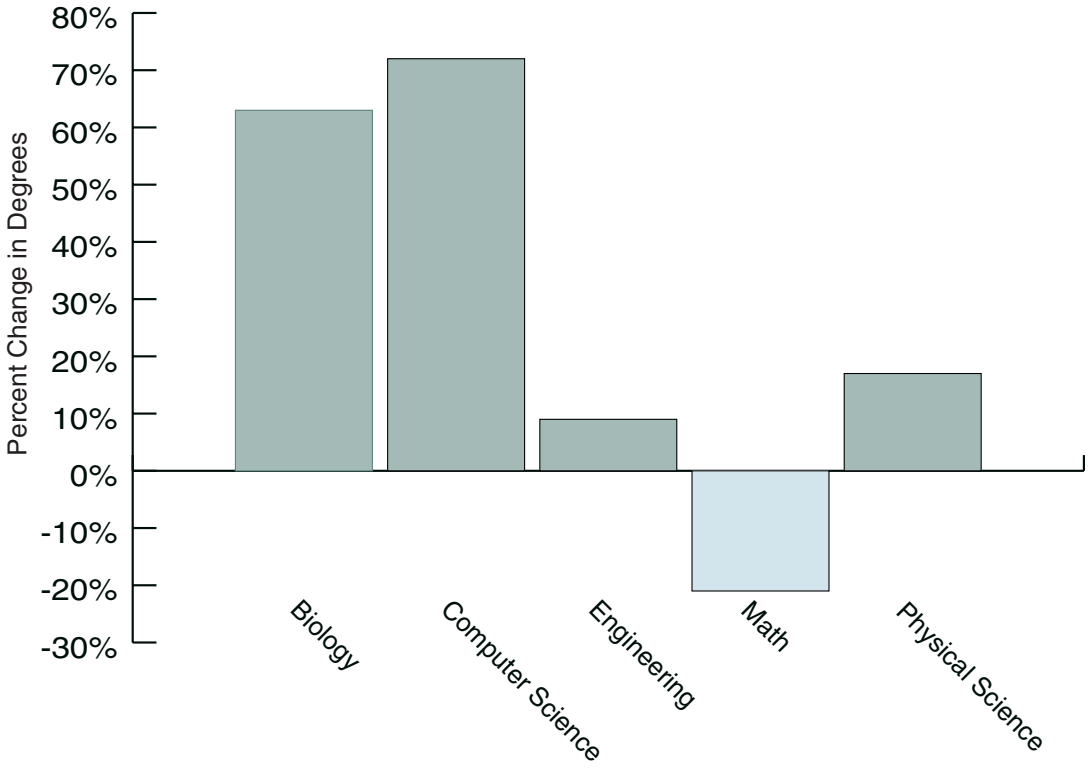

Figure C-17 -- UC Percentage Change S&E Baccalaureate Degrees by Discipline, 1990-2000

Figure C-18 -- UC S&E Baccalaureate Degree Trends, Engineering, 1990-2000

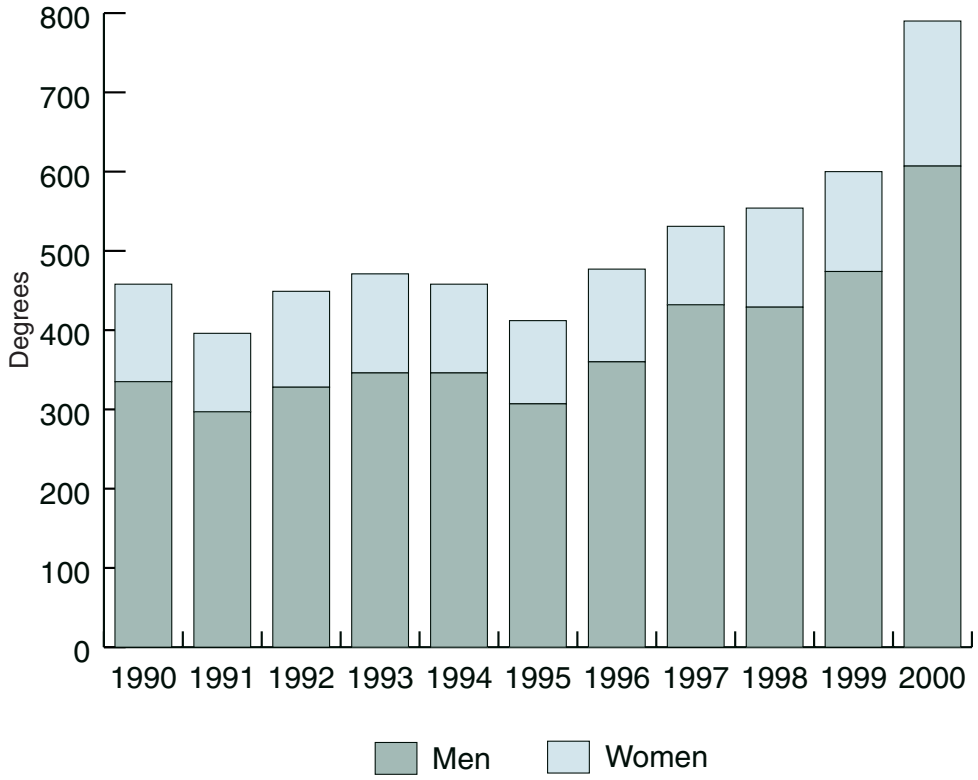

Figure C-19 -- UC S&E Baccalaureate Degree Trends, Computer Science, 1990-2000

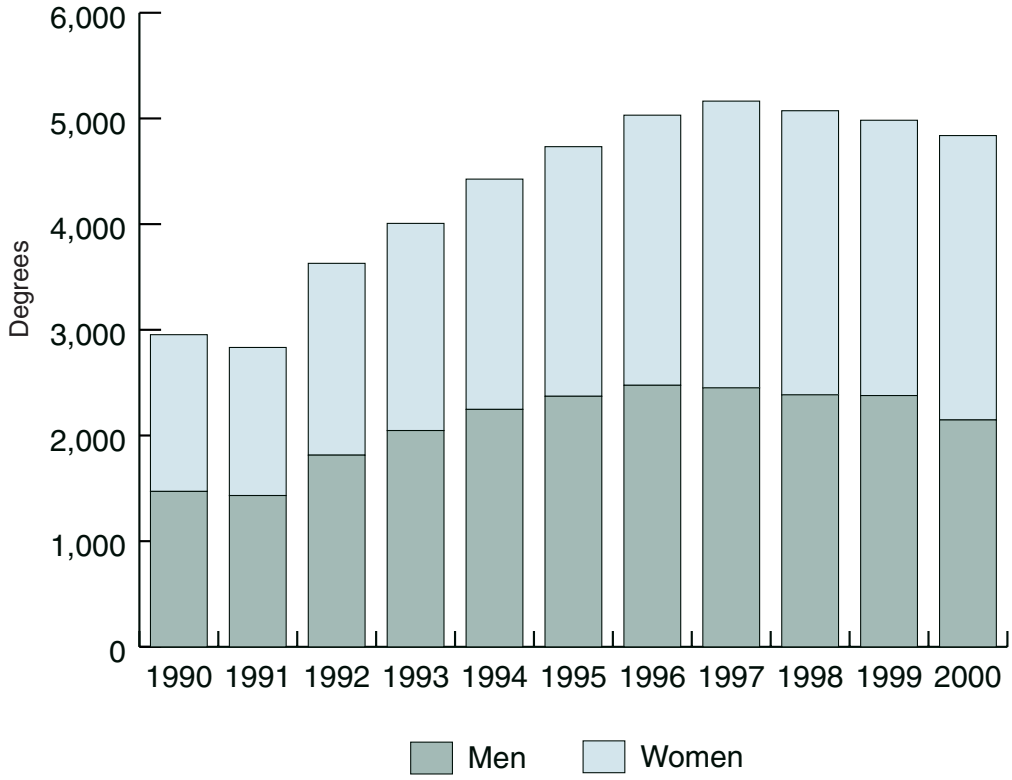

Figure C-20 -- UC S&E Baccalaureate Degree Trends, Biology, 1990-2000

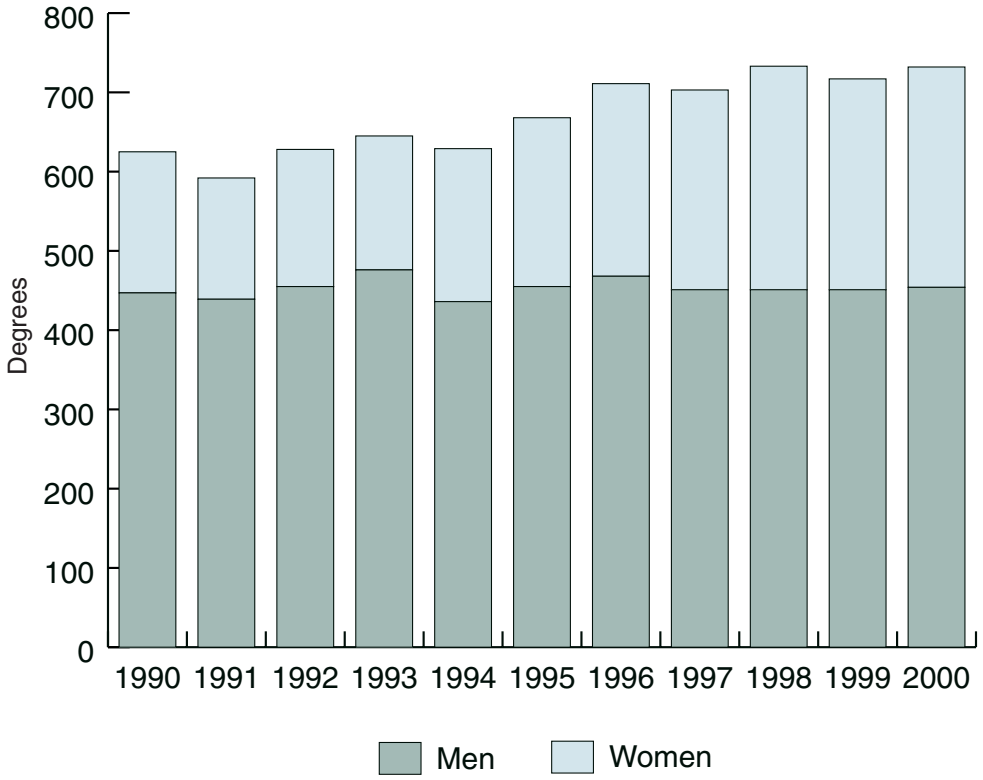

Figure C-21 -- UC S&E Baccalaureate Degree Trends, Physical Science, 1990-2000

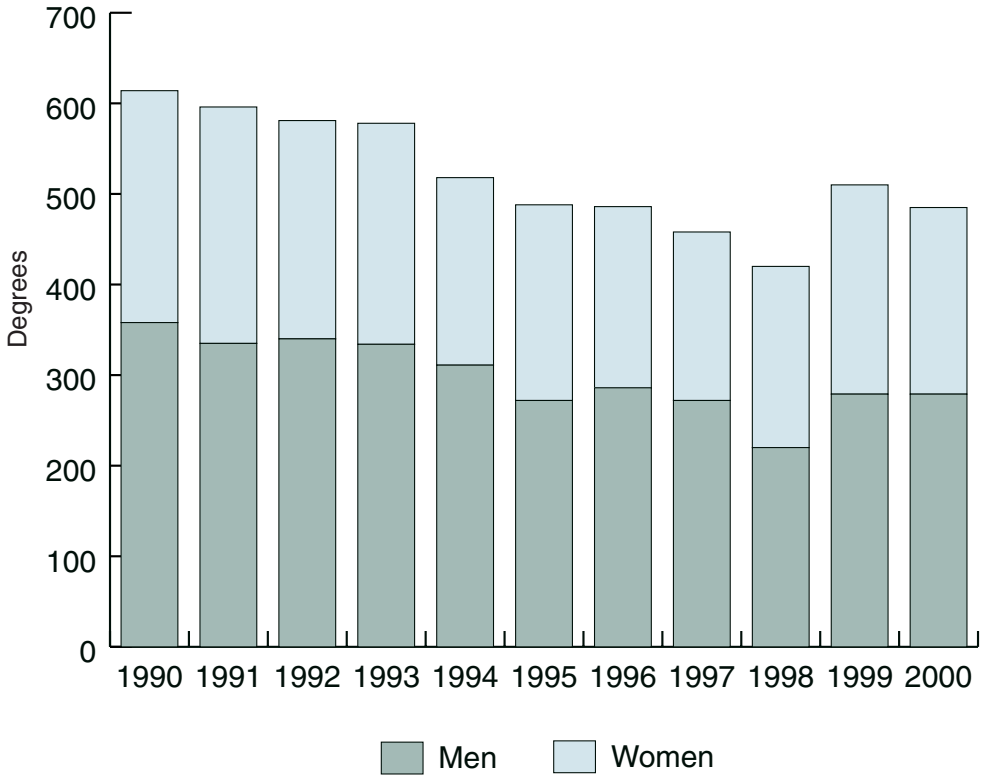

Figure C-22 -- UC S&E Baccalaureate Degree Trends, Mathematics, 1990-2000

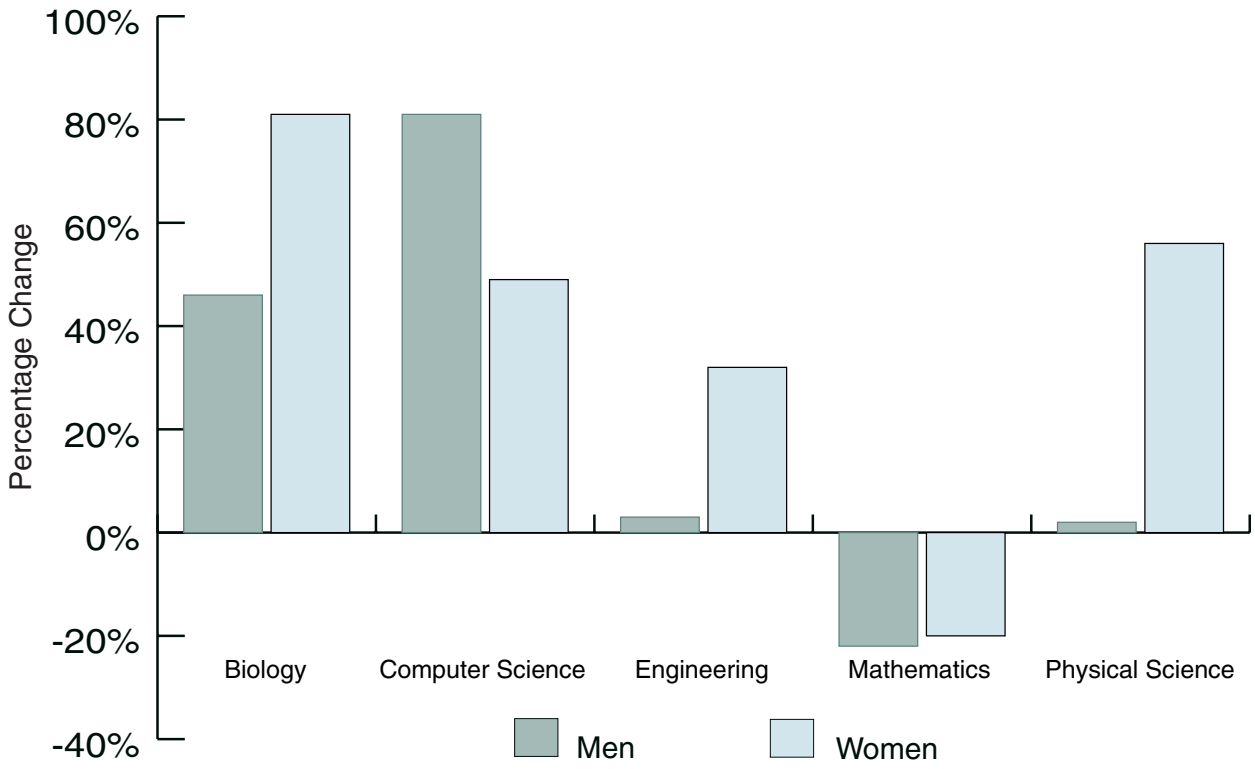

Figure C-23 -- UC Percentage Change S&E Degrees by Discipline and Gender, 1990-2000

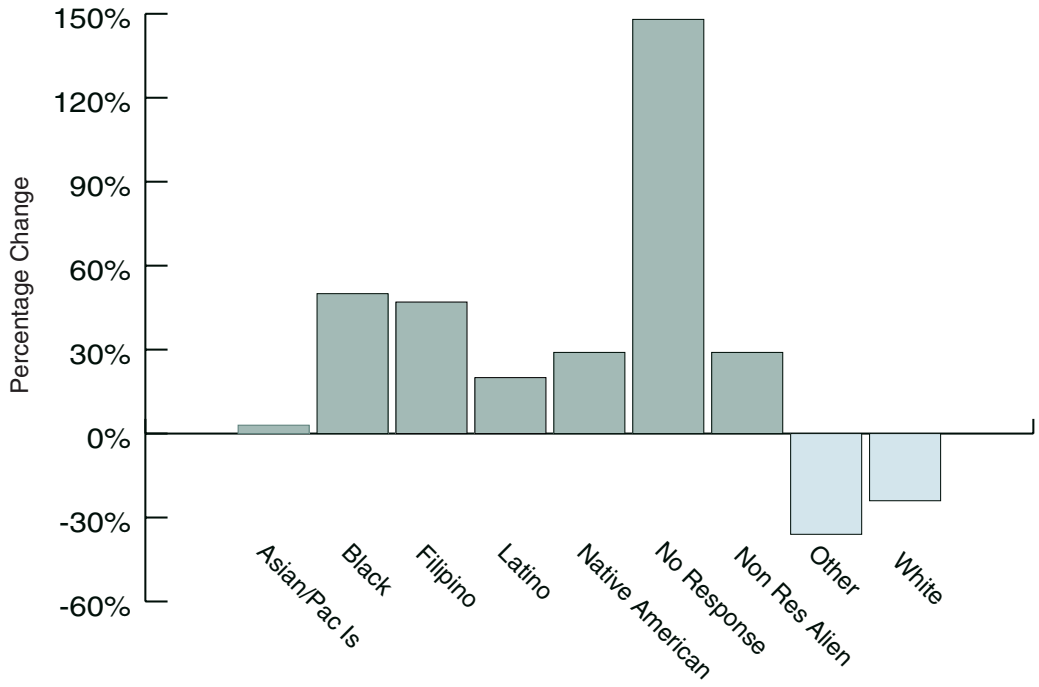

Figure C-24 -- UC Percentage Change S&E Baccalaureate Degrees by Ethnicity, Engineering, 1990-2000

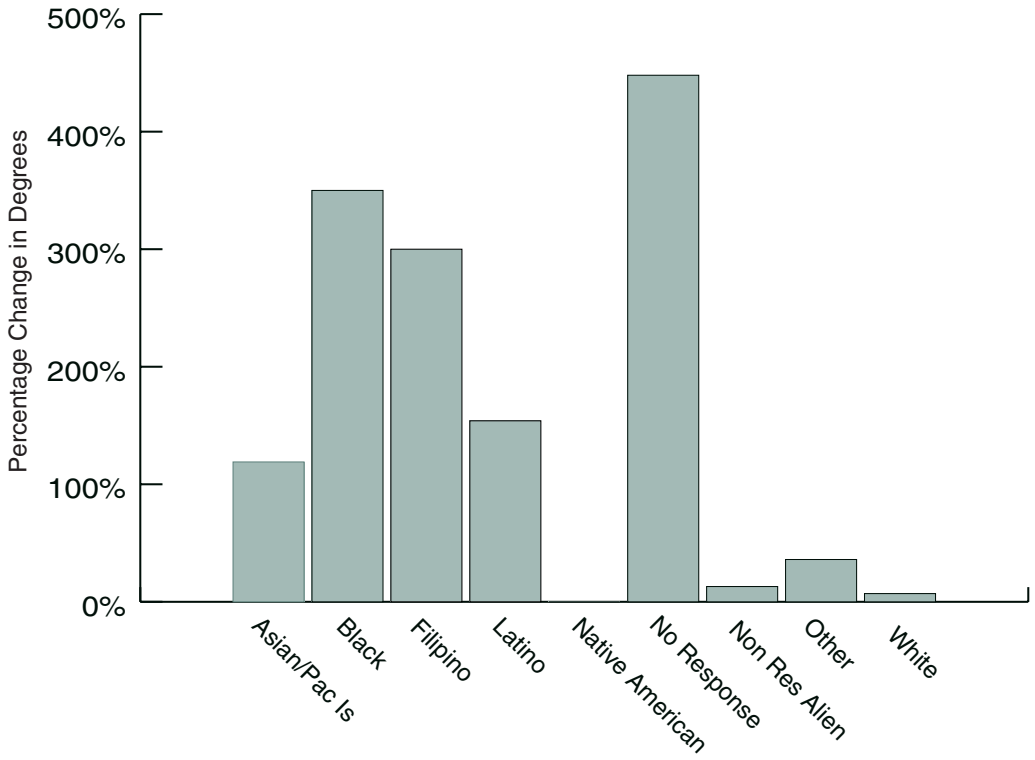

Figure C-25 -- UC Percentage Change S&E Baccalaureate Degrees by Ethnicity, Computer Science, 1990-2000

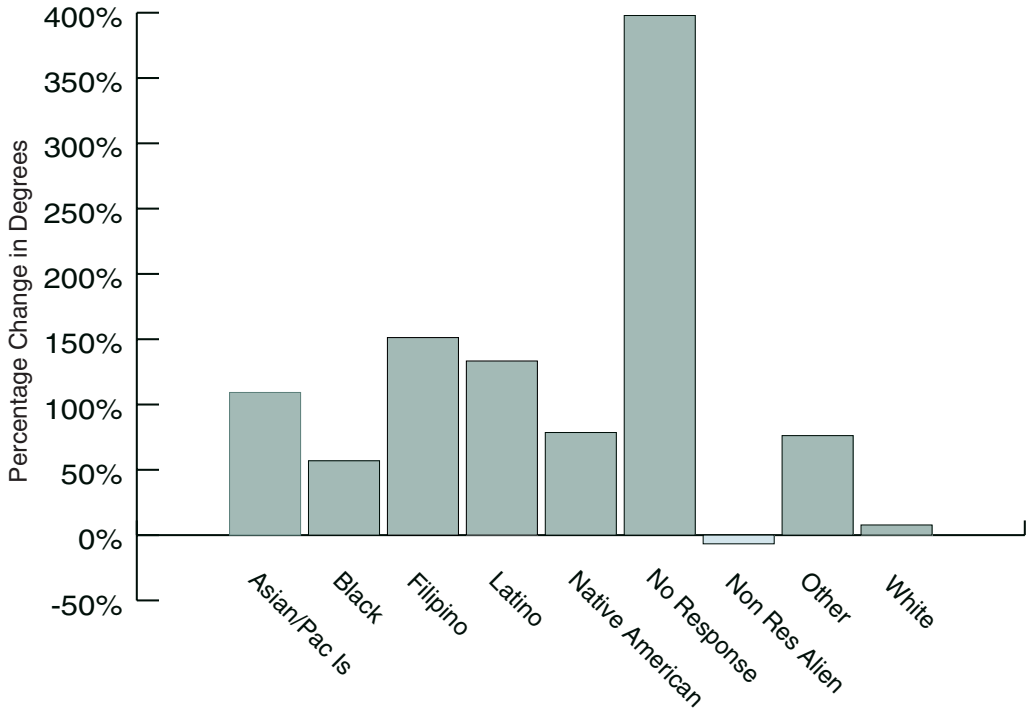

Figure C-26 -- UC Percentage Change S&E Baccalaureate Degrees by Ethnicity, Biology, 1990-2000

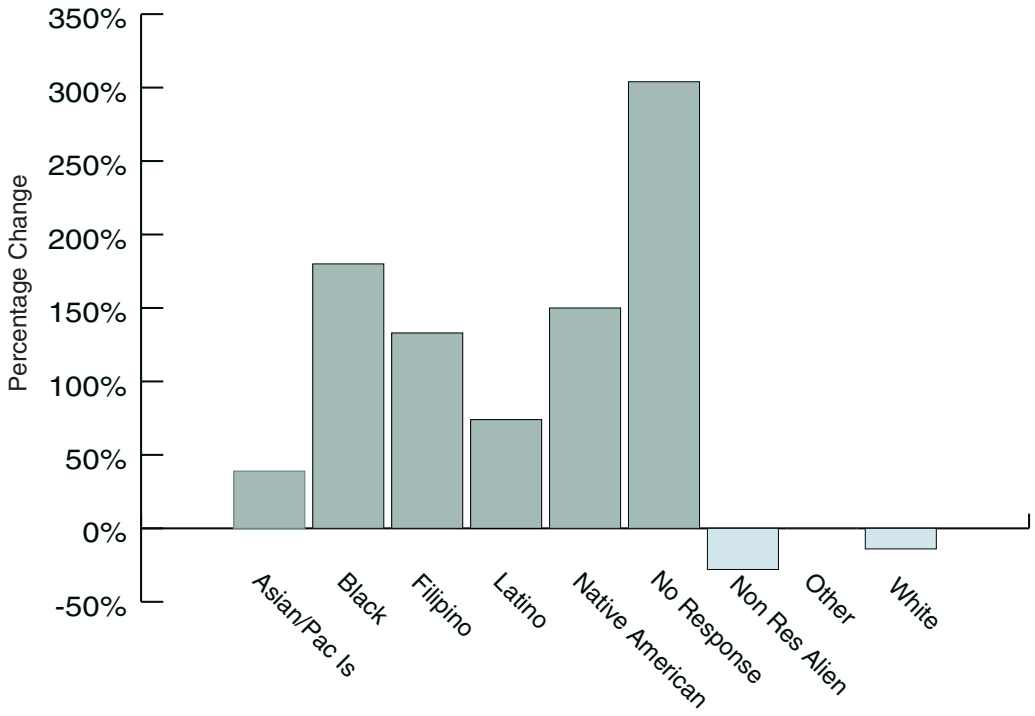

Figure C-27 -- UC Percentage Change S&E Baccalaureate Degrees by Ethnicity, Physical Science, 1990-2000

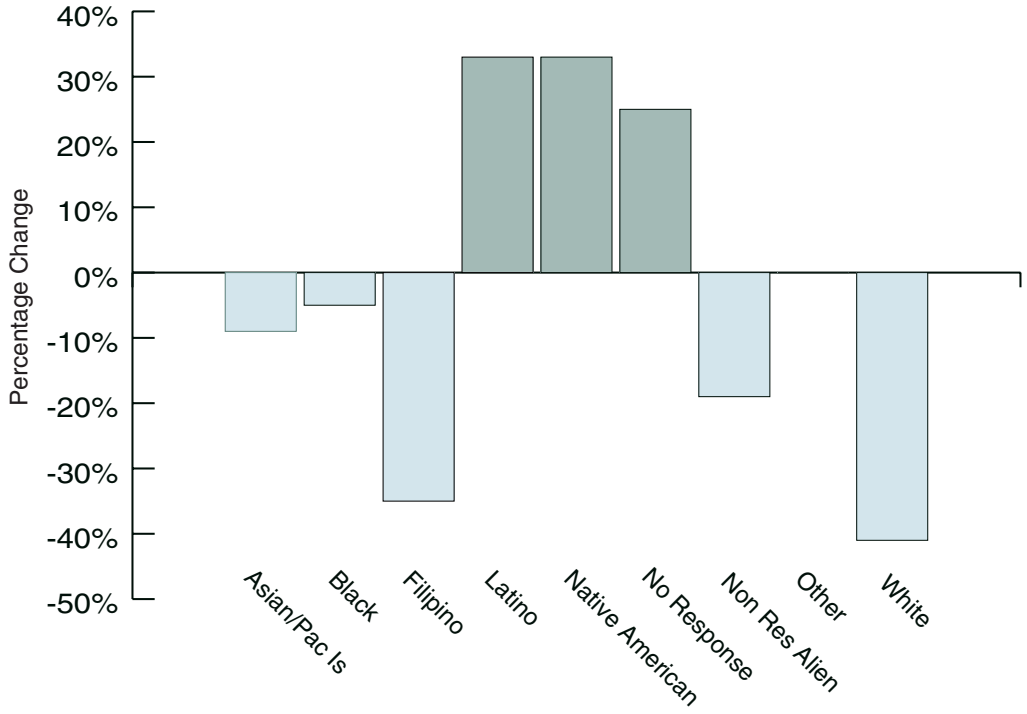

Figure C-28 -- UC Percentage Change S&E Baccalaureate Degrees by Ethnicity, Mathematics, 1990-2000

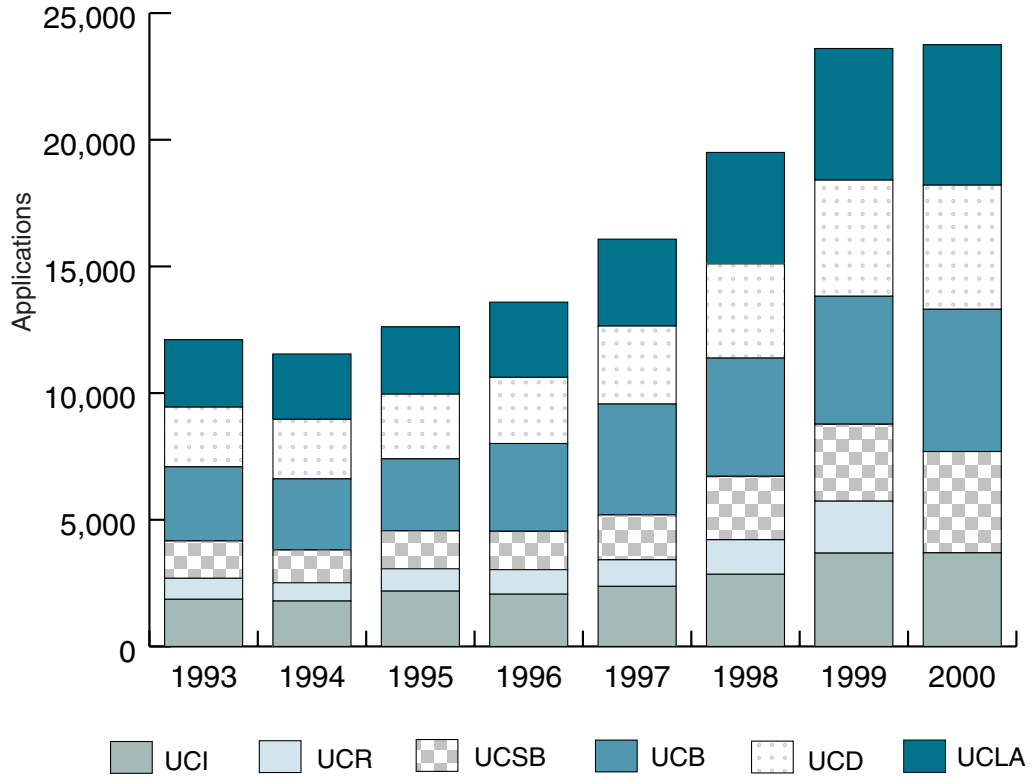

Figure C-29 -- UC S&E Applications Trend, 1990-2000

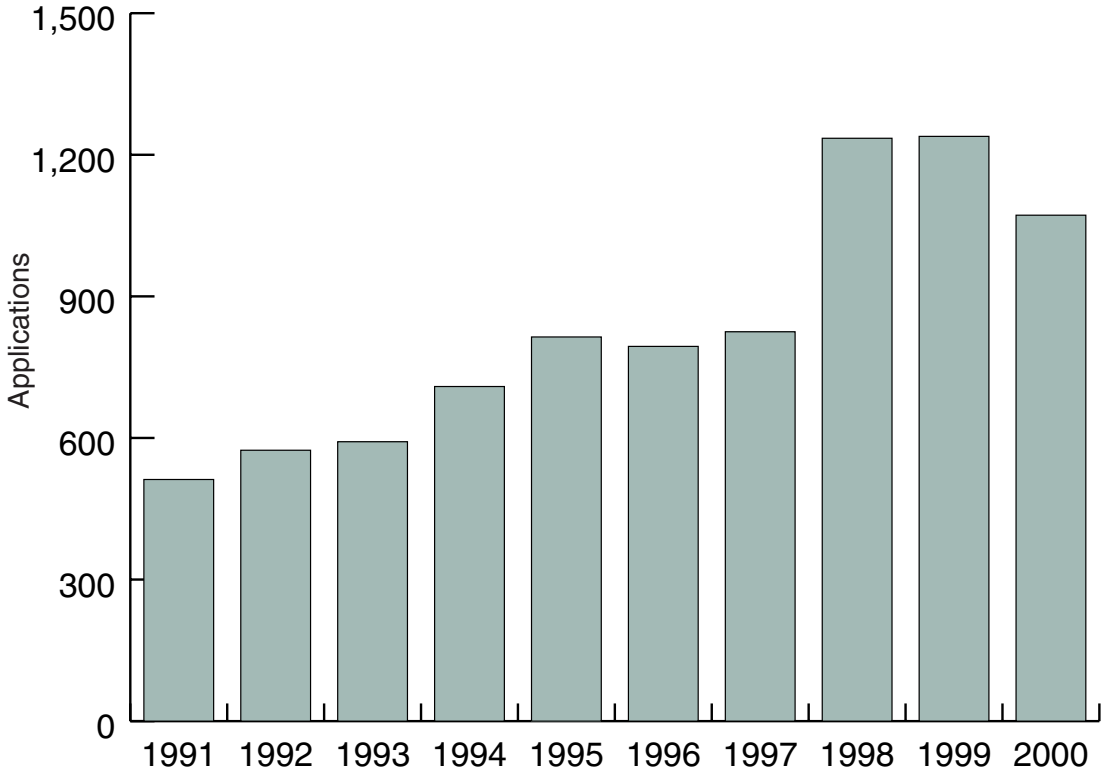

Figure C-30 -- UC Applications by Year, Chemical Engineering, 1990-2000

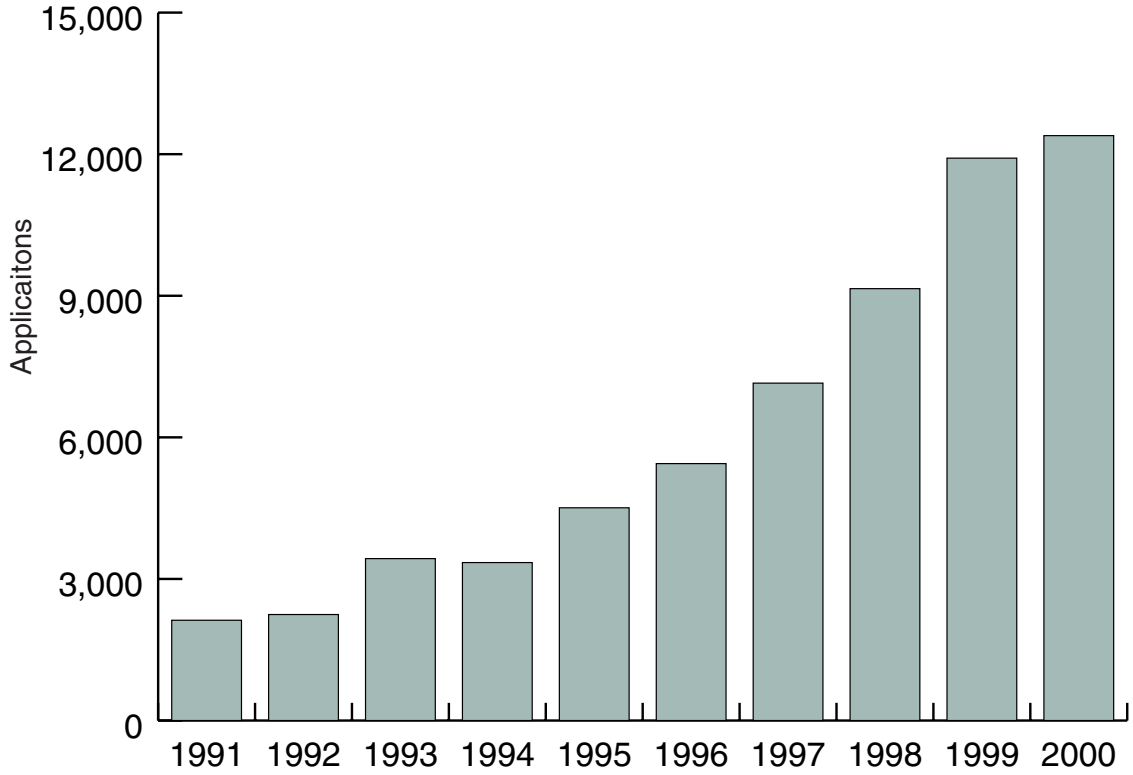

Figure C-31 -- UC Applications by Year, Computer Science, 1990-2000

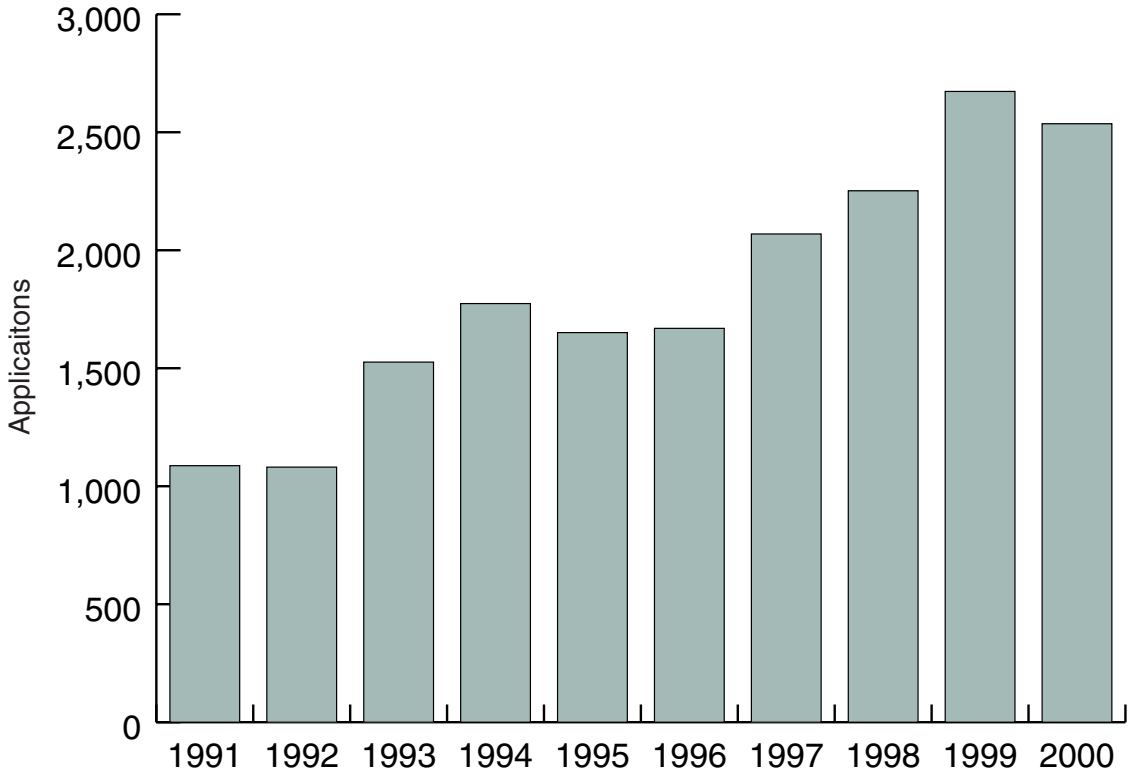

Figure C-32 -- UC Applications by Year, Electrical Engineering, 1990-2000

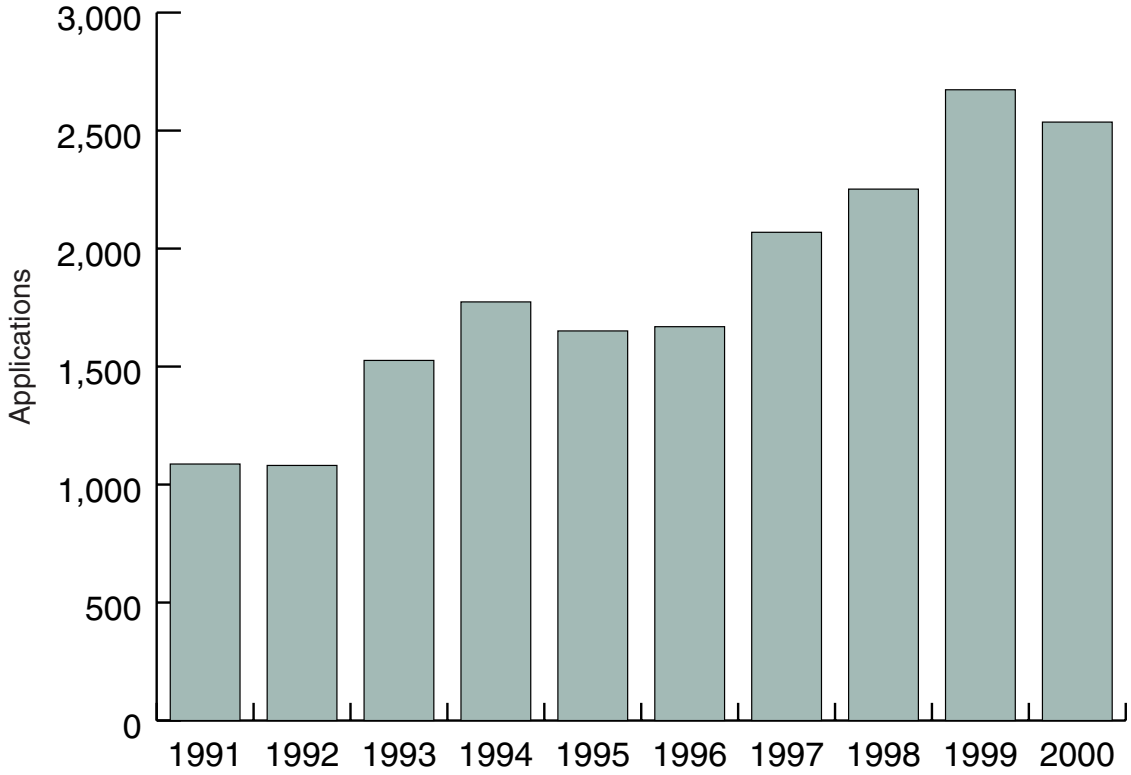

Figure C-33 -- UC Applications by Year, Mechanical Engineering, 1990-2000

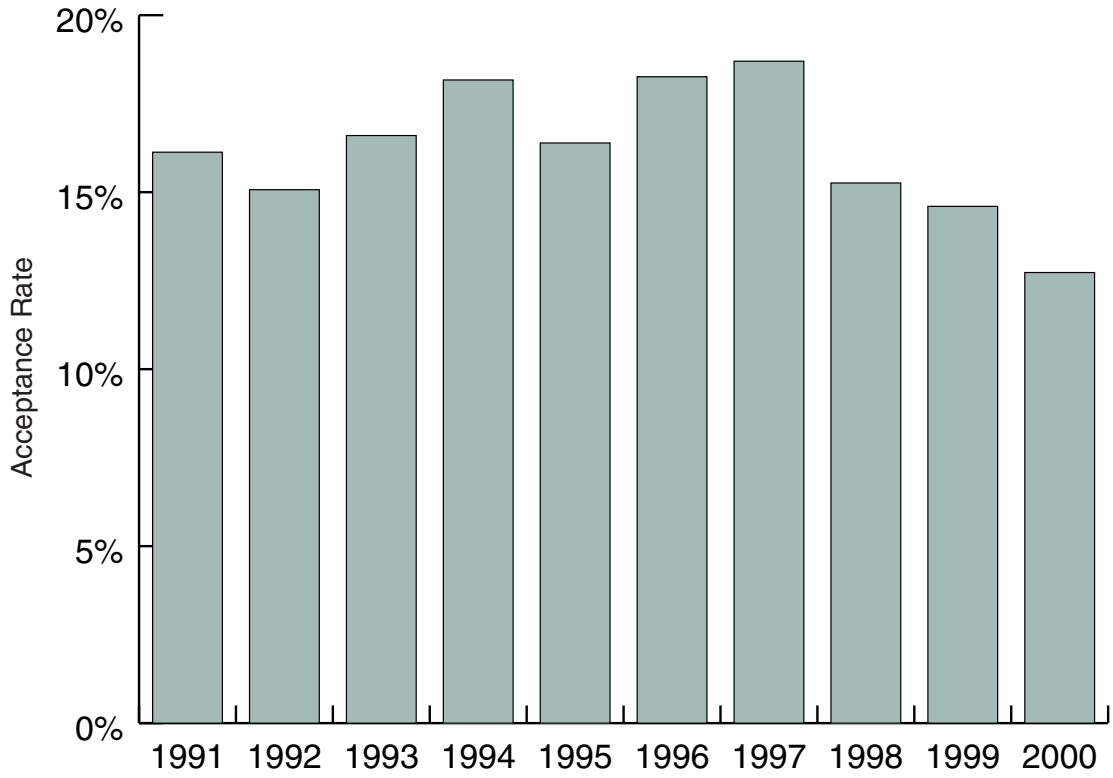

Figure C-34 -- UC Acceptance Rate by Year 1991-2000

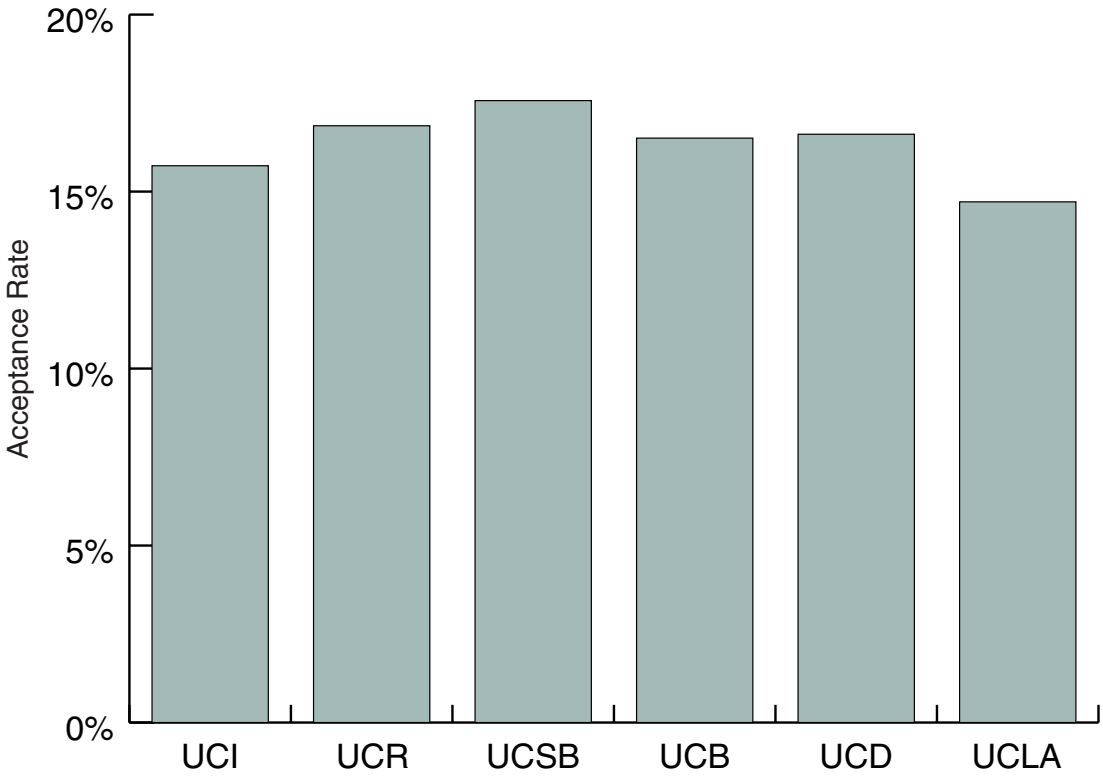

Figure C-35 -- UC Acceptance Rate by Campus

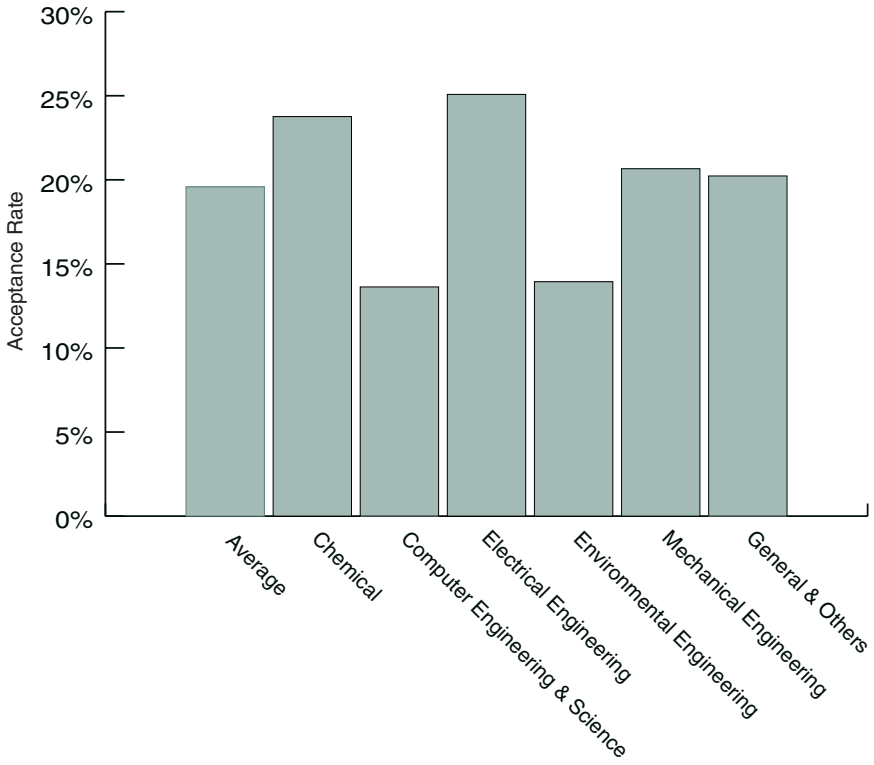

Figure C-36 -- UC Acceptance Rate by Discipline

APPENDIX D. CPEC ENROLLMENT & DEGREE DATA, CALIFORNIA STATE UNIVERSITY

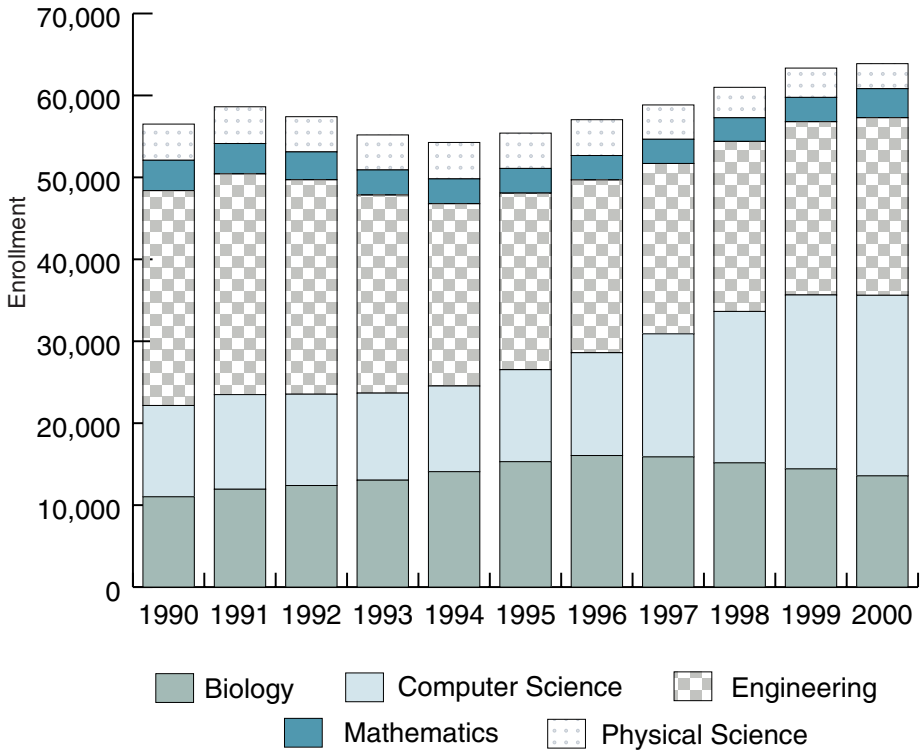

Figure D-1 -- CSU S&E Enrollment, 1990-2000

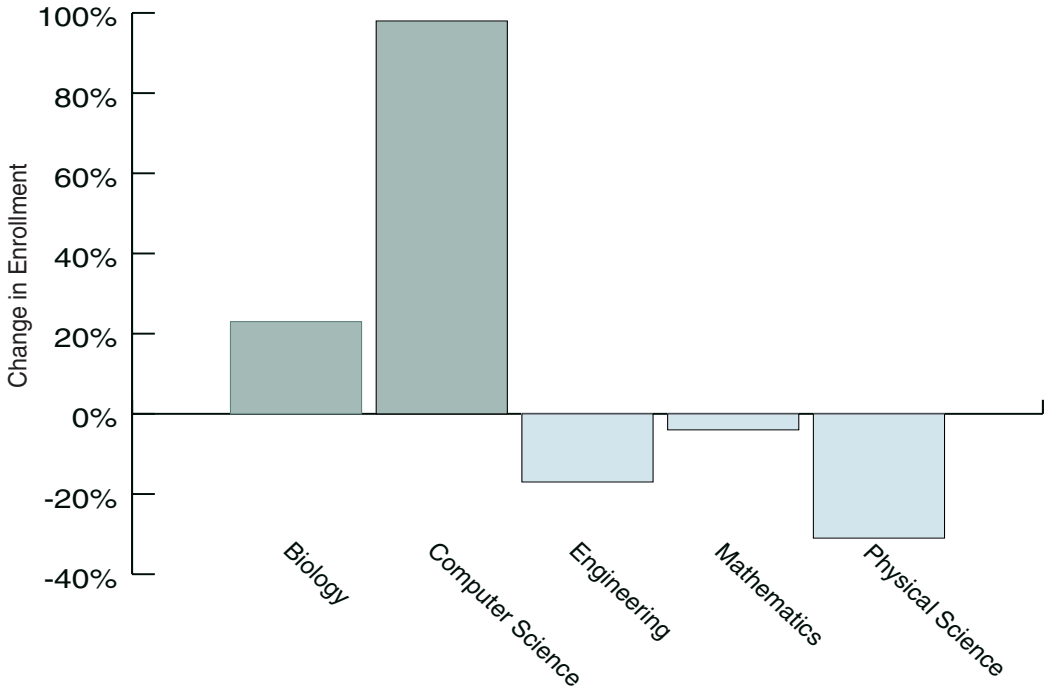

Figure D-2 -- CSU Percentage Change S&E Enrollment by Discipline, 1990-2000

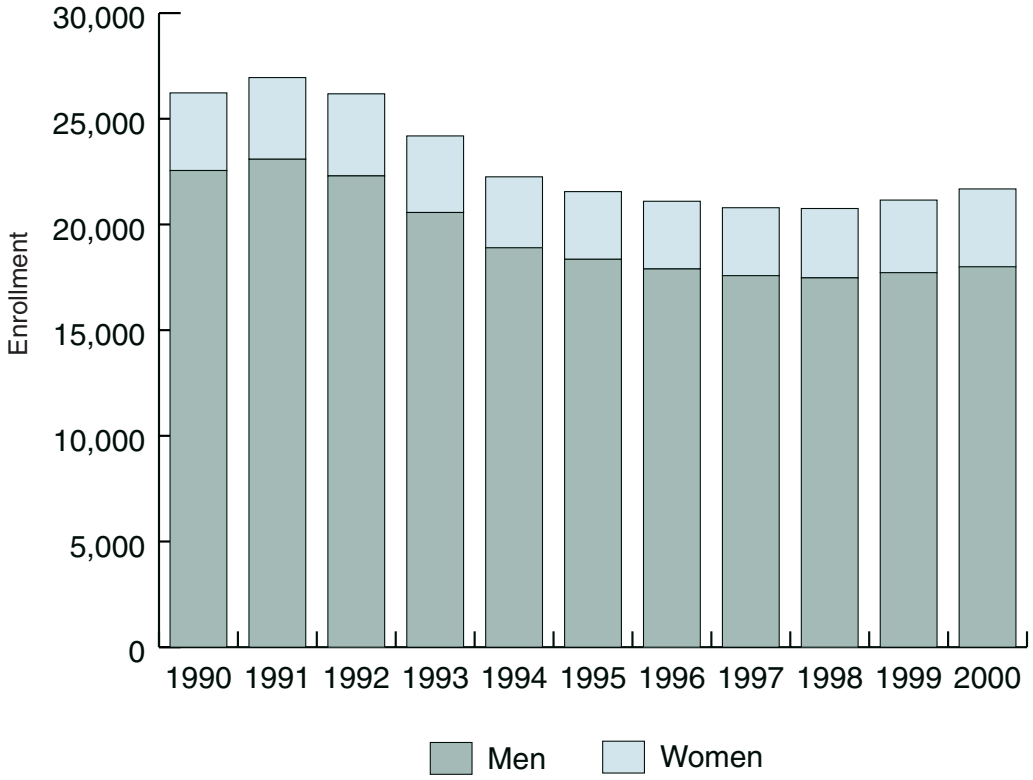

Figure D-3 -- CSU Enrollment Trends, Engineering, 1990-2000

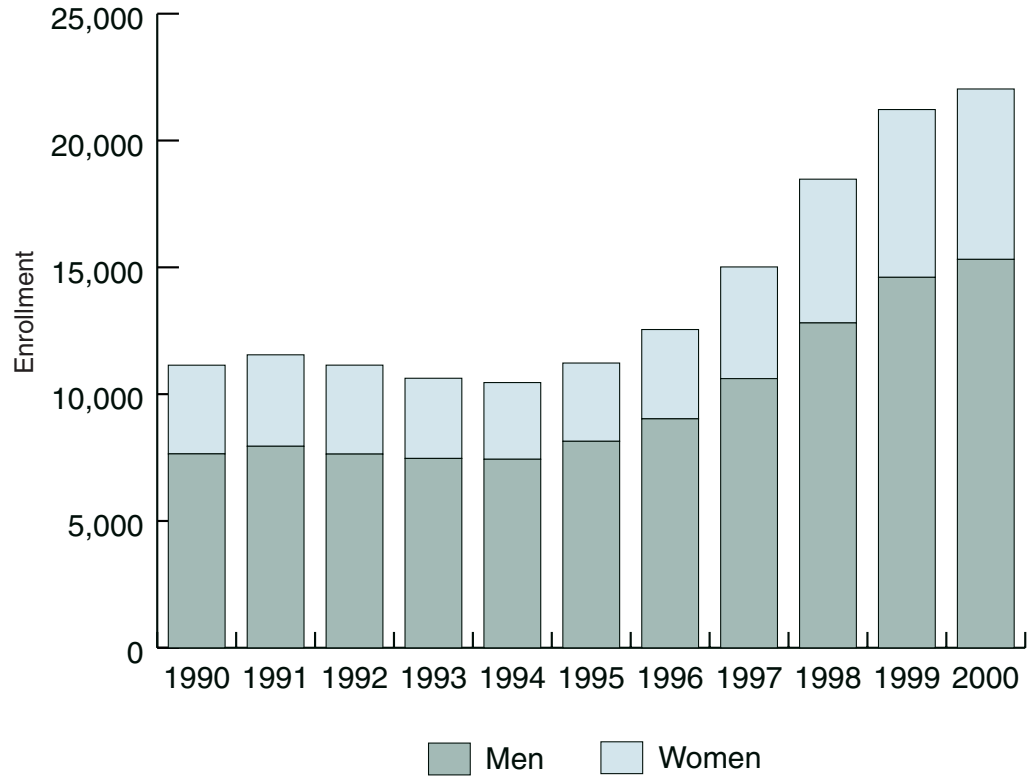

Figure D-4 -- CSU Enrollment Trends, Computer Science, 1990-2000

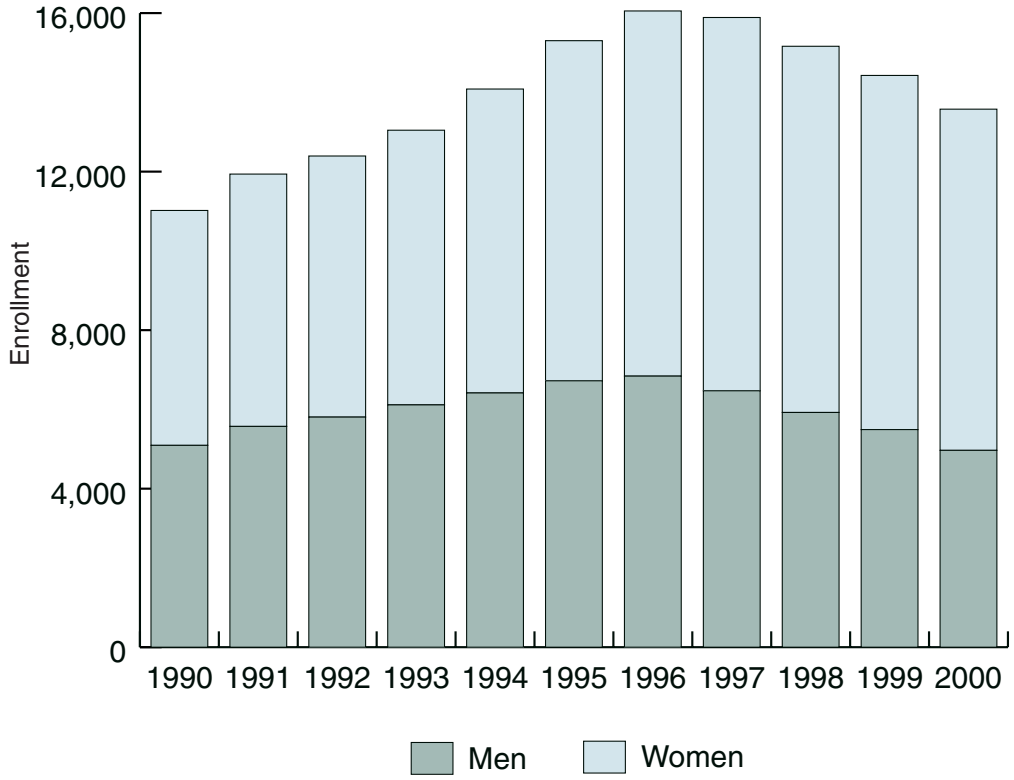

Figure D-5 -- CSU Enrollment Trends, Biology, 1990-2000

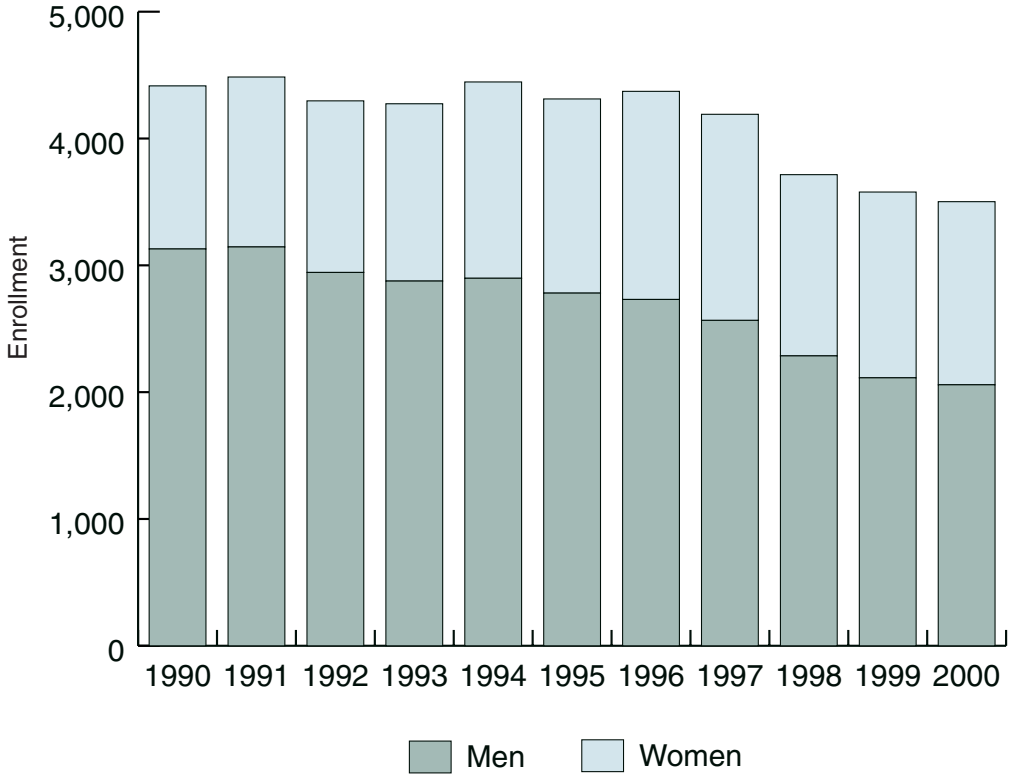

Figure D-6 -- CSU Enrollment Trends, Physical Science, 1990-2000

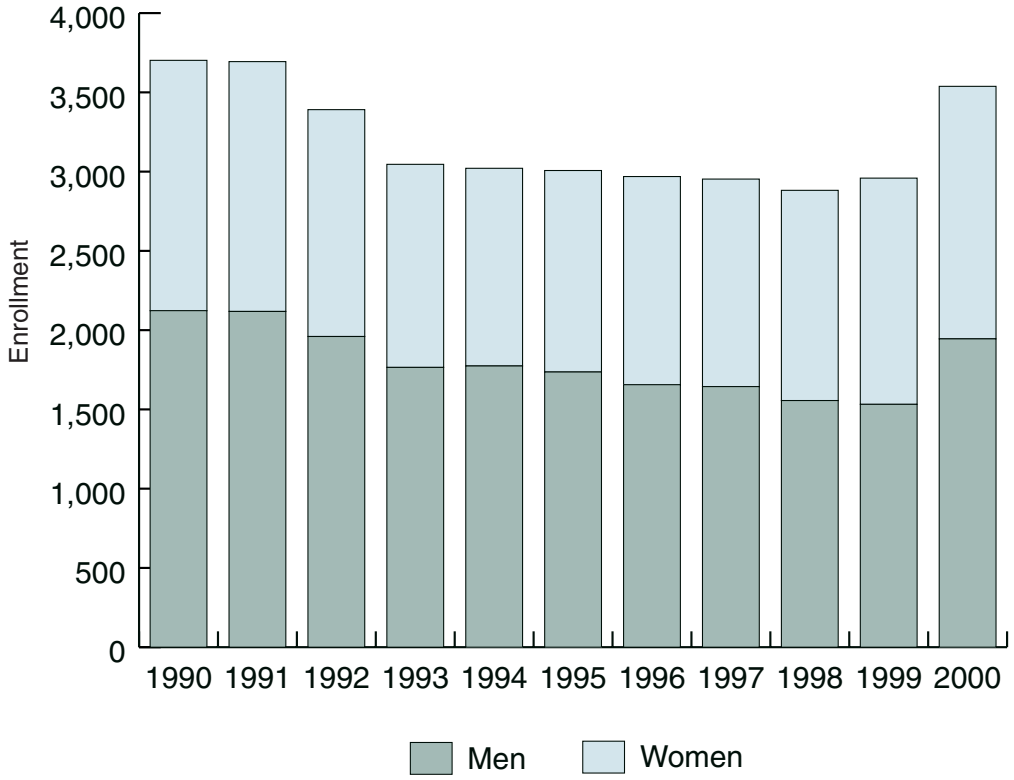

Figure D-7 -- CSU Enrollment Trends, Mathematics, 1990-2000

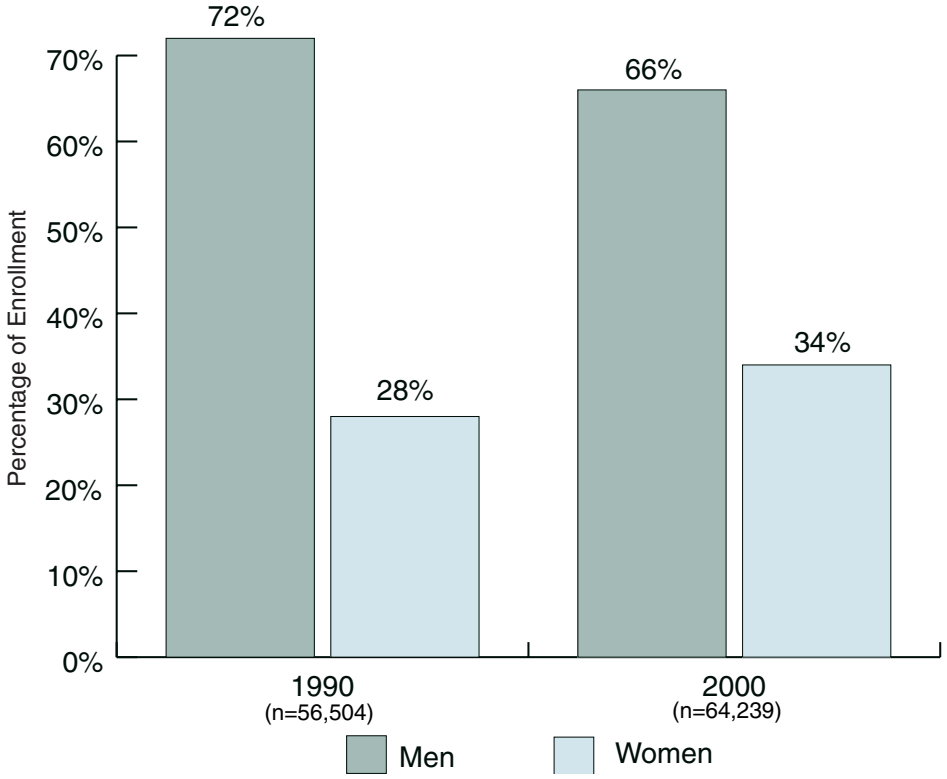

Figure D-8 -- CSU S&E Enrollment by Gender, 1990 & 2000

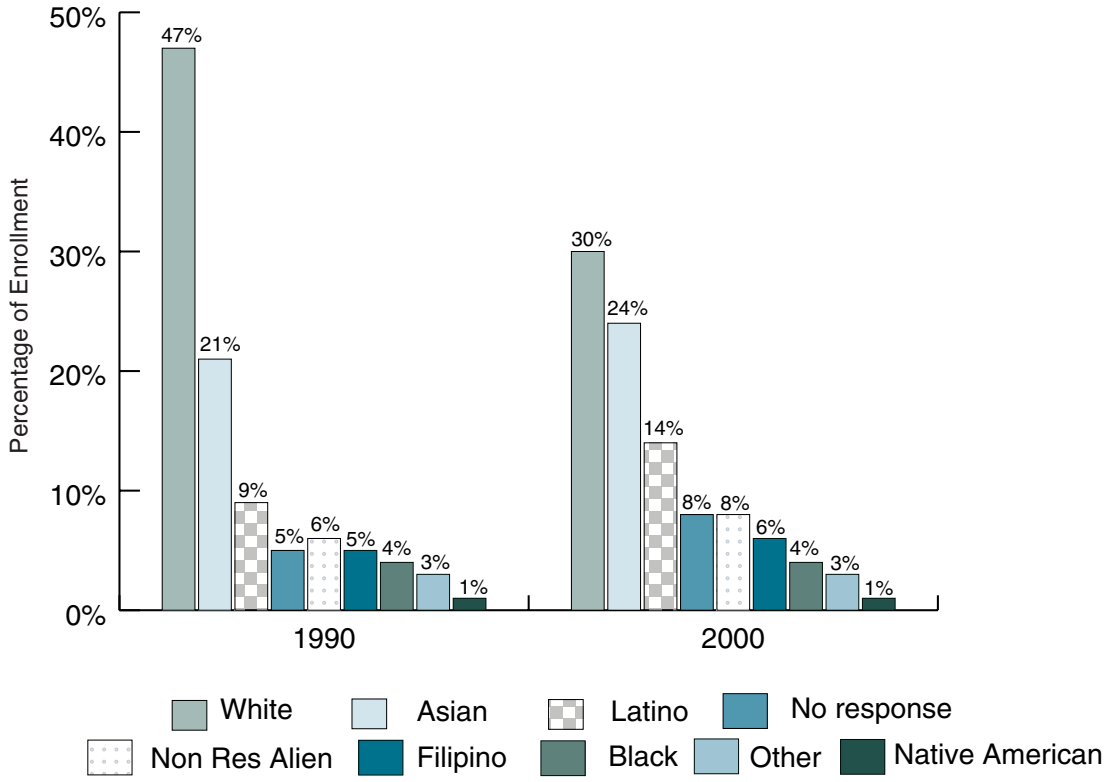

Figure D-9 -- CSU S&E Enrollment by Ethnicity, 1990 and 2000

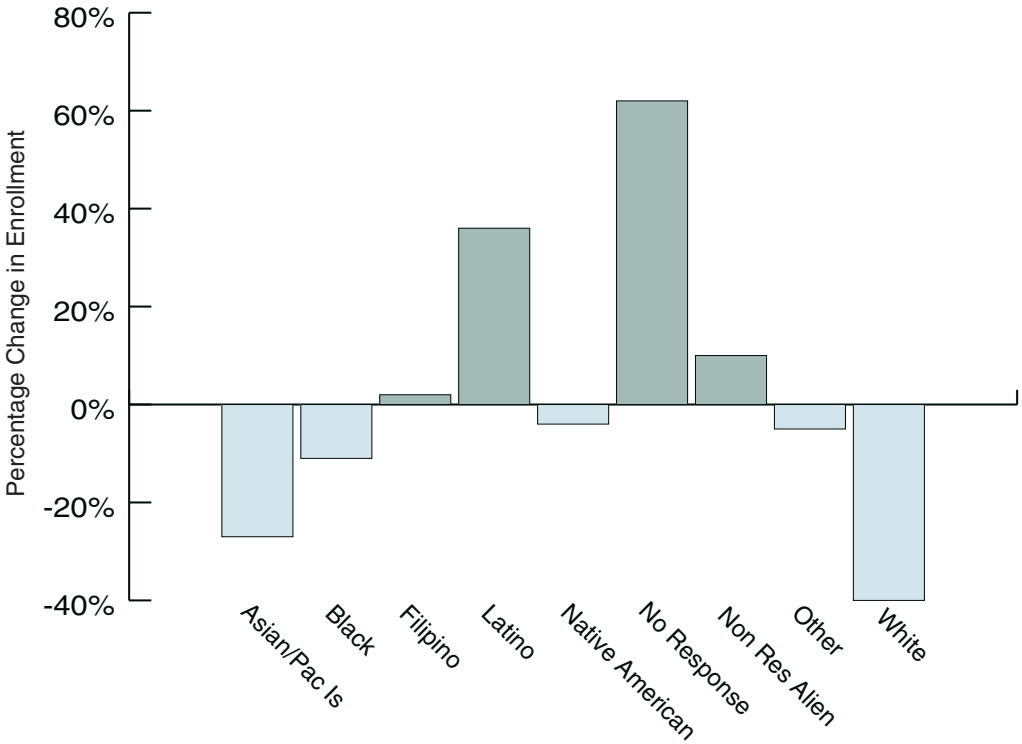

Figure D-10 -- CSU Percentage Change S&E Enrollment by Ethnicity, Engineering, 1990-2000

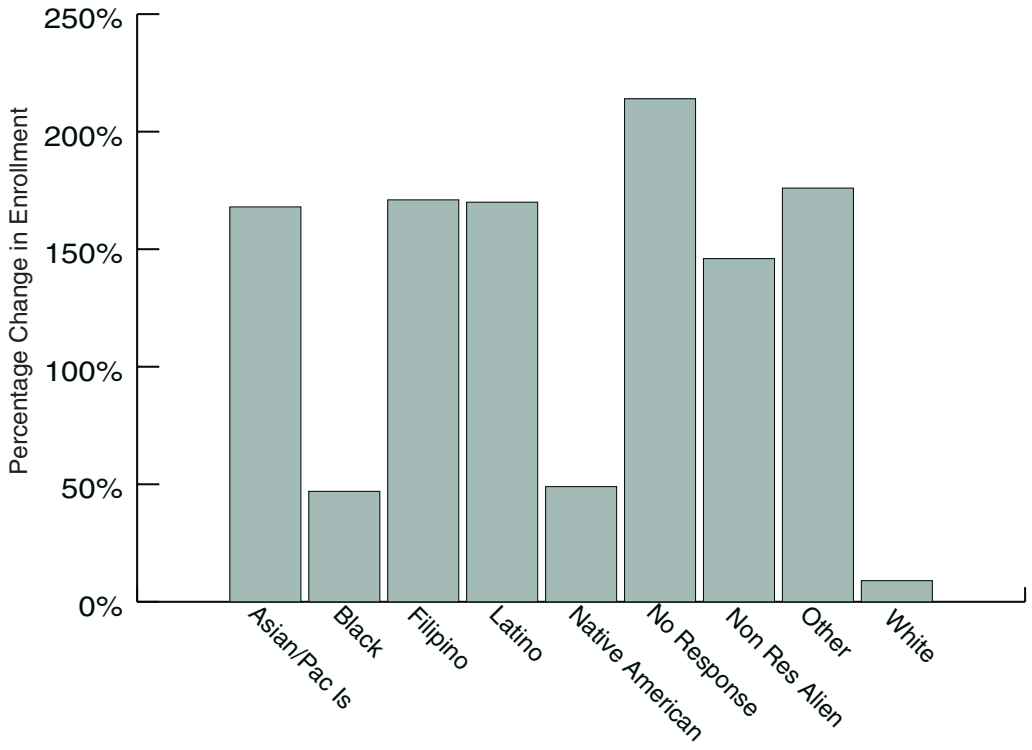

Figure D-11 -- CSU Percentage Change S&E Enrollment by Ethnicity, Computer Science, 1990-2000

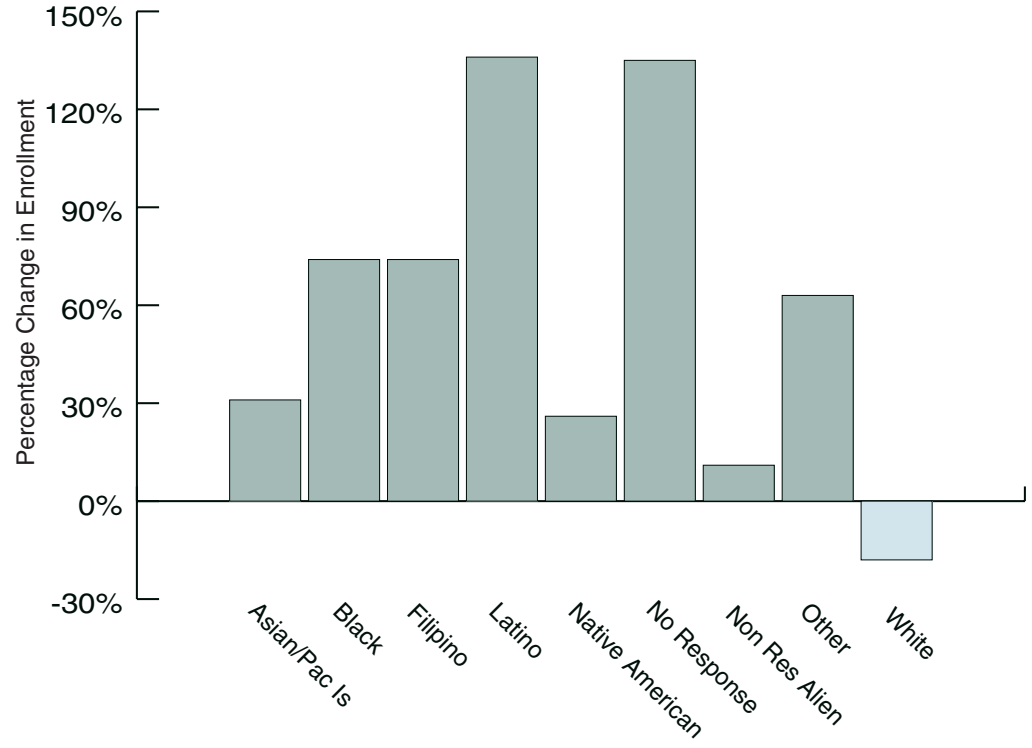

Figure D-12 -- CSU Percentage Change S&E Baccalaureate Enrollment by Ethnicity, Biology, 1990-2000

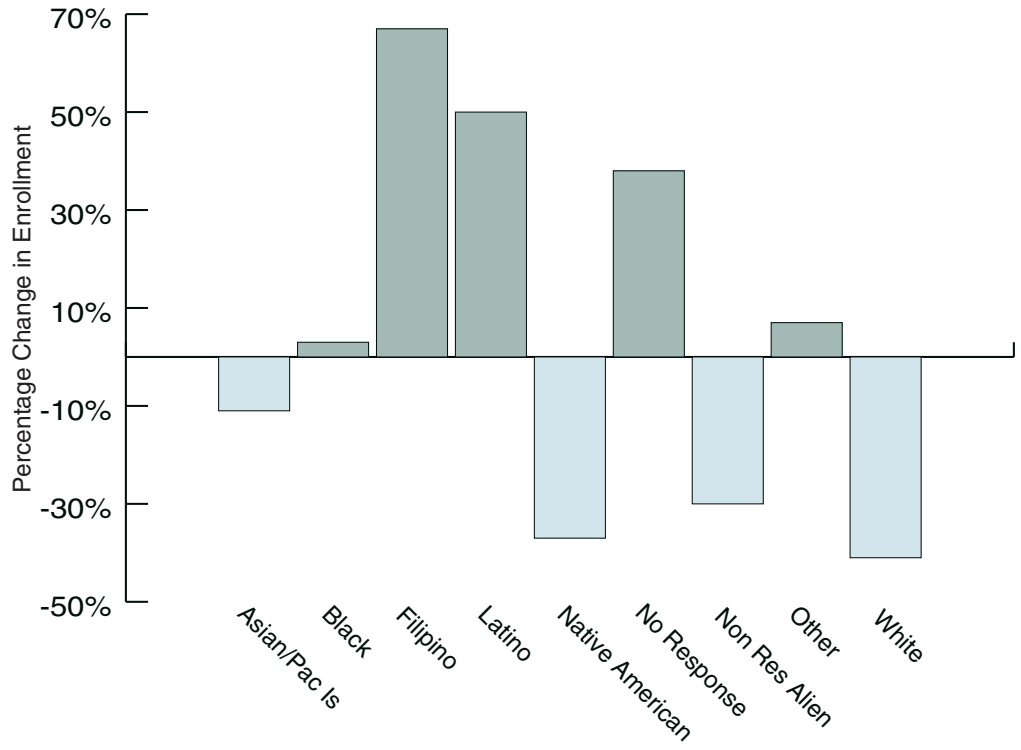

Figure D-13 -- CSU Percentage Change S&E Baccalaureate Enrollment by Ethnicity, Physical Sciences, 1990-2000

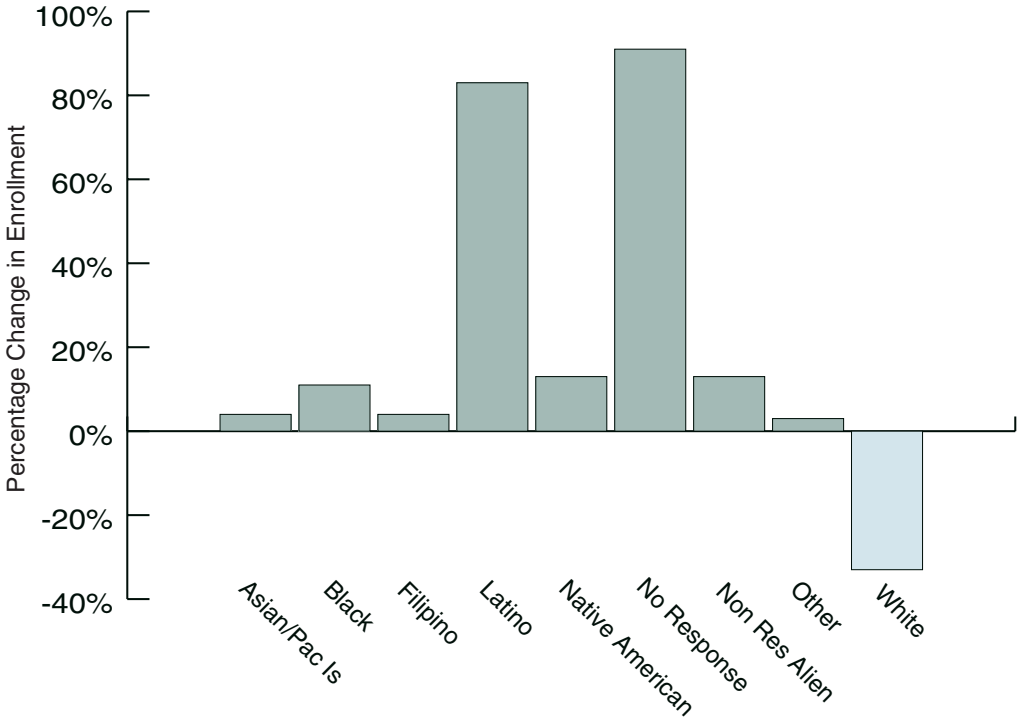

Figure D-14 -- CSU Percentage Change S&E Baccalaureate Enrollment by Ethnicity, Mathematics, 1990-2000

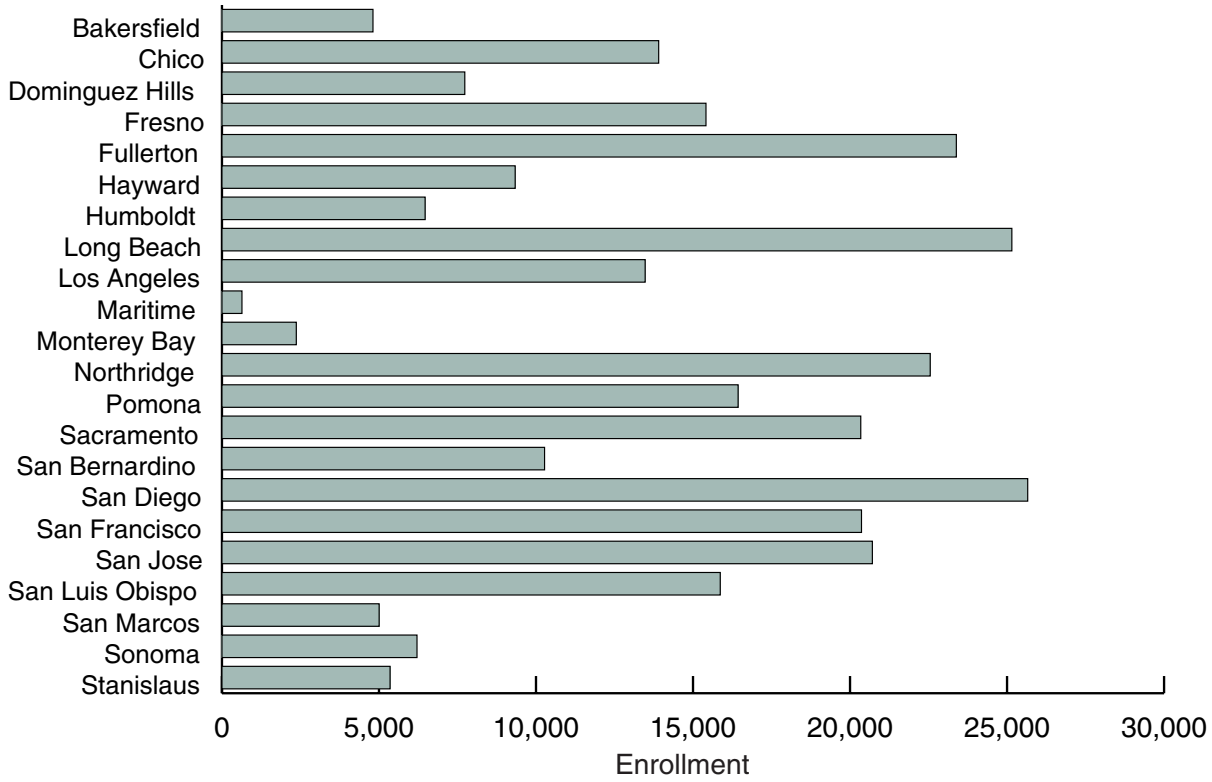

Figure D-15 -- CSU Total Undergraduate Enrollment by Campus, 2000

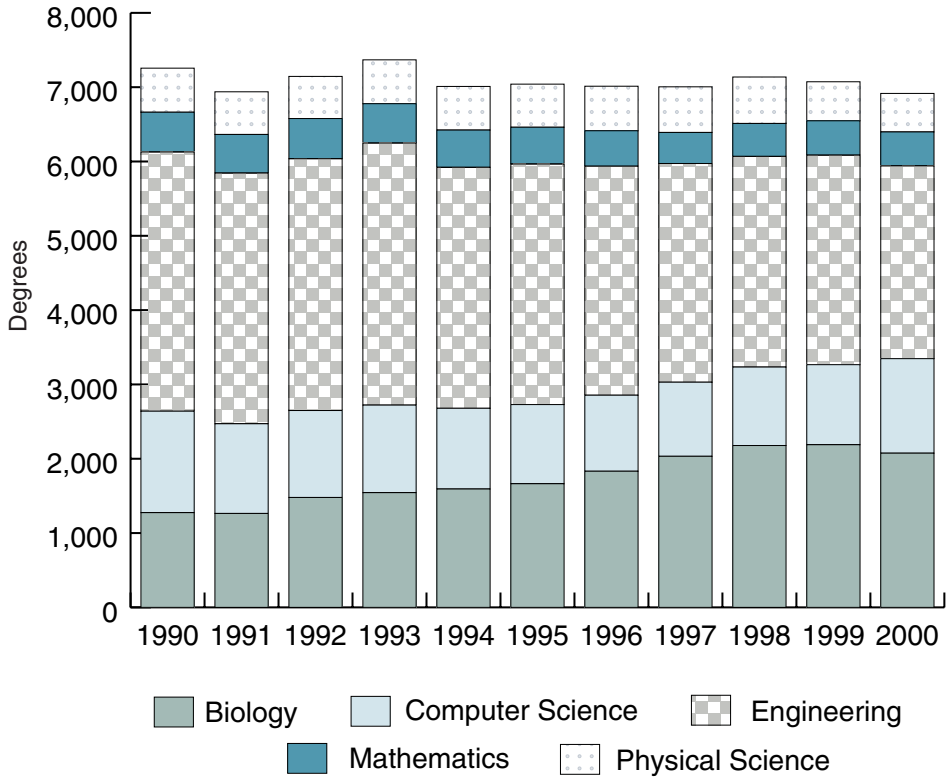

Figure D-16 -- CSU S&E Baccalaureate Degree Trend, 1990-2000

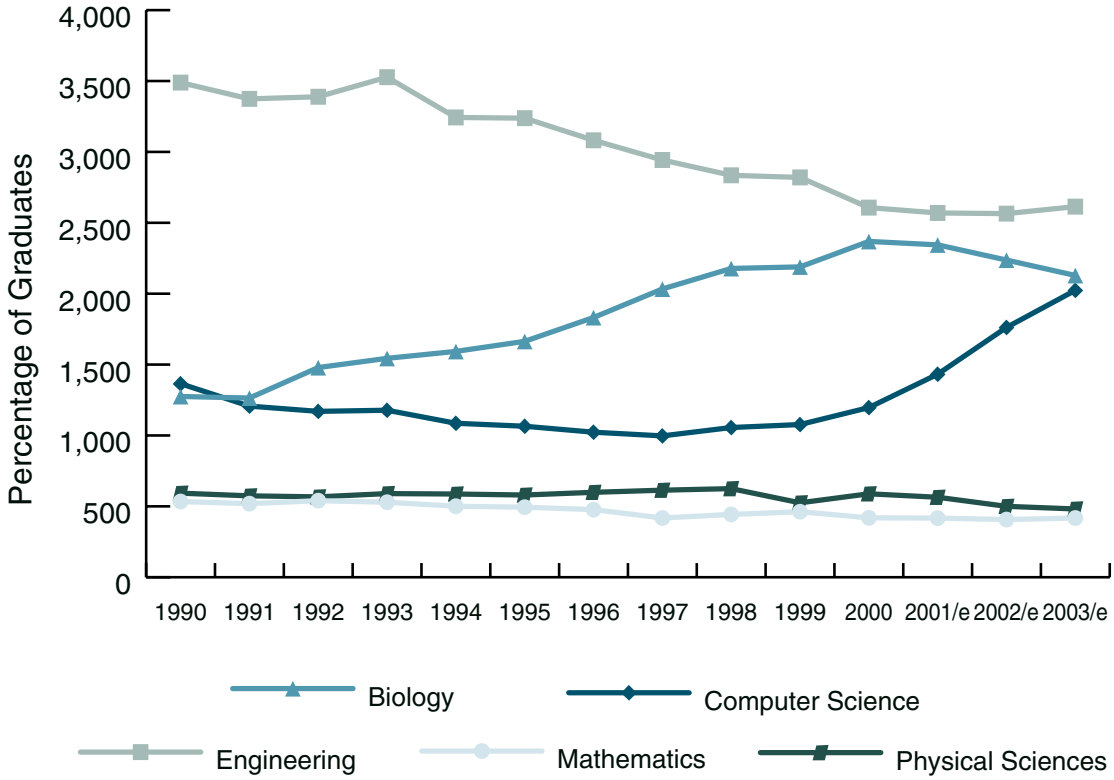

Figure D-17 -- CSU S&E Baccalaureate Degree Trends by Discipline, 1990-2003

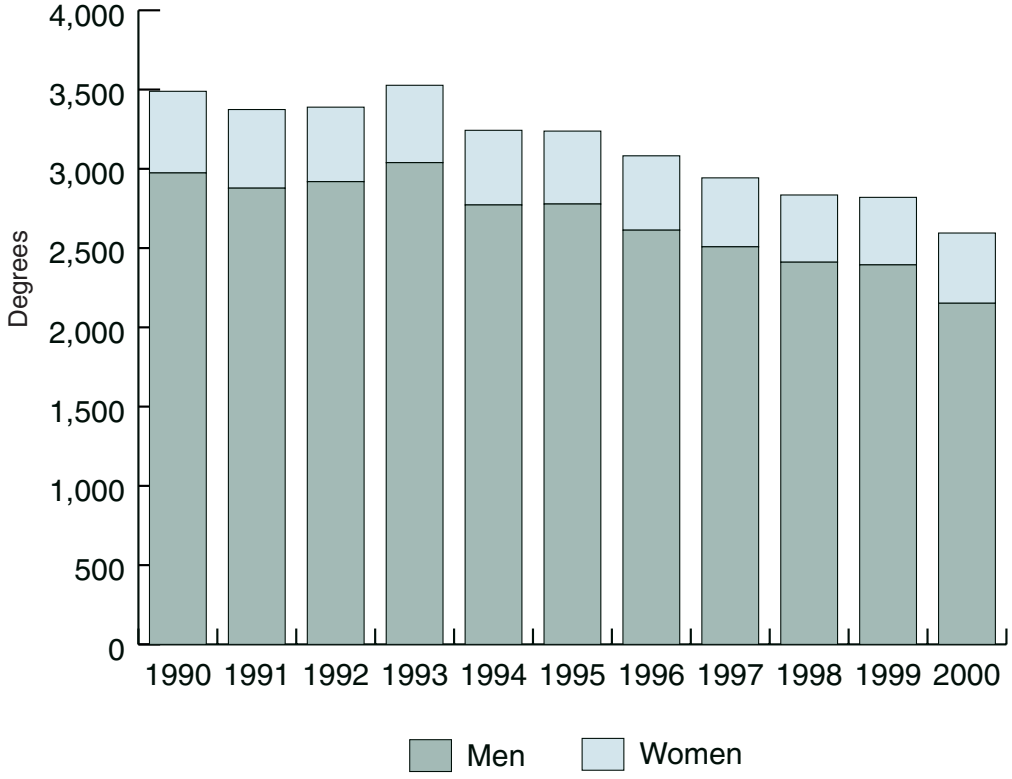

Figure D-18 -- CSU Engineering Baccalaureate Degree Trends by Year by Gender, 1990-2000

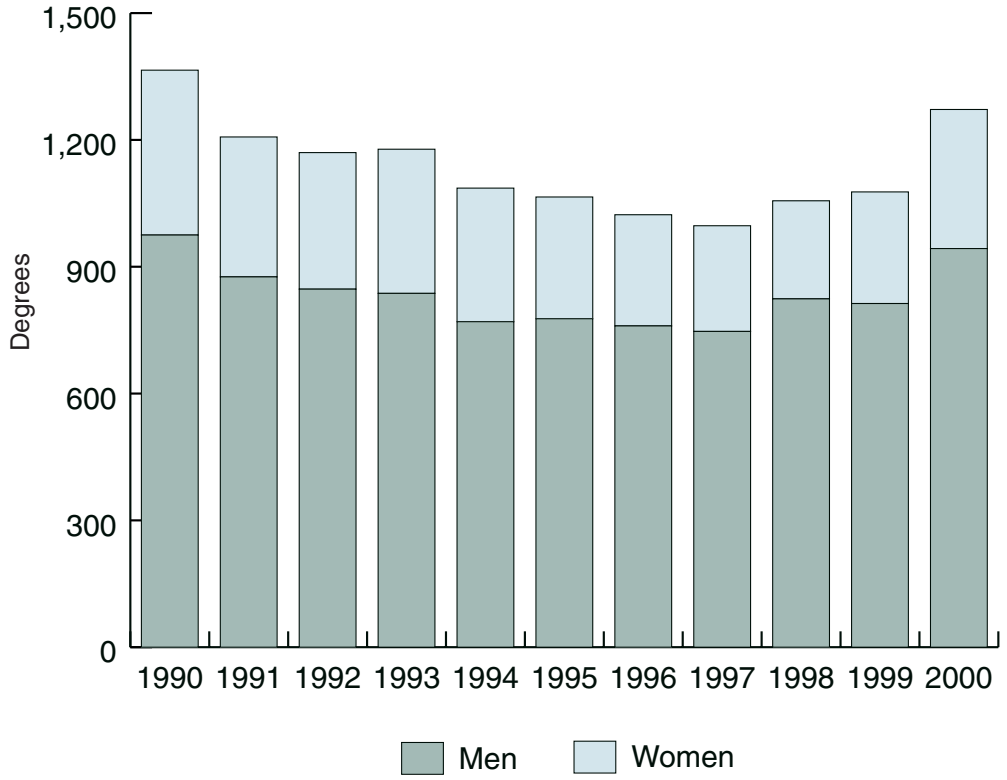

Figure D-19 -- CSU Computer Science Baccalaureate Degree Trends by Year by Gender, 1990-2000

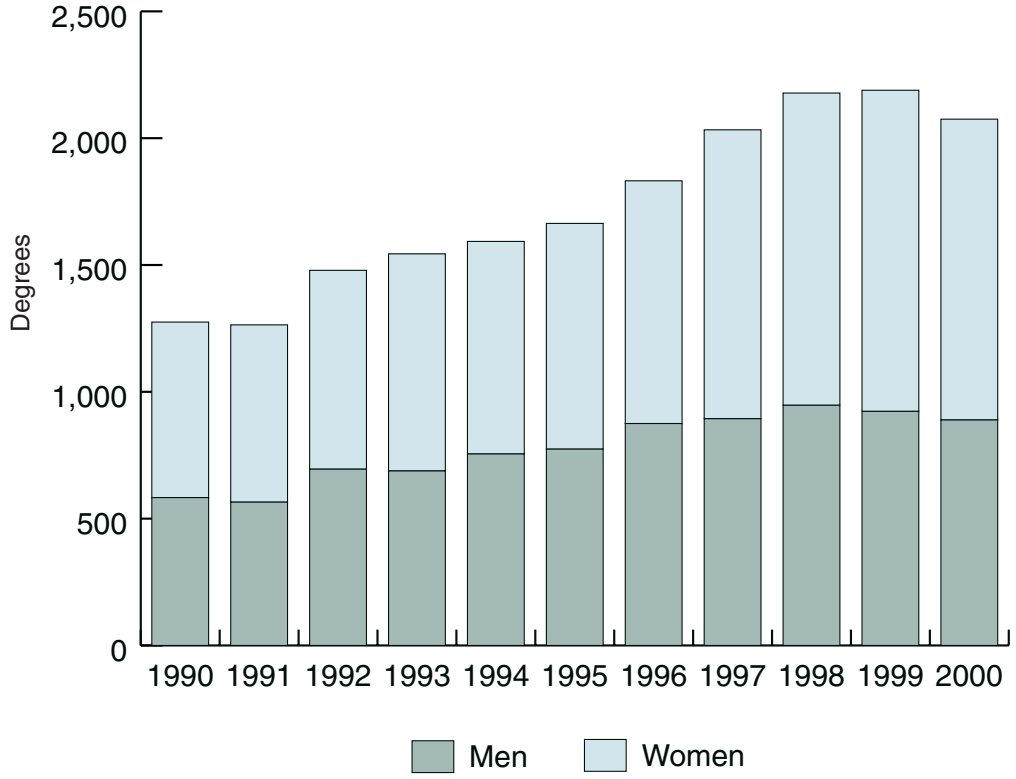

Figure D-20 -- CSU Biology Baccalaureate Degree Trends by Year by Gender, 1990-2000

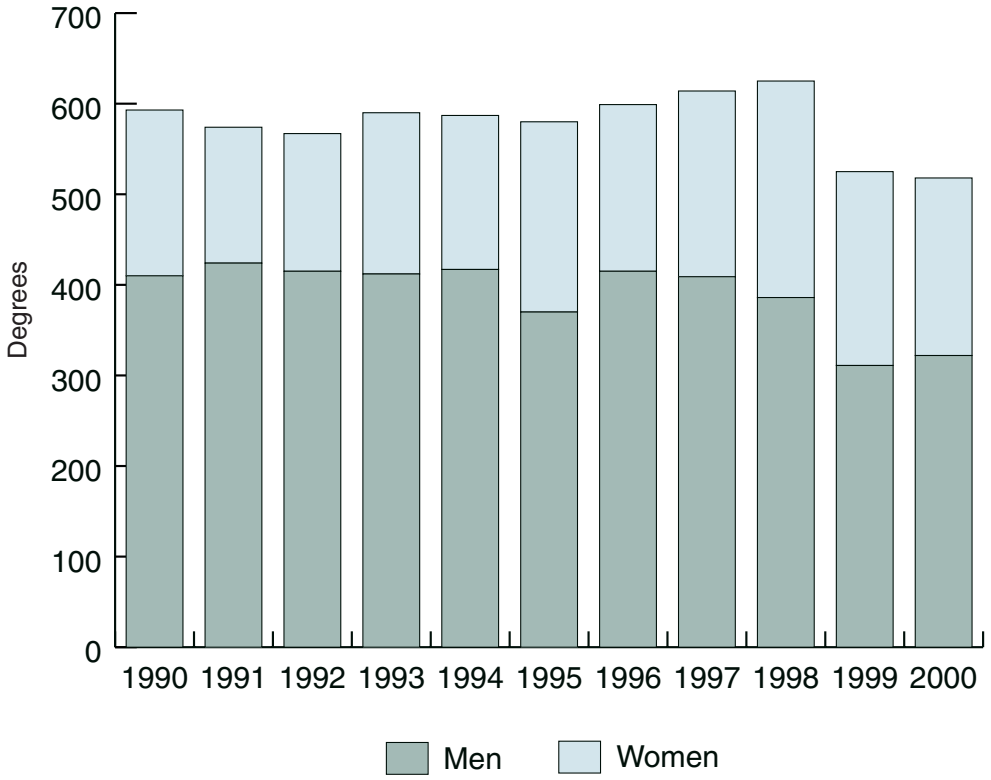

Figure D-21 -- CSU Physical Science Baccalaureate Degree Trends by Year by Gender, 1990-2000

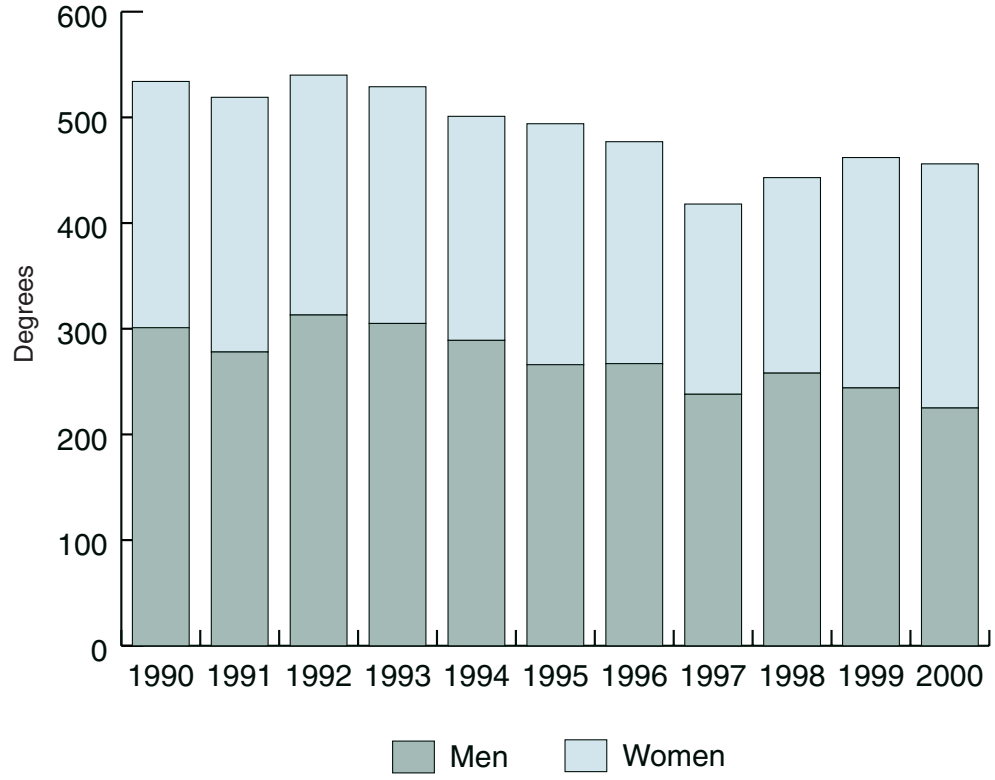

Figure D-22 -- CSU Mathematics Baccalaureate Degree Trends by Year by Gender, 1990-2000

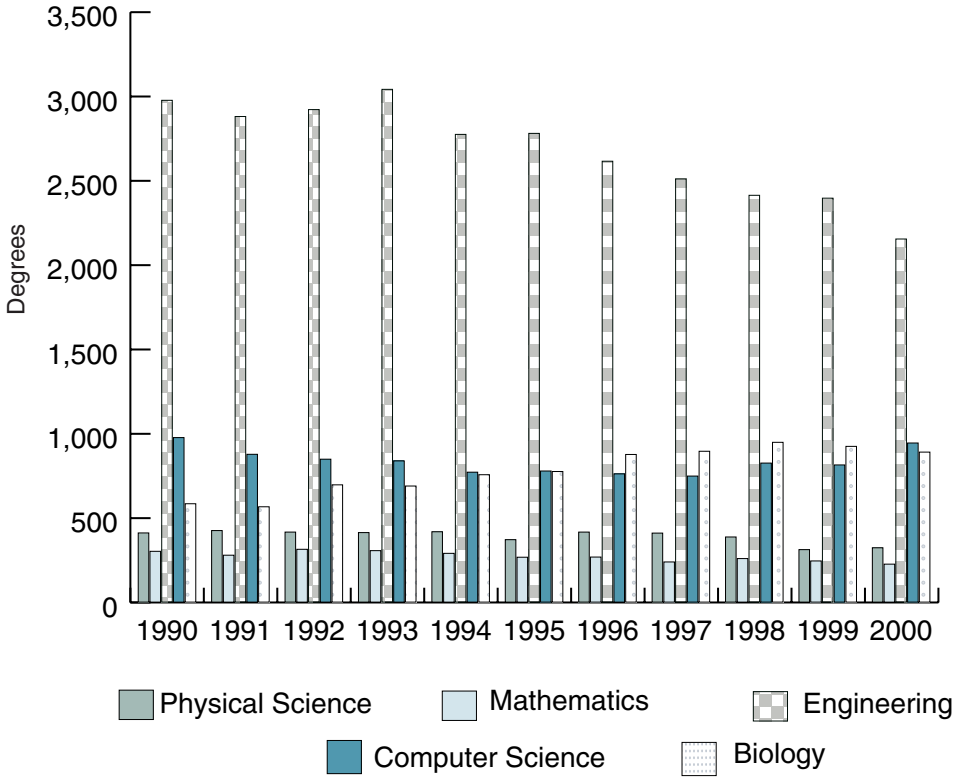

Figure D-23 -- CSU male S&E Baccalaureate Degree Recipients by Discipline, 1990-2000

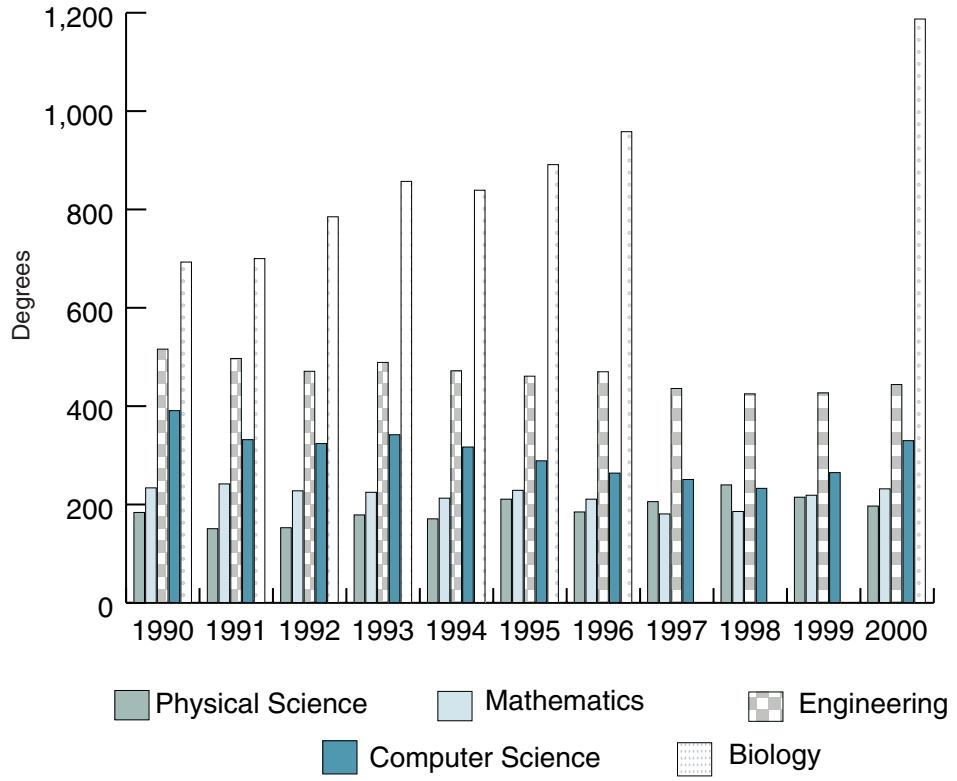

Figure D-24 -- CSU Female S&E Baccalaureate Degree Recipients by Discipline, 1990-2000

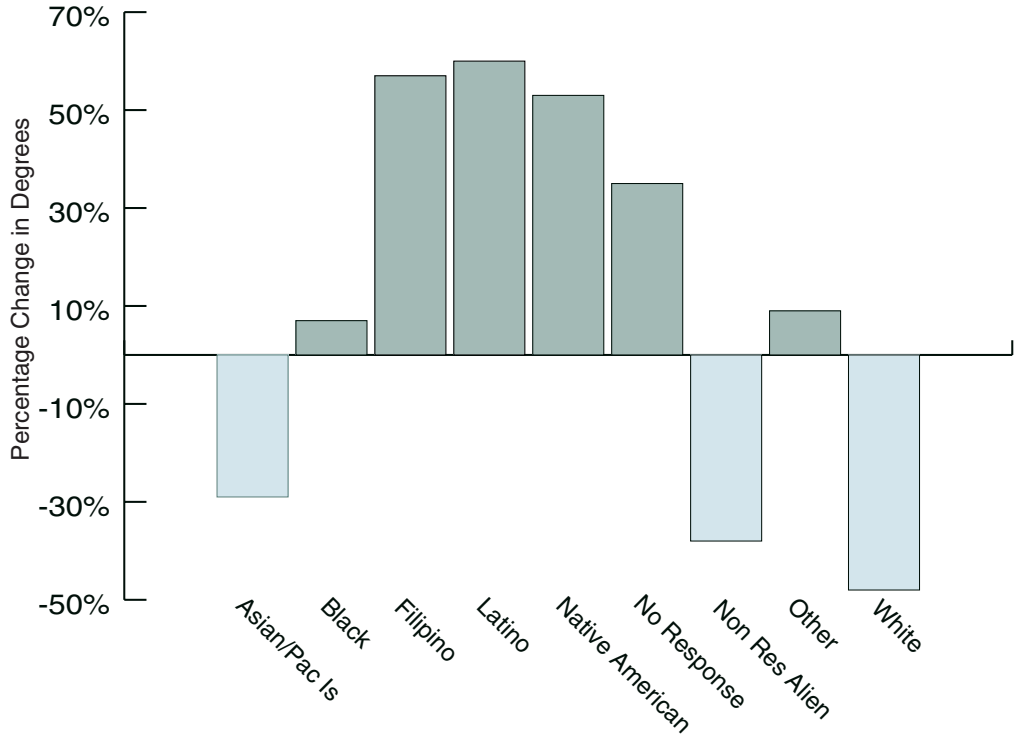

Figure D-25 -- CSU Percentage Change S&E Baccalaureate Degrees by Ethnicity, Engineering, 1990-2000

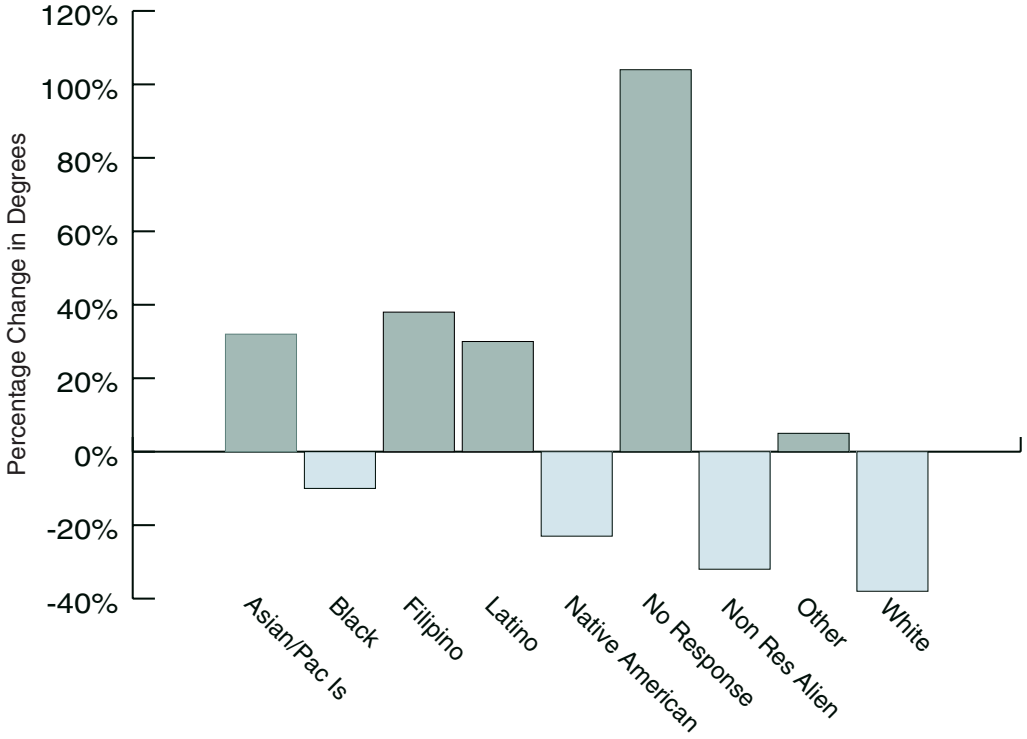

Figure D-26 -- CSU Percentage Change S&E Baccalaureate Degrees by Ethnicity, Computer Science, 1990-2000

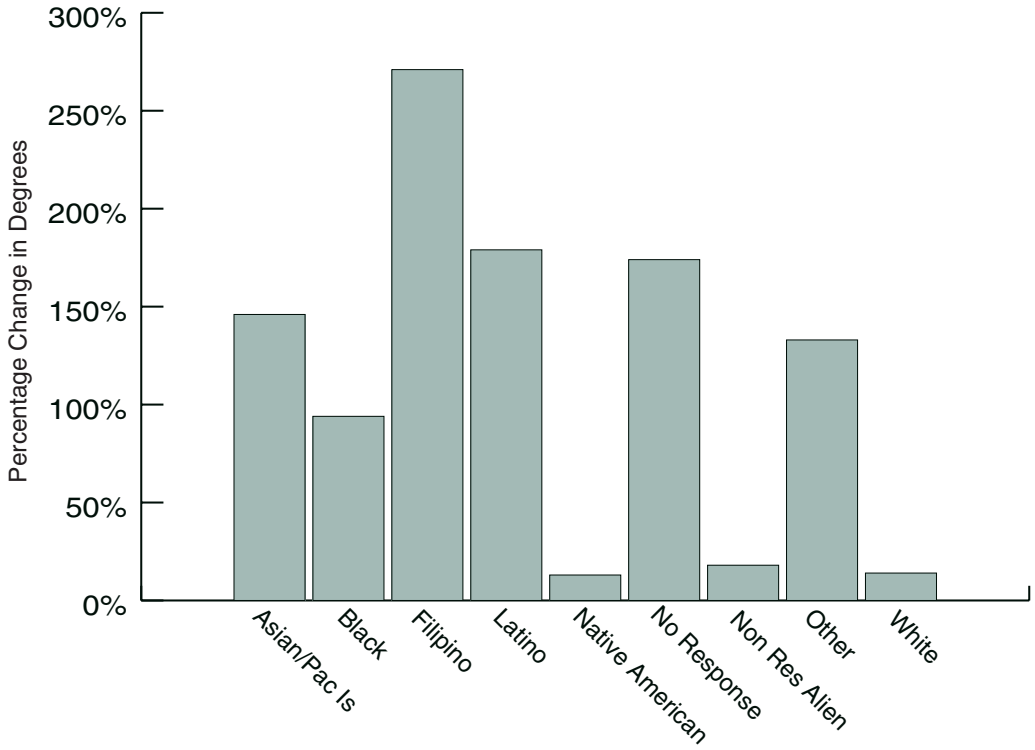

Figure D-27 -- CSU Percentage Change S&E Baccalaureate Degrees by Ethnicity, Biology, 1990-2000

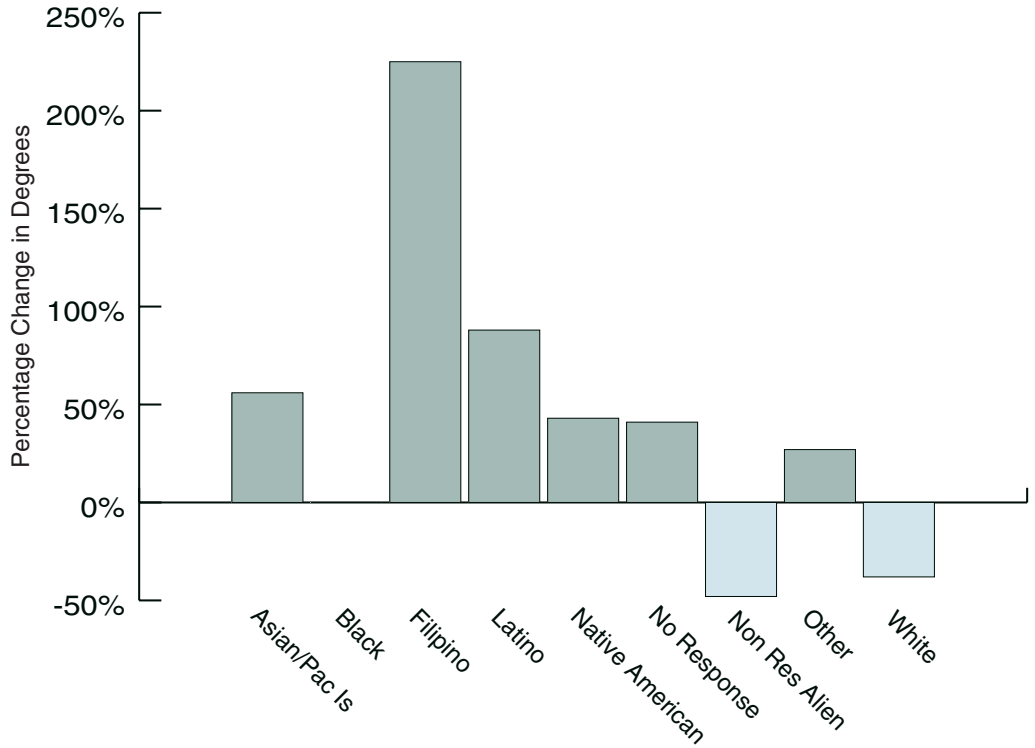

Figure D-28 -- CSU Percentage Change S&E Baccalaureate Degrees by Ethnicity, Physical Sciences, 1990-2000

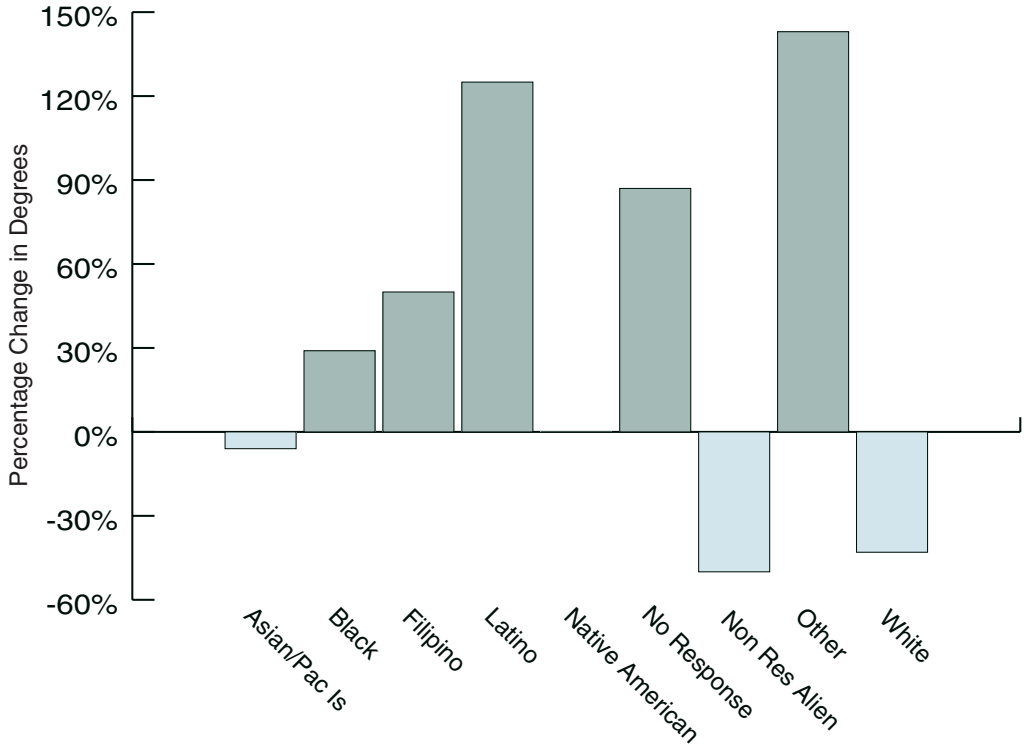

Figure D-29 -- CSU Percentage Change S&E Baccalaureate Degrees by Ethnicity, Mathematics, 1990-2000

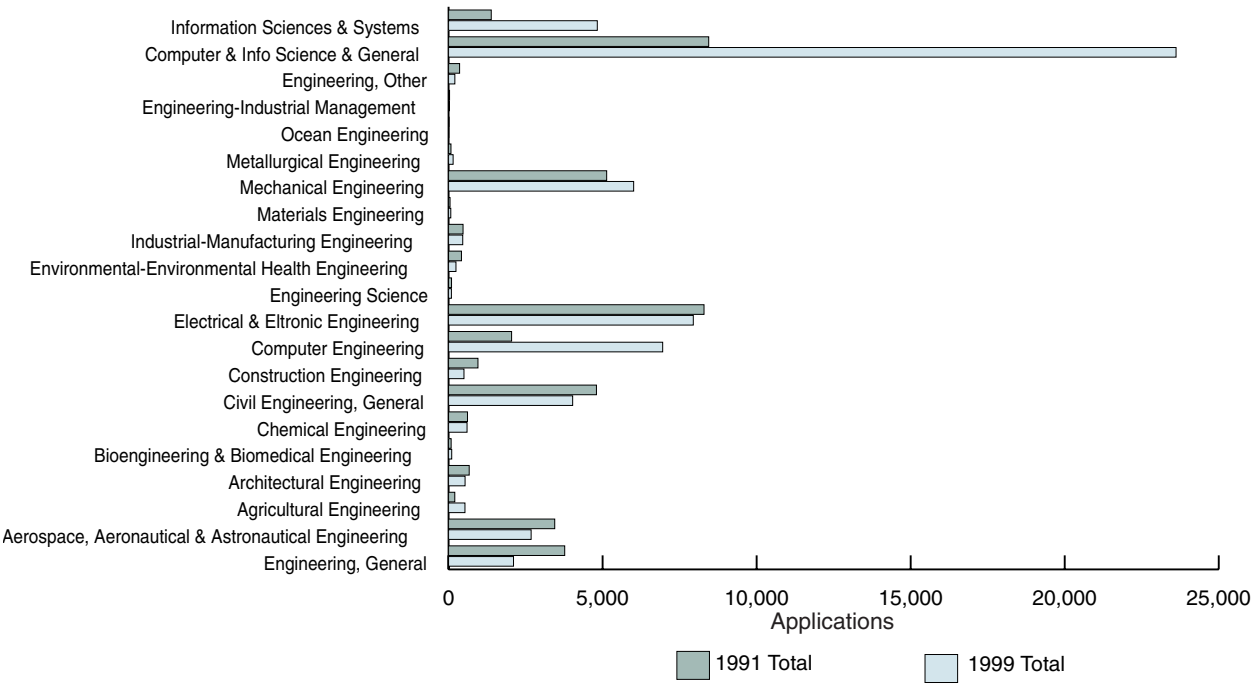

Figure D-30 -- CSU Engineering program Applications, 1991 & 1999

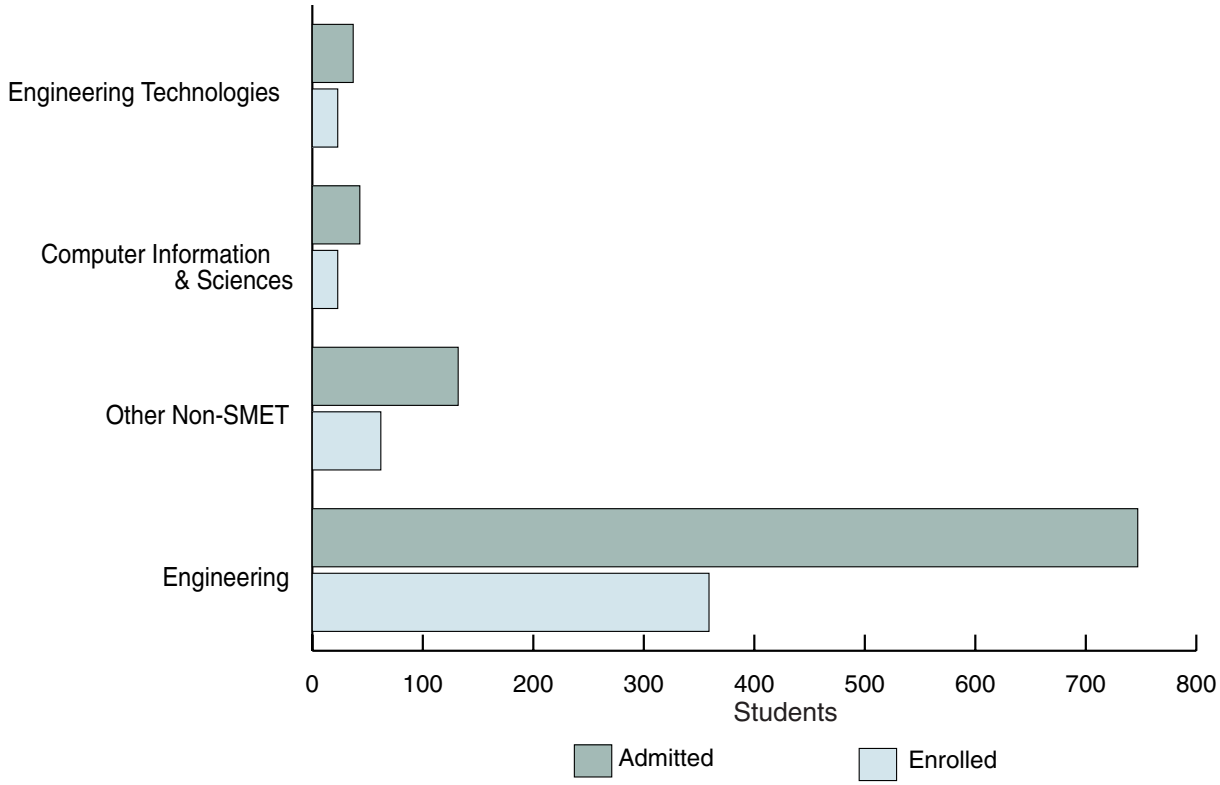

Figure D-31 -- CSU – San Luis Obispo, Admitted vs. Enrolled, by Discipline, Fall 1999

APPENDIX E. CPEC ENROLLMENT & DEGREE DATA, INDEPENDENT INSTITUTIONS

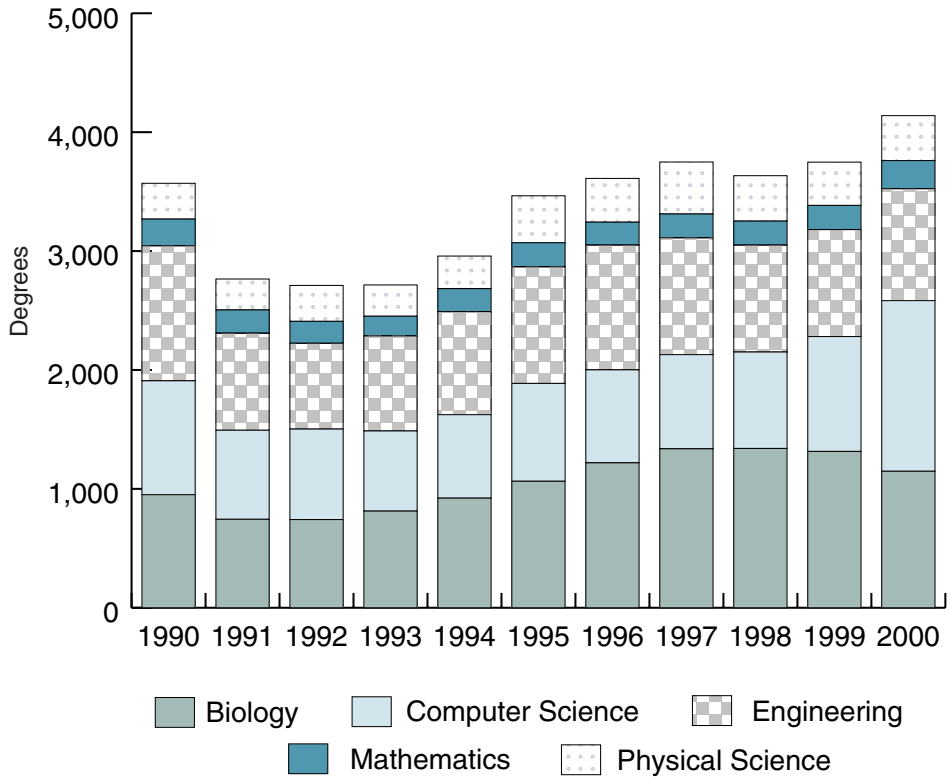

Figure E-1 -- Independent S&E Baccalaureate Degree Trends, 1990-2000

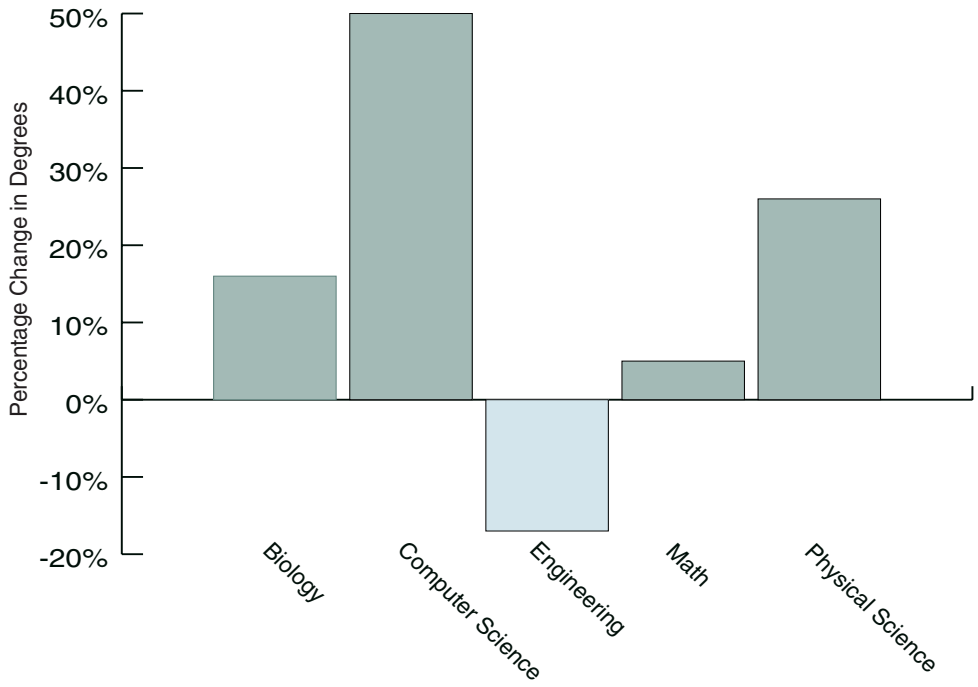

Figure E-2 -- Independent Percentage Change S&E Baccalaureate Degrees by Discipline, 1990-2000

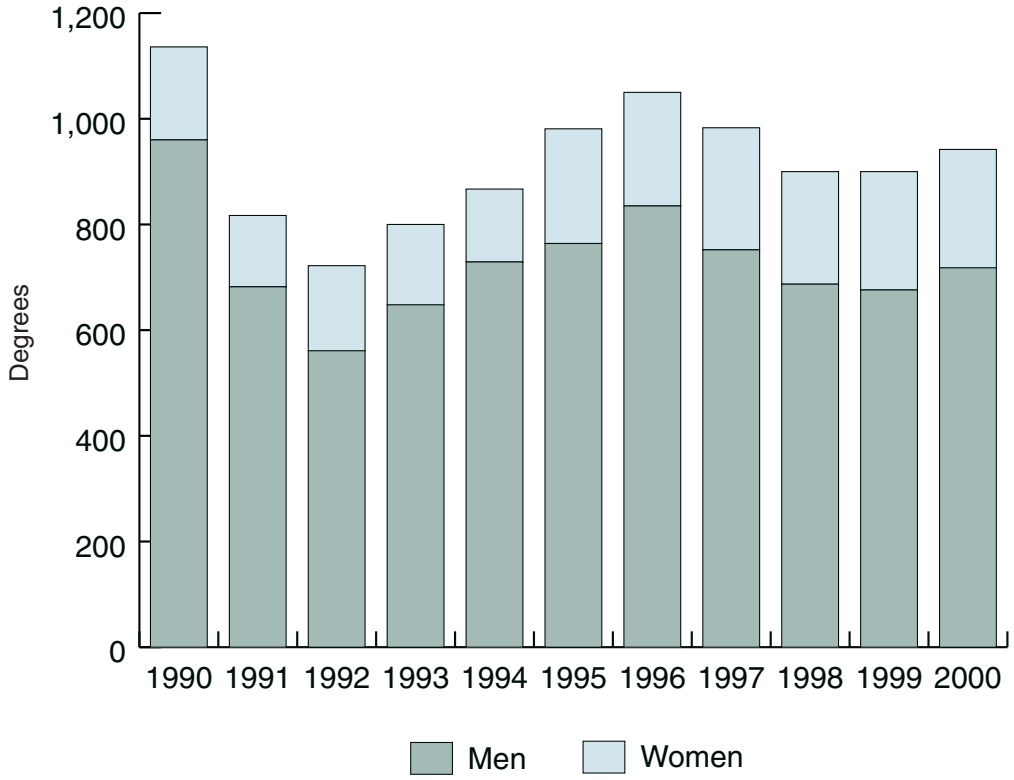

Figure E-3 -- Independent S&E Baccalaureate Degree Trends, Engineering, 1990-2000

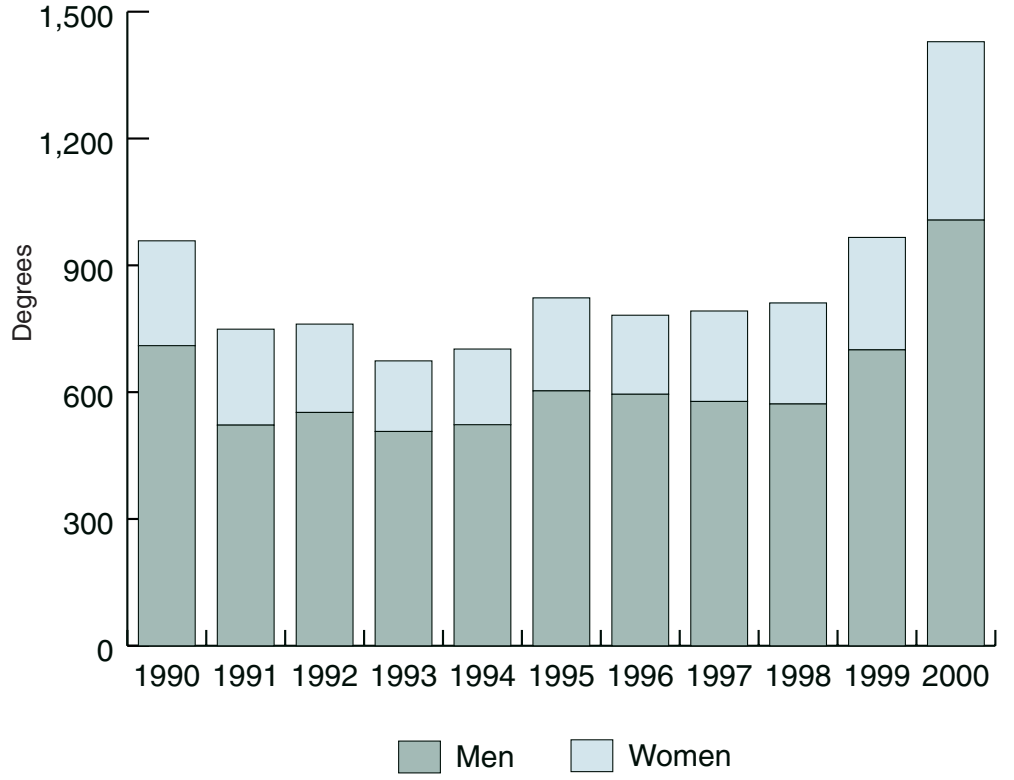

Figure E-4 -- Independent S&E Baccalaureate Degree Trends, Computer Science, 1990-2000

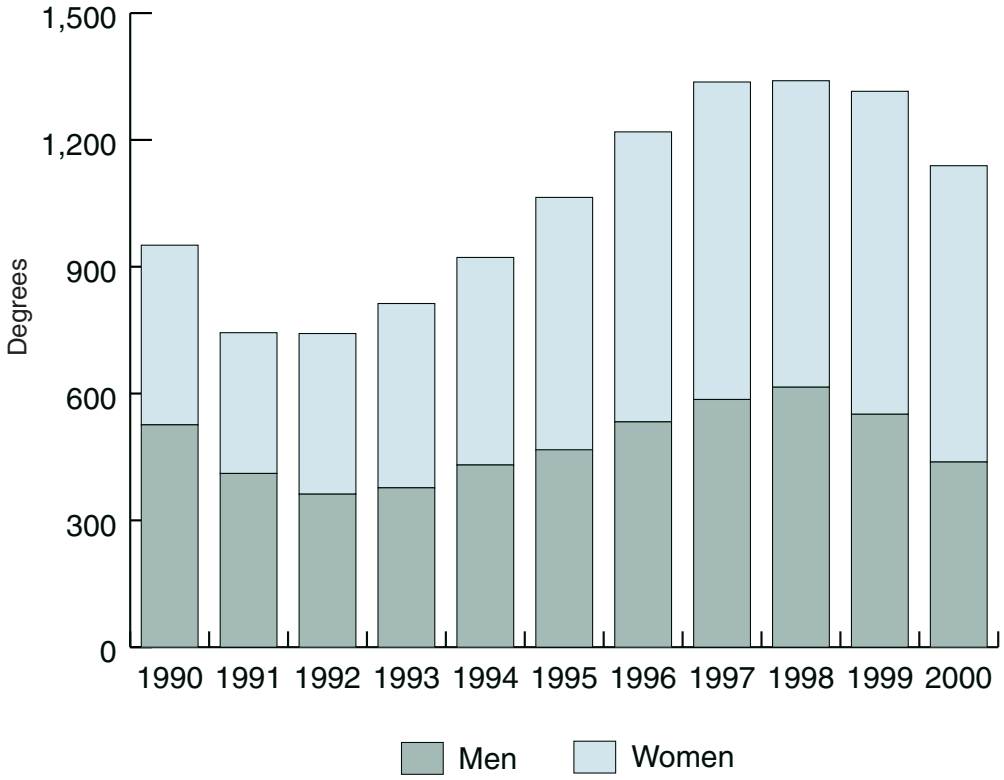

Figure E-5 -- Independent S&E Baccalaureate Degree Trends, Biology, 1990-2000

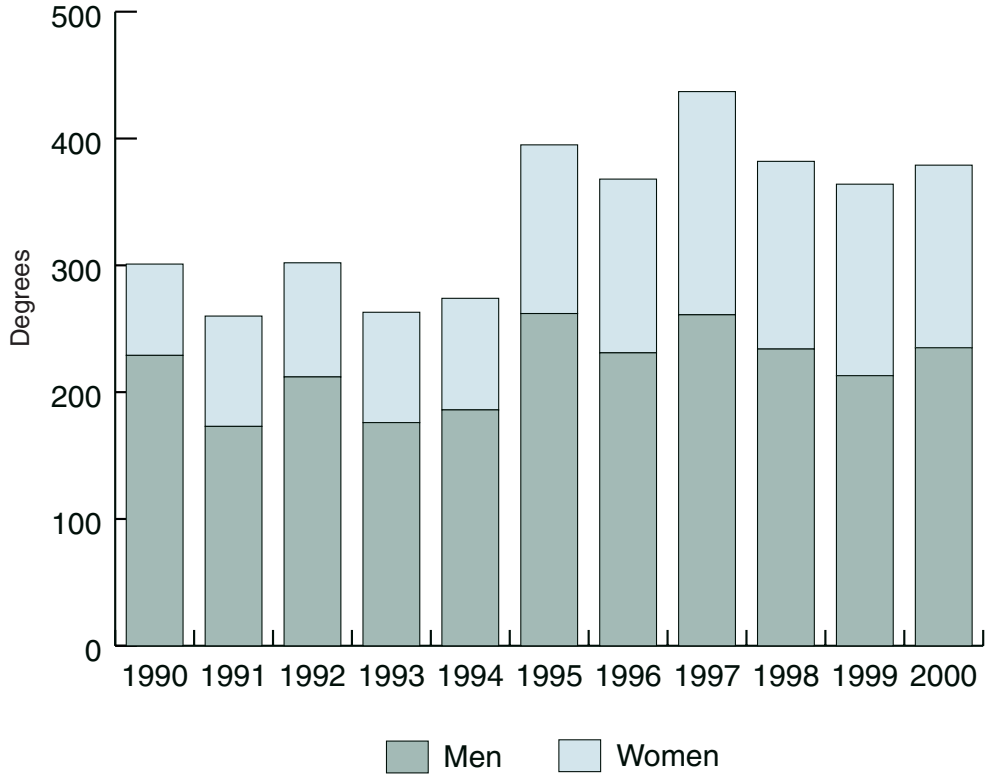

Figure E-6 -- Independent S&E Baccalaureate Degree Trends, Physical Science, 1990-2000

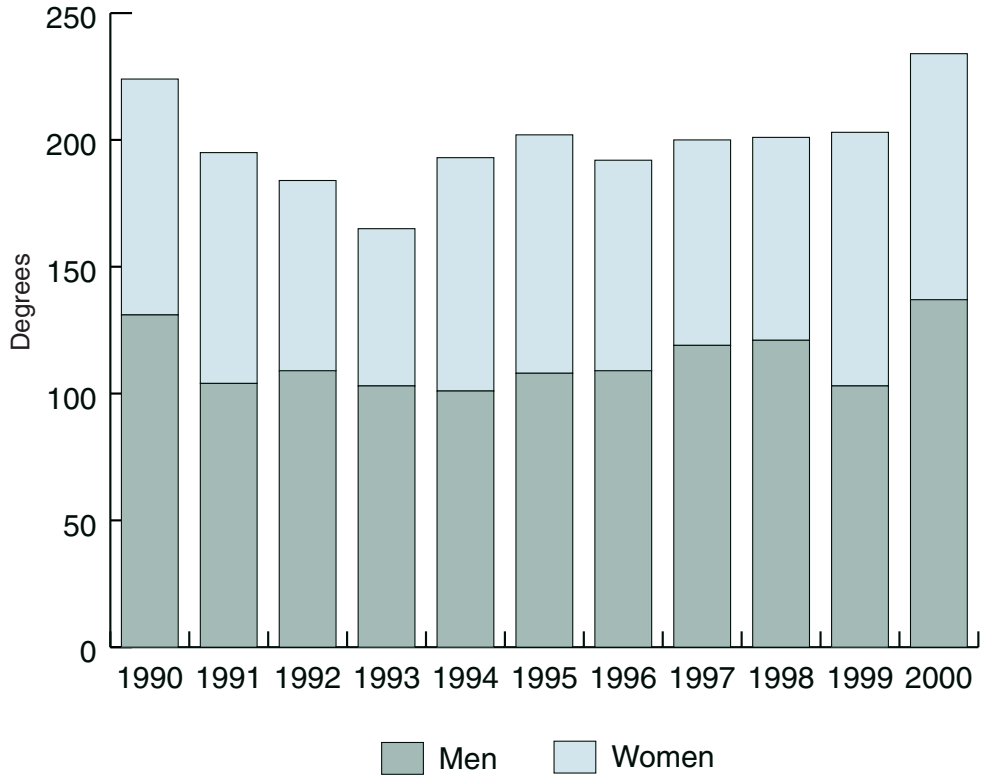

Figure E-7 -- Independent S&E Baccalaureate Degree Trends, Mathematics, 1990-2000

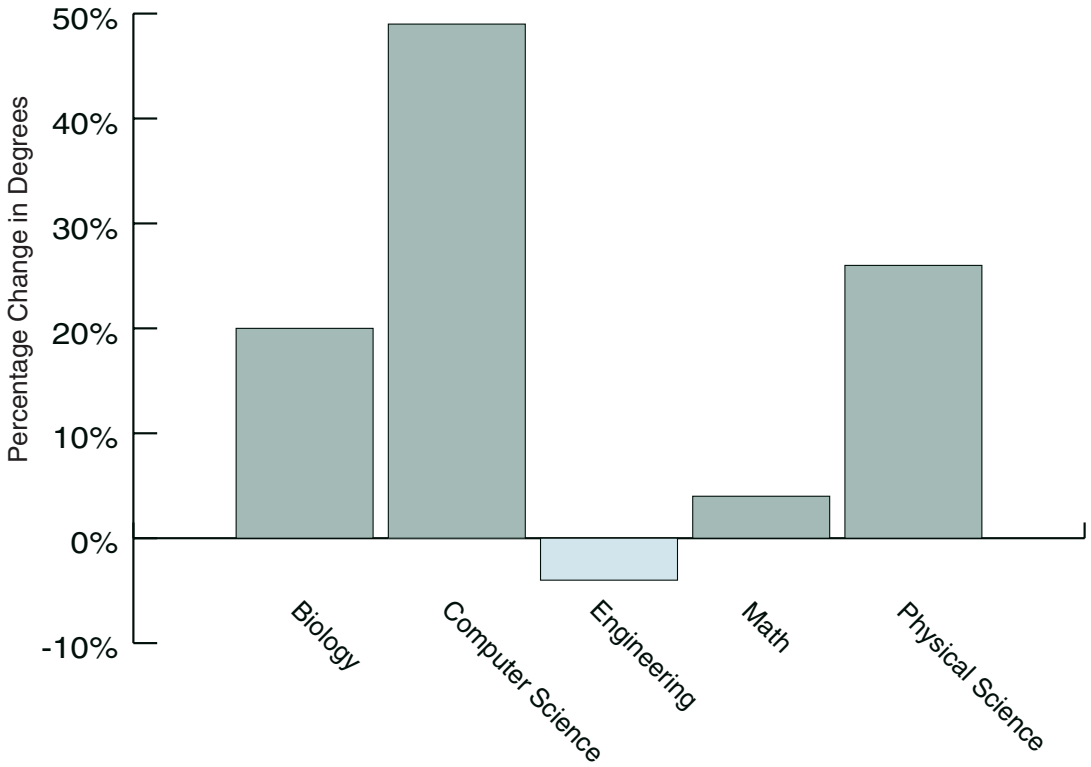

Figure E-8 -- Independent S&E Baccalaureate Degree Percentage Change by Discipline, 1990-2000

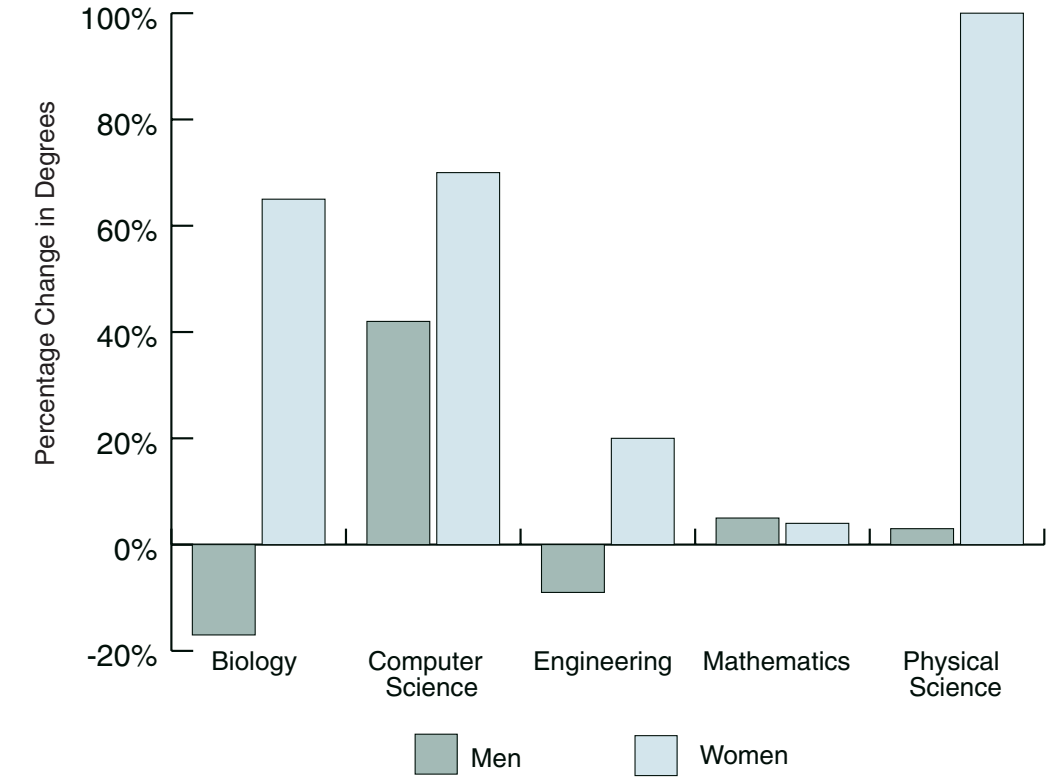

Figure E-9 -- Independent Percentage Change S&E Baccalaureate Degrees by Discipline and Gender, 1990-2000

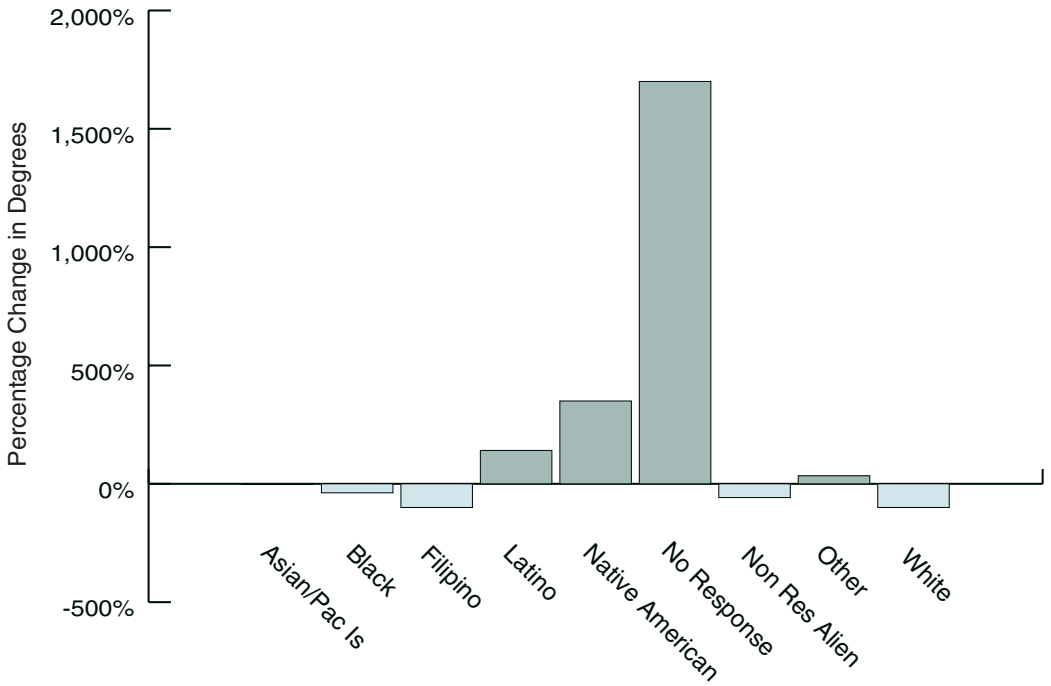

Figure E-10 -- Independent Percentage Change S&E Baccalaureate Degrees by Ethnicity, Engineering, 1990-2000

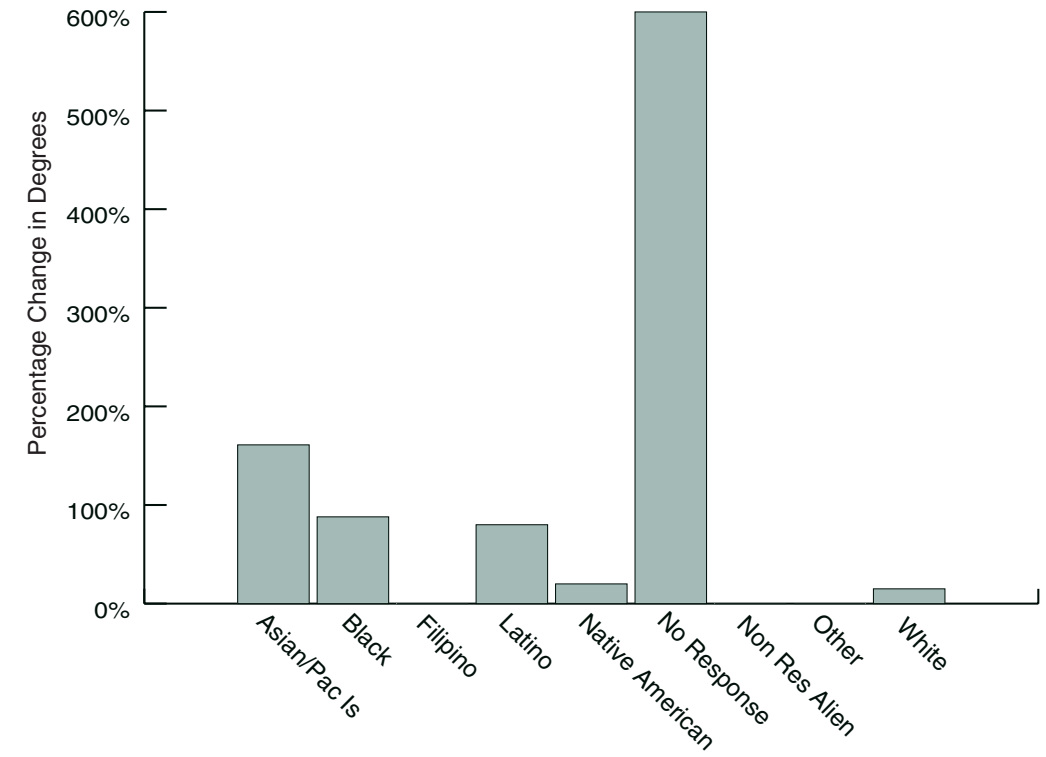

Figure E-11 -- Independent Percentage Change S&E Baccalaureate Degrees by Ethnicity, Computer Science, 1990-2000

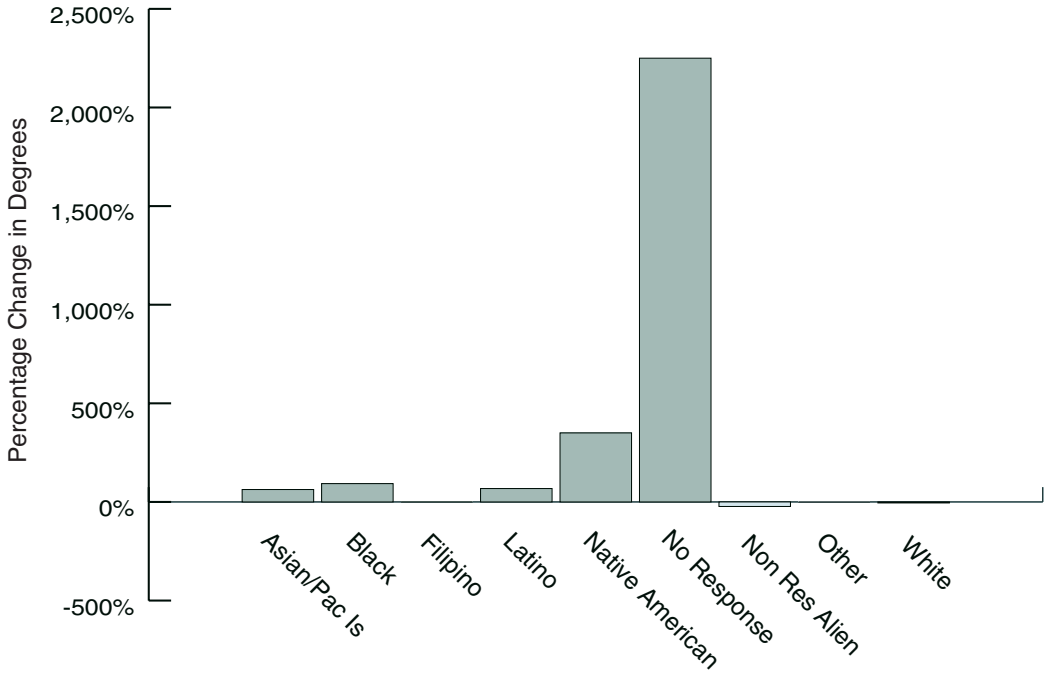

Figure E-12 -- Independent Percentage Change S&E Baccalaureate Degrees by Ethnicity, Biology, 1990-2000

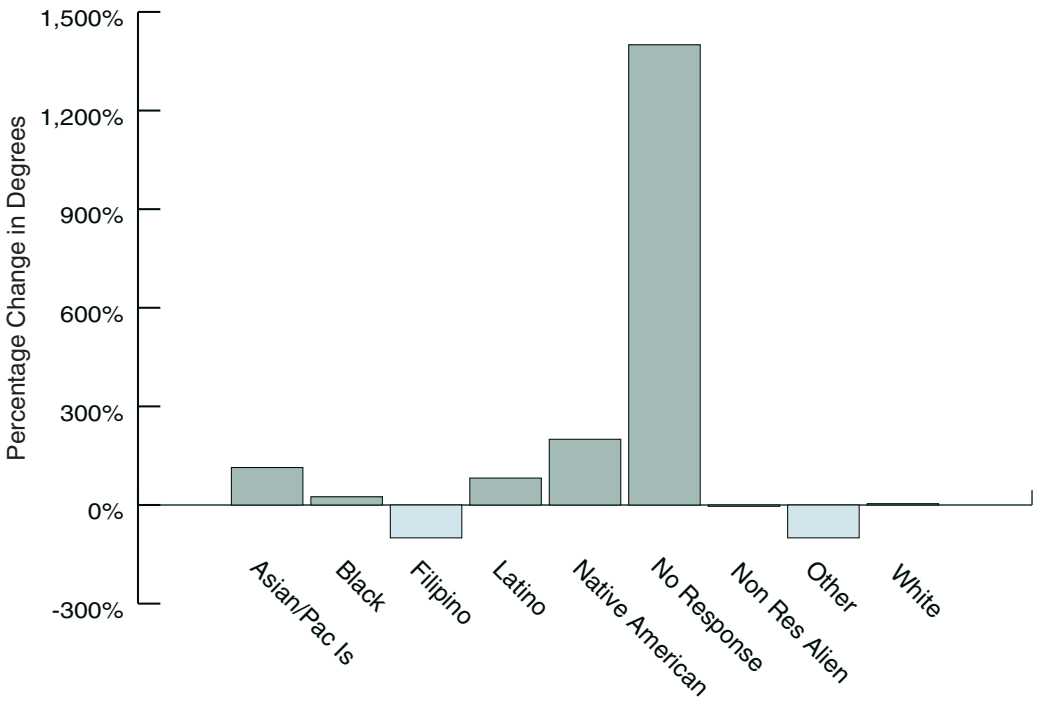

Figure E-13 -- Independent Percentage Change S&E Baccalaureate Degrees by Ethnicity, Physical Science, 1990-2000

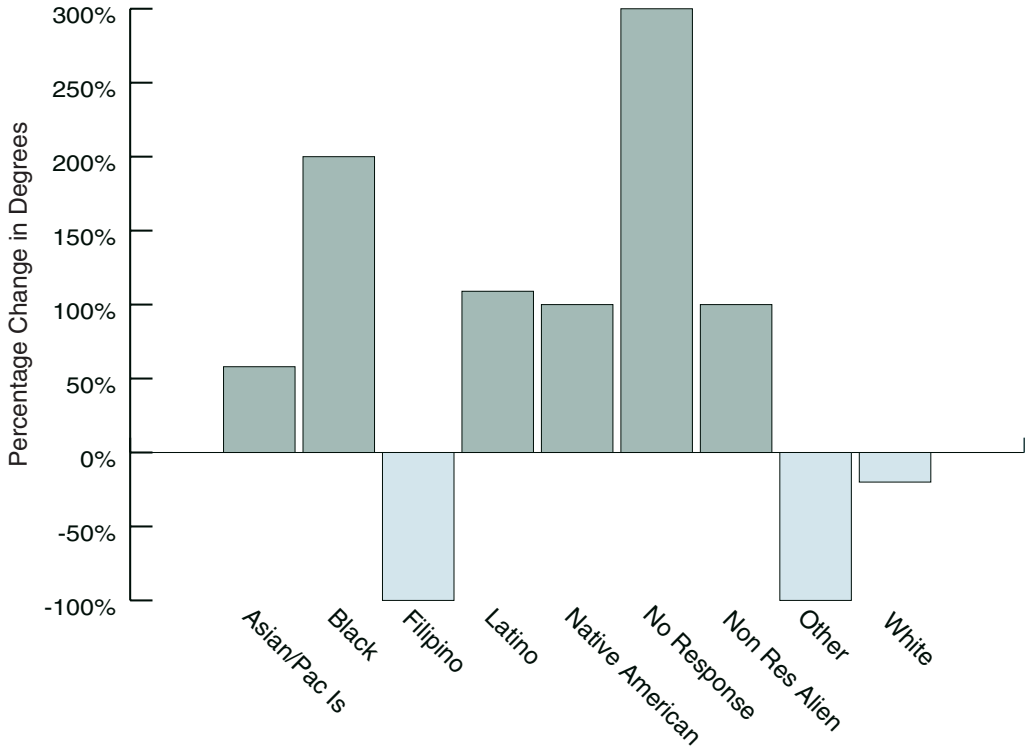

Figure E-14 -- Independent Percentage Change S&E Baccalaureate Degrees by Ethnicity, Mathematics, 1990-2000

APPENDIX F. ACKNOWLEDGEMENTS

This study could not have been completed without the extensive cooperation of various individuals at the University of California, California State University, and the California Postsecondary Education Commission (CPEC).

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University of California, Davis

University of California, Irvine

University of California, Riverside

University of California, San Diego

University of California, Santa Barbara

University of Redlands

Their detailed responses to our questions helped focus both the project and the integral Critical Path Analysis report.

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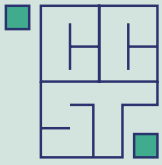

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