DOCUMENT RESUME

ED 238 368 HE 016 907

AUTHOR Thomson, Gregg E.
TITLE Survey of Spring 1982 Graduating Seniors in the College of Engineering, University of California, Berkeley.
INSTITUTION California Univ., Berkeley, Office of Student Research.
PUB DATE May 83
NOTE 82p.
AVAILABLE FROM University of California, Office of Student Research, Berkeley, CA 94720.
PUB TYPE Reports - Research/Technical (143) -- Tests/Evaluation Instruments (160)

EDRS PRICE MF01/PC04 Plus Postage.
DESCRIPTORS Academic Advising; Bachelors Degrees; *College Seniors; *Computer Science; *Engineering Education; Higher Education; Institutional Research; Majors (Students); Questionnaires; *Specialization; *Student Attitudes; *Undergraduate Study
IDENTIFIERS *University of California Berkeley

ABSTRACT

Opinions and experiences of college seniors majoring in engineering at the University of California, Berkeley, were studied in spring 1982. Specific attention was focused on the unequal distribution of interest in the various engineering programs. Data were analyzed by program, year of entry, and commitment to engineering in general and/or one's specific program. Responses to the questionnaire, which is appended, were received from 79 students in electrical engineering and computer science, 49 in mechanical engineering, 25 in civil engineering, 12 in engineering science, 11 in industrial engineering and operations research and 12 in other programs. Findings include the following: students across all programs viewed the employment prospects for students in electrical engineering and computer science as being excellent (and generally better than those in other programs); nearly three of every four students in computer science suggested that their enrollment in engineering was contingent on being in computer science itself; almost 90 percent of the sample of graduating seniors reported that they were satisfied with their education in engineering and with their specific program as well; and only half of the seniors expressed satisfaction with the faculty advising they received. (Author/SW)

OSR

SURVEY OF SPRING 1982 GRADUATING SENIORS IN THE COLLEGE OF ENGINEERING, UNIVERSITY OF CALIFORNIA, BERKELEY

Gregg E. Thomson

May 1983

SURVEY OF SPRING 1982 GRADUATING SENIORS IN THE COLLEGE OF ENGINEERING, UNIVERSITY OF CALIFORNIA, BERKELEY.

Gregg E. Thomson

May 1983

Office of Student Research
University of California
Berkeley, CA 94720
(415) 642-2032

SUMMARY

In the spring of 1982 the College of Engineering at the University of California discussed with the Office of Student Research the possibility of learning more about their students' undergraduate experience in engineering, in particular as it related to issues such as an unequal distribution of interest in the various engineering programs. With the assistance of the College, the Office of Student Research surveyed in April 1982 all seniors who had indicated an intention to graduate at the end of the spring quarter. This report analyzes the results of the seniors who replied (n=188).

An overall response rate of approximately 60% and fairly uniform representation across all major individual programs was obtained. Replies were received from 79 students in Electrical Engineering and Computer Science (EECS), 49 in Mechanical Engineering, 25 in Civil Engineering, 12 in Engineering Science, 11 in Industrial Engineering and Operations Research (IEOR), and 12 in the other smaller programs. For purposes of analysis, EECS was divided into Computer Science (31 students) and other EECS (46 students).

The data were analyzed in several ways—for example, by program, year of entry, and pattern of expressed commitment to engineering (i.e., engineering in general versus one's specific program). Only the program in which students were graduating produced consistent and meaningful differences in reported experiences and attitudes. Results in this report, therefore, are described for the entire sample and then analyzed in terms of program differences where they are observed.

Nearly half of our sample entered the College of Engineering from high school, and another third transferred from community college. Sixty-three percent report that their fathers have at least a college education, and more than a quarter say their fathers are engineers. Students report a wide range

of anticipated careers had one not entered engineering, with the largest group being science and medicine (29%). Students in both Engineering Science and Industrial Engineering and Operations Research (IEOR), two relatively small programs, appear to come from very highly educated families. In the case of Engineering Science those who have remained in the program also are likely to have come from engineering families and have chosen engineering over science or medicine. IEOR students, in contrast, are unlikely to come from engineering families and likely to have chosen engineering over business administration.

There is clear evidence that students across all programs view the employment prospects for students in EECS as being excellent (and generally better than those in other programs). For example, 98% of non-EECS students checked as a distinctive attribute of EECS its good initial employment prospects. Perhaps related to this, EECS students, and in particular the group within Computer Science, report a high degree of allegiance to their program. Insofar as we can determine, not a single person in our sample who entered Computer Science either changed programs or would change if starting again. There is a conspicuous attrition from the Engineering Science program with apparently no offsetting flow--actual or desired--to it, but in other programs this is not the case.

Two-thirds of the seniors report that their primary activity next year will be engineering-related employment. Another quarter indicate that they will immediately pursue graduate studies in engineering. Two-thirds believe they will eventually earn a MS or M.Eng. degree and more than a third anticipate an MBA degree. It is striking that fully 95% of our sample anticipate eventually earning at least one advanced degree.

Almost half of the seniors recalled deciding on engineering before the 12th grade and a third had specified a particular program before college. Graduating seniors in Civil Engineering appear more likely to make earlier choices; those in Engineering Science report later choices. Slightly more than half of the

graduating seniors indicate that they are now "very certain" in their choice of specialty within engineering as well as in engineering as a career. Responses to an open-ended question identify a range of influences affecting the original decision to enter engineering. The most prevalent (39%) of those influences mentioned either first or second was a background or interest in applied math or science.

About a third of the students agreed with the statement "If I couldn't be in the program I'm in, I probably wouldn't be in engineering at all." Differences by program are dramatic: the degree of agreement ranges from Engineering Science (8%) and Mechanical(18%) to IEOR (50%) and Computer Science (73%). Thus, nearly three of every four students in Computer Science suggest that their enrollment in engineering is contingent on being in computer science itself.

Regardless of program, however, students report looking forward to working with computers in their employment. As would be expected, the opportunities for technical problem solving is seen as an attractive feature of the particular program a student has chosen. The exception is IEOR where students are more likely to stress the importance of working with other people and eventual managerial leadership as reasons for choosing one's program. Students in Civil Engineering (52%) are more likely than those in other programs to identify their family as influential in their decision to choose their specific program.

Family and parental resources (45%) and earnings and savings (48%), excluding the Coop work program, are identified as the main sources of financial support for the junior and senior years. Forty-three percent of the seniors report receiving financial aid through the Berkeley financial aid office. Nearly 30% of the students will have educational loans of less than $5,000 upon graduation, while an additional 14% will have loans of $5,000 or more.

As students approach graduation, they report a high degree of satisfaction with their undergraduate experience. Almost 90% of the graduating seniors in

our survey report that they are generally satisfied with their education in engineering in general and in their specific program as well. In contrast, only half of the seniors report satisfaction with the faculty advising they have received. Students in Civil Engineering report especially high degrees of satisfaction; Engineering Science students indicate the least satisfaction. Seven of every eight students report good career prospects associated with graduation in their program.

The majority of the students rate their instructors as good teachers, though IEOR students (36%) are much less likely to concur. Computer Science students are much less likely than others to rate positively their program's equipment and facilities.

About three-quarters of the students indicate that they have a clear idea of the kind of career that they will have in engineering, but for Computer Science the figure is 100%. Conversely, about half the students indicate that they wish they had known about the various programs in engineering before choosing the one they did, but only 21% of the Computer Science students feel this way. Furthermore, a clear majority of seniors in our study favor the idea of a two-year common curriculum before choosing a program. Less than 30% of the Computer Science students think this would be a good idea. Again, the evidence suggests that Computer Science students are distinctly set on their particular program and career paths.

When asked to identify the person, office, service, or experience outside of formal coursework that has been most helpful, more students (28%) wrote "myself," "no one," or left the question blank than any other type of response. Thirty-nine percent of the Computer Science students gave such a response. In no program was the percentage mentioning faculty, staff or administrative assistance as high as 20%.

When asked for suggestions to improve undergraduate education, 30% mentioned course-related issues (e.g., course requirements). In each program except Civil (12%), from 26% to 39% of the students identified the need for improvement in their instructors, notably in the areas of teaching skills and accessibility.

In summary, the pattern of results suggest generally high levels of satisfaction with the undergraduate experience in engineering. There is, however, fairly consistent evidence of distinct contrasts among certain programs. In particular, Computer Science, Engineering Science, IEOR and Civil Engineering each has its own characteristic pattern of responses.

Implications of these results are discussed, especially in light of the limitations of the research design, i.e., retrospective reports of graduating seniors, and the College's desire to consider the implementation of curriculum changes. Some of the opportunities for further analysis afforded by these data are also highlighted.

CONTENTS

LIST OF TABLES

BACKGROUND AND ACKNOWLEDGEMENTS

This study grew out of a conversation during the Winter quarter of 1982 between Arthur Bergen, Associate Dean of the College of Engineering, and W. M. Laetsch; Vice-Chancellor for Undergraduate Affairs, about students and undergraduate education. The Office of Student Research, which is a part of the division of Undergraduate Affairs, provided the services of Mr. Gregg Thomson, Senior Analyst, for the development, oversight, analysis, and writing of this survey project. The College of Engineering, in turn, provided funds to support the direct expenses of the project, including the hiring on a part-time basis of Mary Ann Rettig-Zucchi, a graduate student in the School of Education. She deserves special thanks for the very effective and conscientious way in which she co-ordinated the many aspects of the survey distribution and collection, and the preparation of the results for final analysis. In addition, Mr. Bergen, Karl Pister, the Dean of the College of Engineering, and Ms. Iola James, Management Services Officer in the College, all provided generous assistance and consultation throughout the project. In the Office of Student Research Ms. Cecilia Wainryb assisted with the computer analyses and Ms. Joy Boyd with typing and table preparation. They deserve special mention and thanks.

The results of the survey have been reviewed by the College of Engineering but inaccuracies in the results or their interpretation are the sole responsibility of the author.

INTRODUCTION

This report provides the basic results of a survey of Spring 1982 graduating seniors in the College of Engineering at the University of California, Berkeley. The purpose of the survey was to elicit the opinions and reported experience of the graduating seniors on a number of issues of concern to the administration of the College of Engineering. Of central concern over the past few years has been the unequal distribution of interest in the various academic programs within the College. Specifically, Electrical Engineering and Computer Science (EECS) is in very great demand. Despite higher admissions standards than the other programs, EECS must still turn away numerous students. In contrast, for example, Civil Engineering, which the College considers to have a strong faculty and solid program of study, is undersubscribed.

To understand both the reasons underlying the unequal distribution of student interest and the possibilities of modifying it, the College wished to assess the nature of commitment to a specific program of study manifested by the graduating seniors. Questions addressing the timing, certainty, and personal factors affecting the choice of program as well as engineering in general were of interest, therefore, as were perceptions of career prospects associated with each of the major programs.

There has been some discussion within the College of Engineering about the desirability of instituting a common curriculum for the first two years of study, thereby increasing student exposure to a wider range of program possibilities. The feasibility of this innovation was addressed directly by eliciting student opinion concerning it and related curriculum changes. Indirect measures of the possibility of relatively easy re-distribution of students among programs were obtained by examining, for example, reported satisfaction within one's program and the degree of stability of program preference over time.

The specific concern about the distribution of students among programs afforded an opportunity to assess in more general terms the undergraduate experience in engineering. Therefore, the questionnaire also reflected a "taking stock" of one's undergraduate education. This entailed, for example, providing an evaluation of faculty advising, an area with which the College is concerned.

The College of Engineering solicited the assistance of the Office of Student Research to conduct the survey. The College provided funds to support the hiring of a part-time graduate research assistant to carry out the "nuts and bolts" of the questionnaire distribution and the preparation of the data for analysis. These tasks were performed admirably by Mary Ann Rettig-Zucchi, a graduate student in the School of Education. The questionnaire itself was designed by the Office of Student Research and Ms. Rettig-Zucchi in consultation with the College of Engineering.

Special thanks are extended to Associate Dean Arthur Bergen, Dean Karl Pister and Ms. Iola James. Their generous support and assistance at each stage of the project made the completion of the survey possible.

This report contains four sections. First, the methodology of the survey and cautions associated therewith are discussed. Second, perceptions of the various programs and stability of choice of program are examined. These results were first presented orally to the Dean and Associate Dean by the Office of Student Research in June 1982. No further analysis of these aspects of the survey has been undertaken at this time, and the results are merely reviewed as a good introduction to the third section of the report which provides a more detailed analysis of the general undergraduate experience in engineering as reported by graduating seniors.

The results will suggest that, for many aspects of the undergraduate experience in engineering, there are significant differences among students. Furthermore, these differences appear to be directly associated with the program one has gone through rather than, for example, how early one entered the College of Engineering. The implications of these results for possible curriculum revision are discussed in a final section.

METHODS AND LIMITATIONS

A review of the relevant literature conducted by Ms. Rettig-Zucchi yielded several studies that examined factors associated with entry into engineering and attrition from it (Smoth 1960, Elton & Rose 1967, Taylor & Hanson 1970, Athanasion 1971, Brainard 1974, Elkins & Luetkemeyer 1974, Morgan 1974). Additional studies in recent years have addressed issues associated with the experience of women and ethnic minorities in engineering (Amazigo 1973, Becker & Mowsesian 1976, Ott 1976, Durchholz 1977). However, Ms. Rettig-Zucchi was unable to locate any published research that investigated specific programs within engineering. The type of survey undertaken here is apparently unusual, if not the first of its kind. Given the absence of previously published work, an original eight-page questionnaire was developed. It is included here as Appendix A.

Ordinarily, one would like to draw on the knowledge of individuals of the group being surveyed in constructing a new research instrument. (This might be accomplished by soliciting input in the drafting of the questionnaire or by pilot testing it on a small scale once drafted.) However, the College of Engineering realized that it would be most practical were the questionnaire distributed at the beginning of the Spring Quarter when each senior filed his or her study list with the College. To meet this deadline

the questionnaire was constructed during the Winter Quarter final examinations and subsequent quarter break. This inflexible schedule precluded direct student input. Ms. Rettig-Zucchi was able, however, to interview several Engineering faculty members recommended by the Associate Dean of the College. Their ideas and suggestions were used in formulating the questionnaire.

The following procedures were followed for the distribution and collection of the questionnaires. Each Engineering student filed a Spring Quarter study list during the week of April 12 (with the exception of a few students who filed late). In turn, the curriculum assistant handed a packet of survey materials to each student who filed a required statement of intention to graduate. In addition to the questionnaire there was a cover letter from the Dean of the College of Engineering and a return envelope addressed to the College of Engineering. There was also a prominently marked return box in the undergraduate office of the College.

Questionnaires were available to those who filed late as well as to those who misplaced the first copy. On April 23 a postcard from the Dean urging return of the completed questionnaire was sent to each student identified by the undergraduate office as a graduating senior. Response rate was monitored by program during the month following distribution of the questionnaire. A relatively low response rate from Civil Engineering students was noted, so a second postcard, this time from the Associate Dean, was directed to Civil Engineering students on May 11.

Theoretically, therefore, each graduating senior was personally handed a questionnaire and received as well an individual postcard reminder (or, in the case of Civil Engineering, two postcard reminders) to return the questionnaire.

A. Adequacy of Our Data

These procedures appeared to work fairly successfully, producing an overall response rate of perhaps 60%. Several ambiguities make it impossible to calculate the response rate with exact precision. Of the 295 questionnaires actually taken by students, 188 were returned, a completion rate of 64%. However, individual names were not recorded or checked off as questionnaires were handed out. So we do not know how many students took more than one questionnaire--a factor that would lead us to underestimate the true response rate--or how many simply returned the questionnaire uncompleted to the stack--a factor that would lead us to overestimate the true response rate. A couple of weeks into the Spring Quarter 324 students were identified as graduating seniors (though on April 23 only 313 were identified and sent the reminder postcard). Using this as a base gives an estimated response rate of 58%. On the other hand, by the end of the Spring Quarter the apparent number of graduating seniors had risen to 346, giving a response rate of 54%.

Response rate by program is presented in Table 1. Using the more conservative 346 figure one can see that, with the exception of the small naval architecture program, response rates were fairly uniform, ranging from 50% (Civil Engineering) to 71% (Engineering Science).

We believe this is rather successful response rate for a study of this type. The curriculum assistant is quite busy with required procedures during study list filing and in quite a few instances apparently did not remember to hand a graduating senior the questionnaire. Moreover, the questionnaire is relatively long and involved and, typically, seniors may be less likely than, say, freshmen or sophomores to complete impersonal requests of this sort. Given the relatively conscientious way in which the

questionnaires appeared to have been completed, the response rate (approximately 55-60%) and the number of completed questionnaires (188) permit us to proceed with an analysis of the results.

TABLE 1. RESPONSE RATE BY PROGRAM

Seniors Graduating Spring Quarter 1982* Program	Number	Number of Surveys Returned	Response Rate
Civil	52	26	50.0%
Electrical Engineering and Computer Science (EECS)	138	79	57.2%
Engineering Science	17	12	70.6%
Industrial Engineering and Operations Research (IEOR)	21	11	52.4%
Manufacturing	3	2	66.7%
Materials Science	6	2	33.3%
Mechanical	85	45	52.9%
Mineral	2	1	50.0%
Naval Architecture	3	1	33.3%
Nuclear	5	2	40.0%
Double Majors	(14)	(7)	(50.0%)
EECS/MSE	4	2	50.0%
ME/MSE	8	4	50.0%
MSE/Chem	1	0	0
NE/Chem	1	1	100.0%
TOTAL	346	188	54.3%

*Figures obtained from "Preliminary list of Spring '82 graduates," College of Engineering.

Nonetheless, there are a number of cautions to be aware of in interpreting the results of a study of this type. Generally speaking we will find that the 188 graduating seniors express relatively high degrees of satisfaction with the College of Engineering and their programs in particular. To more fully understand the undergraduate experience in Engineering, however, one would like to be able to follow a group of students through each step of the process. Asking only graduating seniors to reconstruct and summarize their experiences

introduces several possible sources of bias. Three in particular might be mentioned: (1) differential attrition (students who leave before becoming graduating seniors may differ from those who do not, e.g., in degree of satisfaction with the College); (2) biased recall (students may remember or interpret earlier experiences inaccurately, e.g., perhaps rationalizing prior decisions or behaviors); and (3) cohort obsolescence (what is true for graduating seniors' past experiences may not be true for, e.g., current freshmen). Another more general source of bias is differential response rate (students who respond to a survey may differ from those who do not--the latter, e.g., may be less satisfied or more alienated).

Therefore, despite an adequate response rate and good quality of data, one should exercise caution in interpreting the results, especially in estimating the degree of favorable results apparent in the survey. Moreover some programs are quite small, e.g., Engineering Science and Industrial Engineering and Operation Research (IEOR), and large percentage differences represent a very small number of actual individuals. In these instances especially it is important to keep in mind that apparent large differences among programs may reflect only the experiences of the particular group of seniors who responded to the questionnaire.

B. Strategies for Data Analysis

The obvious concern of the College of Engineering was to better understand the undergraduate experience with reference to the various programs. Therefore, the first analytical approach to the data was the most straightforward: results were analyzed according to the program in which students indicated they were graduating. This gives us a direct way to assess the similarities as well as differences of experience across program. Do, for example, EECS students express attitudes about their Engineering education that are strikingly different from those reported by students in Civil or

Mechanical? What do patterns of differences suggest for possible directions that undergraduate Engineering might take?

We also thought it important to examine both when students entered Engineering at Berkeley (for example, freshman versus junior entry) and when a definite decision about a specific program was made. Both, it is reasonable to assume, might affect significantly the evaluation of one's educational experience. If it can be shown that there are large and meaningful differences between, for example, early and late entrants, undergraduate policies should be modified or targeted with these differences in mind. Analysis of results on this basis showed surprisingly little differences between both early and late entrants (e.g., freshman versus junior) into the College of Engineering and early and late decisions about a particular program. Therefore, in this report results will not be discussed in these terms.

The lack of apparent differences in attitudes and reported experiences associated with differences in entry into Engineering may strike one as surprising. Table B1 in Appendix B illustrates this absence of variation according to entry for a series of thirty-one questions. One may wish to examine these results and compare them with the differences of far greater magnitude evident in the program by program results.

The third approach examined the relative expression of commitment to engineering and to one's specific program as a basis for understanding the undergraduate experience in the College of Engineering. This was accomplished by defining four different commitment patterns based on the degree of agreement to the statements "I can easily imagine myself in a career other than engineering" and "If I couldn't be in the program I'm in, I probably wouldn't be in engineering at all" and indication of alternative career choice. This approach permitted an assessment of the extent to which one's basic orientation

to engineering as a career might be associated with differences in the undergraduate experience. That is, do students who express a commitment to engineering in general and students who report that their involvement with engineering is contingent upon being in a specific program share or fail to share common experiences and evaluations of their undergraduate life? Do students who report that they would have likely pursued a career in scientific research if they had not entered engineering differ from those whose alternative career was law or business administration?

Again the results are not impressive on this basis. While some differences in reported attitudes and experiences do exist by pattern of commitment, they are not as dramatic as differences according to program and usually overlap with them. Therefore, for the purposes of this report only the first approach to the results, i.e., differences according to program in which one is graduating, will be followed. Relationships among the three approaches are explored in Appendix B, however.

PROGRAM ATTRIBUTES AND REPORTED STABILITY OF PROGRAM CHOICE

Student perceptions of characteristic requirements and employment attributes associated with each of the various programs were of obvious interest. A format that asked students to indicate their impressions of distinctive characteristics of each program was developed (Question 17, page 4 of the questionnaire). In Table 2 the percent of students graduating in a given program is compared with the percent of those students outside the program who assign that attribute. This analysis was completed for Civil, EECS, Engineering Science, and Mechanical.

Several interesting patterns of student perceptions are evident. Most striking is the confirmation of the highly favorable view of the employment prospects for students in EECS that generally has been reported to exist at this time. In both the overall results (Appendix A) and the comparisons by those in and not in a particular program presented here (Table 2), the

TABLE 2

PERCENTAGE OF GRADUATING SENIORS CHOOSING PARTICULAR ACADEMIC REQUIREMENTS AND EMPLOYMENT ATTRIBUTES AS DISTINCTIVE FOR SELECTED AREAS OF ENGINEERING: RATINGS BY THOSE GRADUATING IN A GIVEN AREA COMPARED WITH THOSE NOT GRADUATING IN THAT AREA

Requirement or Characteristic

Note: Differences Greater Than 22% Underlined

Program	Civil		EECS		Eng. Science		Mechanical	
Rated By	Selves	Others	Selves	Others	Selves	Others	Selves	Others
Number Rating	25	140*	79	94*	12	149*	45	122*
Math Skills	68%	61%	86%	64%	92%	66%	90%	81%
Writing Skills	84%	51%	38%	28%	42%	44%	64%	39%
Mechanical Abilities	56%	54%	25%	19%	42%	19%	80%	85%
Originality	56%	41%	67%	52%	67%	37%	64%	52%
Good initial employment prospects	32%	28%	86%	98%	25%	13%	67%	63%
Good long-term employment prospects	80%	51%	81%	78%	50%	19%	78%	66%
High initial salaries	8%	14%	84%	93%	17%	12%	42%	41%
Computer applications	84%	44%	96%	95%	75%	45%	64%	57%
Rapid career advancement	36%	9%	68%	52%	25%	10%	27%	23%
Good long-term advancement	80%	39%	66%	49%	33%	18%	67%	43%
Variety of work	96%	44%	72%	40%	83%	38%	84%	51%
Prestige	64%	28%	70%	52%	33%	17%	53%	35%

*Students who rated only their own program or provided unusable data not included. Accordingly percentages based on only students who actually rated program. Total number excluded ranged from 14-22.

perceptions of other programs.

However, one might note also those areas where the perceptions of students graduating in a particular program differ markedly from those of students outside the program. This is most evident for Civil Engineering and Engineering Science. Though employment prospects in these fields may not be viewed as extraordinary as those in EECS, the less sanguine views of students outside the fields may suggest some room for more informed views. Note in particular the discrepancies across all four programs in perceptions of variety of work (and for computer applications in Civil and Engineering Science), though one might caution that ratings of variety may be highly subjective. Specifically, perceived variety for one interested in a particular field of engineering might appear quite uniform, if not monotonous, for someone without the same interest. Nonetheless, these results do provide interesting student perceptions of the various programs, and discrepancies between the views of particular programs held by students within a particular program and those of students outside them may be instructive.

Stability of Program Choice

Of equally central interest for assessing the likelihood of any modifications in the distribution of students among programs is the general degree of stability of program choice currently demonstrated. To assess this, students were asked to indicate their choice of program at four points in time: desired program when initially coming to the College of Engineering, program actually entered, program graduating in, and, finally, a hypothetical choice of program now assuming one was starting again and would be admitted to one's program of choice (Question 11, page 3). Results of this analysis are presented in Table 3. As can be seen, EECS commands a favorable and highly stable appeal. More

TABLE 3

GRADUATING ENGINEERING SENIORS' PROGRAMS
(1) ORIGINALLY WANTED WHEN BEGINNING ENGINEERING AT BERKELEY,
(2) ACTUALLY ENTERED, (3) NOW GRADUATING IN, AND
(4) CHOICE IF STARING AGAIN

A. Program Wanted When Beginning UCB Engineering Contrasted With Program Actually Entered

	Originally Wanted	Entered	Net	Wanted, Not Entered	Entered, Not Wanted
Civil	19	20	+1	3 (16%)	4 (20%)
EECS	82	73	-9	12 (15%)	3 (4%)
Eng. Science	14	16	+2	1 (7%)	3 (7%)
Mechanical	44	42	-2	6 (14%)	4 (9%)

B. Program Entered When Beginning UCB Engineering Contrasted With Program Actually Graduating In

	Entered	Graduating	Net	Entered, Not Graduating	Graduating, Didn't Enter
Civil	22	24	+2	1 (4%)	3 (12%)
EECS	74	78	+4	1 (1%)	5 (6%)
Eng. Science	17	12	-5	5 (29%)	0 (0%)
Mechanical	44	45	+1	2 (4%)	3 (7%)

C. Program Graduating In Contrasted With Program Chosen If Starting Again

	Graduating	Would Choose Now	Net	Graduating, Would Not Choose	Would Choose, Not Graduating
Civil	23	21	-2	4 (17%)	2 (9%)
EECS	76	85	+9	2 (3%)	11 (13%)
Eng. Science	10	7	-3	4 (40%)	1 (14%)
Mechanical	41	35	-6	9 (22%)	3 (9%)

D. Program Wanted When Beginning UCB Engineering Contrasted With Program Chosen If Starting Again

	Originally Wanted	Would Choose Now	Net	Wanted, Would Not Choose Now	Choose Now, Did Not Want Orig.
Civil	19	21	+2	5 (26%)	7 (33%)
EECS	80	83	+3	9 (11%)	12 (14%)
Eng. Science	13	7	-6	8 (61%)	2 (29%)
Mechanical	42	35	-7	15 (36%)	8 (23%)

students wanted EECS than actually entered it, of those entering only one student is not graduating, and of those graduating only two students would not choose EECS if starting over. Civil and Mechanical show somewhat less stability with approximately one student in five indicating that he or she would not choose the same program again. In contrast, Engineering Science appears to demonstrate significantly more attrition both real and hypothetical. As a summary indicator, more than half of the students who indicated an original preference for Engineering Science would not choose the program again. For Civil, IEOR (data not shown in the table) and Mechanical the figures are 26%, 33% and 36%, respectively.

Only 11% of those with an original preference for EECS would not choose it again, an impressive figure considering that it includes several students who actually entered other programs. (This particular point will be explored further near the conclusion of the report.)

The stability of program choice is examined with the data presented in slightly different fashion in Table 4. Here EECS students are divided into two categories: Computer Science and Other EECS. As subsequent analysis will suggest, this is an important distinction in understanding variation in the undergraduate experience in Engineering. Here the significance of the distinction is merely adumbrated because Computer Science and Other EECS are both very stable categories. Note, however, that not a single person in our sample who entered Computer Science switched out or, insofar as we can determine, would switch out if starting again. This striking degree of program allegiance or stability will be analyzed further. After Computer Science, the order of program stability would appear to be: Other EECS, Civil, Mechanical, IEOR and Engineering Science. Again, the data as displayed in Table 4 demonstrate the conspicuous attrition from the Engineering Science program with apparently no offsetting flow to it.

TABLE 4. STABILITY OF CHOICE OF PROGRAM WITHIN ENGINEERING

MEASURE OF STABILITY	Civil (22,25)	Comp. Sci. (31,31)	Other EECS (44,48)	Eng. Sci. (17,12)	IEOR (12,11)	Mech. (44,49)
Original Entrants Who Switched Out	5%	0%	2%	29%	25%	4%
Current Graduates Who Switched In	12%	0%	8%	0%	18%	6%
Original Entrants Who Would Not Choose Program Again	14%	0%[1]	4%[1]	65%	33%	21%
Current Graduates Who Would Not Choose Program Again	12%	0%[1]	6%[1]	40%	9%	25%

Note: n's in parentheses (original entrants followed by current graduates).

[1]Percent that would choose neither Computer Science nor Other EECS (further distinction not available).

STUDENT BACKGROUND AND CAREER ORIENTATION

The general background and career orientation of students by program is explored in Tables 5-10. This information may be of interest for at least two reasons. First, it helps establish a general overall picture of the educational and occupational orientation of undergraduate students in engineering. Second, observed differences among students in the various programs may help us assess the distinctive appeal of certain programs or in fact explain apparent program differences or other items that are more directly a result of background differences.

Table 5 examines by program a student's school prior to entering Berkeley engineering. Were students in one program, for example, overwhelmingly from

TABLE 5. PREVIOUS SCHOOL OR COLLEGE BY PROGRAM

PREVIOUS SCHOOL	Civil (25)	Comp. Sci. (31)	Other EECS (47)	Eng. Sci. (12)	IEOR (11)	Mech. (49)	Total (186)
High School	48%	42%	45%	42%	73%	45%	46%
UC Berkeley	4	7	6	33	18	6	8
Community College	32	42	36	17	0	39	34
Other	16	10	13	8	9	10	12

Note: n's in parentheses.

TABLE 6. SELECTED MEASURES OF PARENT BACKGROUND BY PROGRAM

PARENTAL BACKGROUND	Civil (25)	Comp. Sci. (31)	Other EECS (47)	Eng. Sci. (12)	IEOR (11)	Mech. (49)	Total (186)
Father has College Degree	46%	65%	48%	92%	90%	63%	63%
Mother Went to College	36%	61%	51%	92%	80%	57%	55%
Father is an Engineer	28%	26%	28%	58%	18%	20%	27%

Note: n's in parentheses.

high school and those in another transfers from community college, then apparent program differences in, for example, reported satisfaction with advising, might actually reflect differences in entry status. Note, however, that relationships between previous school and program are limited to the small and rather atypical Engineering Science and IEOR programs. In the former case, students are more likely than the average to have transferred from elsewhere at Berkeley and in the latter to have come directly from high school. In all the larger programs students from high school approximate the overall average of 46% and those from community college approximate the 34% average. The implication here is that any vast observed differences between students in the various programs are not a function of different points of entry to the College of Engineering. Moreover, it is worth pointing out that this type of information on previous school is available from university records and need not be taken from respondents to a questionnaire.

Similarly, Engineering Science and IEOR students report parental backgrounds that distinguish them from students in larger programs (Table 6). Both programs have a high percentage of highly educated parents. The two differ, though, in that more than half of Engineering Science students report that their fathers are engineers but only 18% of IEOR do, the lowest figure of any program. Among the other programs, students in Civil Engineering appear to be less likely than average to report having highly educated parents. (The extent to which differences in parental education are related to, or reflect, differences in ethnicity and foreign or native-born status among the programs has not been examined at this point.)

Variations by program in the probable choice of a career had one not entered engineering (Table 7) are most pronounced for the small number of students in Engineering Science and IEOR. A majority of the former believe they would have pursued a career in science or medicine, while a majority of the

TABLE 7. PROBABLE CAREER HAD ONE NOT ENTERED ENGINEERING BY PROGRAM*

CAREER GROUP	Civil (25)	Comp. Sci. (31)	Other EECS (47)	Eng. Sci. (12)	IEOR (11)	Mech. (49)	Total (186)
Science or Medicine	24%	23%	21%	64%	0%	39%	29%
Business Administration	20	13	16	9	55	14	18
Computer Industry	8	26	22	9	9	2	13
Law or Architecture	32	10	7	0	18	12	12
Skilled Trade	4	7	7	0	0	18	8
All Others	12	23	26	18	18	14	20

Note: n's in parentheses.

*Question 8: "If you had not gone into engineering, what career (occupation) would you probably have chosen?" See appendix for full wording of choices.

latter indicated a choice of business administration. The diversity of alternative career choices indicated by students in the larger programs is striking. Students in Computer Science, for example, are distributed across several categories with only 26% choosing an alternative career in computers. It might be noted, however, that 40% of Mechanical Engineering students reported that they would have gone into science or medicine, and nearly a third of those in Civil suggested law or architecture.

Table 8 reports student indications of expected primary activity for next year. As can be seen, about two-thirds of the students expect to pursue employment in engineering and one-fourth plan to enter graduate studies in engineering. Computer Science are most likely to plan direct engineering employment and Engineering Science and IEOR somewhat less likely.

Student indication of preferred eventual work in engineering (Table 9) also suggests the distinctiveness of the students in the small Engineering

TABLE 8. EXPECTED PRIMARY ACTIVITY FOR NEXT YEAR BY PROGRAM

EXPECTED ACTIVITY	Civil (25)	Comp. Sci. (31)	Other EECS (47)	Eng. Sci. (12)	IEOR (11)	Mech. (49)	Other (12)	Total (187)
Engineering Employment	56.0	82.2	63.8	45.9	54.5	75.5	83.3	68.4
Engineering Graduate Study	34.0	17.7	27.6	33.3	18.2	20.4	16.7	24.1
(Total-Engineering)	(90.0)	(100.0)	(91.5)	(79.2)	(72.7)	(95.9)	(100.0)	(92.5)
Other Employment	0.0	0.0	6.4	0.0	0.0	2.0	0.0	2.1
Other Graduate Studies	8.0	0.0	0.0	16.7	9.1	0.0	0.0	2.7
MBA	2.0	0.0	0.0	4.2	18.2	2.0	0.0	2.1
Other	0.0	0.0	2.1	0.0	0.0	0.0	0.0	0.5

Note: n's in parentheses.

Six students checked two possibilities each (engineering employment and either engineering graduate school or MBA in each case). Percentages associated with these choices were divided equally between the two choices.

TABLE 9. PREFERRED TYPE OF EVENTUAL WORK IN ENGINEERING BY PROGRAM

PREFERRED WORK	Civil (25)	Comp. Sci. (31)	Other EECS (48)	Eng. Sci. (12)	IEOR (11)	Mech. (48)	Other (12)	Total (187)
Research & Development	8%	36%	30%	67%	0%	27%	17%	27%
Design	32	26	32	0	0	23	17	23
Management	52	13	17	0	18	21	25	21
Corporate Management	0	16	6	8	46	13	8	11
All Others[1]	8	10	15	25	36	17	33	18

Note: n's in parentheses.

[1] Includes, for total, Other-Specify (11%), Teaching (4%), Production Engineering (2%), and Sales or Technical Marketing (1%).

TABLE 10. GRADUATE DEGREES ANTICIPATED AT BERKELEY OR ELSEWHERE BY PROGRAM (% FOR EACH DEGREE)

DEGREE	Civil (25)	Comp. Sci. (31)	Other EECS (48)	Eng. Sci. (12)	IEOR (11)	Mech. (49)	Other (12)	Total (188)
MS or M. Eng.	64%	68%	75%	58%	27%	64%	67%	67%
Ph.D. or D. Eng.	4%	29%	19%	58%	0%	4%	8%	18%
MBA	24%	58%	27%	17%	64%	33%	42%	36%
At Least 1 Advanced Degree	92%	94%	98%	100%	91%	94%	100%	95%

Note: n's in parentheses.

Science (two-thirds prefer research and development) and IEOR (nearly half prefer corporate management). More than half of the students in Civil Engineering express a preference for Engineering Management.

Finally, in Table 10 students' predictions of advanced degrees likely to be earned are summarized. It is striking that fully 95% of the graduating seniors in our study anticipate earning at least one advanced degree. Students across all programs aspire most often to a MS or M.Eng., except IEOR students, where the MBA is seen as more likely. This is, of course, consistent with the career orientation of IEOR students that is evident in the previous tables (as is the perceived likelihood of the doctoral degree for Engineering Science students). Nearly as high a proportion of Computer Science students also anticipate a MBA degree at some point.

CHOOSING AND FINANCING ONE'S PROGRAM IN ENGINEERING

Tables 11, 12, 13 and 14 examine different aspects of the choice of a career in engineering and of one's specific program. Tables 15, 16 and 17 present student information about the financing of their undergraduate education.

Table 11 presents only selected findings for the timing and certainty of choice of engineering and program. Question 1 and Question 2 (page 1 of the questionnaire in Appendix A) provide the full distribution of the responses for the overall sample. Nearly half of the seniors report having chosen engineering as a career path before the 12th grade and a third have chosen a specific program before college. Civil Engineering students are more likely to report earlier choices, Engineering Science students less likely. Certainty of choice, as one would expect, increases from the reported initial choice to the present for both engineering in general and specific program. Note that the largest percentage increase in certainty of program choice occurs for Computer Science students, going from 23% to 61% Very Certain.

TABLE 11. Certainty of Choice of Engineering and Program by Individual Program

	Civil (25)	Comp. Sci. (31)	Other EECS (47)	Eng. Sci. (12)	IEOR (11)	Mech (49)	Total (186)
Early Choice of Engineering (% Before 12th Grade)	68 %	45 %	46 %	27 %	55 %	41 %	46 %
Early Choice of Program (% Before College)	46 %	42 %	36 %	17 %	27 %	27 %	33 %
Initial Certainty of Engineering Choice (% Very Certain)	36 %	32 %	43 %	9 %	18 %	33 %	32 %
Certainty of Choice of Engineering Now (% Very Certain)	60 %	58 %	60 %	46 %	36 %	61 %	58 %
Initial Certainty of Program Choice (% Very Certain)	38 %	23 %	19 %	25 %	27 %	27 %	24 %
Certainty of Choice of Program Now (% Very Certain)	56 %	61 %	55 %	50 %	46 %	41 %	52 %

TABLE 12. Coded Responses by Program to Request to Describe "THE MOST IMPORTANT INFLUENCE(S) THAT AFFECTED YOUR DECISION TO ENTER THE FIELD OF ENGINEERING"--Percent Choosing Each Response as Either First or Second Influence Mentioned

Influence	Civil (25)	Comp. Sci. (31)	Other EECS (48)	Eng. Sci. (12)	IEOR (11)	Mech. (49)	Total* (188)
Applied Math, Science Background, Interest	32	26	33	33	54	51	39
General Aptitude	20	26	23	25	36	40	25
Anticipated Career Benefits	32	19	27	8	27	22	24
Persons Such As Teachers, Relatives	28	33	17	42	27	16	22
Computers, Electronics Interest	16	32	23	25	0	0	15
Interest in Building or Designing Things	12	6	8	8	0	14	11
Anticipated Social Contribution	12	7	4	17	9	10	9
Anticipated Work Characteristics	12	10	8	0	0	4	6
Other	4	0	8	8	9	8	6
Left Request Blank	4	10	4	8	0	10	6
Indicated at Least Two Influences	72	58	56	75	64	65	63

Note: n's in parentheses.

*Total includes 12 students in smaller programs.

TABLE 13. Six Most Frequent Coded Responses to Question "WHAT HAS BEEN THE MOST IMPORTANT INFLUENCE AFFECTING YOUR CHOICE OF YOUR SPECIFIC PROGRAM?"

RESPONSE	TOTAL % CITING	PROGRAM WITH HIGHEST %	% CITING
Experience and/or Interest in Computers and/or Electronics	21%	Comp. Science Other EECS	45% 42%
Characteristics of the Program Itself (e.g., its breadth)	16%	Eng. Science	50%
General Aptitude or Conducive Environment	16%	IEOR	36%
Work Characteristics (e.g., the product, environment, etc.)	7%	Civil	28%
Like Building, Designing Things	7%	Mechanical	18%
Career Benefits (e.g., financial opportunities)	7%	Other EECS	15%

TABLE 14. Reasons for Choosing Specific Program by Program
(% Agreeing or Strongly Agreeing with Each Statement)

Statement Appearing on Questionnaire	Civil (25)	Comp. Sci. (31)	Other EECS (47)	Eng. Sci. (12)	IEOR (11)	Mech. (45)	TOTAL (187)
9. If I couldn't be in the program I'm in, I probably wouldn't be in engineering at all.	24	73	38	8	50	18	34
3. Financial considerations played an important role in my choice of program within engineering.	40	61	51	8	27	45	43
10. One of the main reasons I chose my program is that it leads to a career where I can help maintain or improve the quality of the environment.	72	34	45	67	36	69	53
12. One of the reasons I chose my program is because of the good probability it would lead to a job in the Bay Area.	32	58	53	33	46	33	42
11. The opportunity to work with computers is something I will be looking for in future jobs.	76	97	75	67	82	73	77
1. A major reason for choosing my particular program in engineering was my preference for solving challenging technical problems.	88	84	85	75	55	96	84
2. A major reason for choosing my particular program in engineering was the probability that it will provide opportunities for eventual managerial leadership.	76	55	53	17	91	49	54
13. The opportunity to work with other people is a priority for me.	68	74	66	83	91	76	74
30. My family was an important positive influence in my choice of specific program.	52	32	32	33	20	35	33
28. My high school counselor was an important positive influence in my choice of specific program.	4	7	4	0	0	0	3

n's in parentheses.

These results are open to various interpretations. One reasonable inference, however, is that students' sense of certainty regarding their choice of program is not necessarily well established initially. Therefore, though students express considerable allegiance to their programs once they have progressed through them, it may be a mistake to conclude from this that there is no chance of modifying the pattern of program choice at the beginning of the undergraduate experience.

Table 12 categorizes open-ended responses to a request to describe "the most important influence(s) that affected your decision to enter the field of engineering." It must be stressed that a fuller appreciation for the students' interpretation of career choice influences may be gained by examining the verbatim responses themselves. It is of interest, however, to see whether these responses fall into any discernible and meaningful pattern. A background or interest in applied mathematics or science was mentioned by significantly more students (39%) than any other influence. A quarter of the students suggested general aptitude as a key influence. Students in Mechanical Engineering and IEOR were especially likely to mention each of these influences. Anticipated career benefits, mentioned by 24% overall, were more likely to be identified as an influence by Civil Engineering students and less likely by Engineering Science students. Personal influence from teachers or relatives was more salient for the latter (recall the high percentage of Engineering Science students who reported that their fathers were engineers). A third of the Computer Science students also identified a relative or teacher as being influential as well as an interest in computers or electronics. Note the EECS students (both Computer Science and Other EECS) were somewhat less likely to identify multiple influences on the decision to enter the field of engineering. It is probably most accurate to conclude that the

coded perceived influences do reveal some suggestive differences among students in the various programs, though one would not want to treat these results in this form as anything more than suggestive.

Students were also asked to indicate the "most important influence affecting your choice of your specific program" and coded results are presented in Table 13. It is again important to emphasize that examination of the verbatim responses may provide a fuller and more realistic sense of student perceptions of this critical issue. Moreover, students gave such a range and variety or relatively specific responses that categorization of these responses was problematic. As can be seen in Table 12, no single category of response was identified by more than roughly a fifth of the students overall. There are some differences by program that might be highlighted, though. For example, students in Computer Science and Other EECS programs are much more likely than other students to indicate that prior experience or interest with computers influenced their choice of program--43% versus only 2 or 3%. It is hardly surprising that this difference was found (in fact there would probably be some cause for concern were it not), but one might reflect on the significance of the actual percentages. That is, whether 43% is seen as high or low for EECS students is a matter of interpretation, especially given the perhaps less than fully appreciated degree of computer applications in other engineering programs (Table 2).

These results also suggest, again as one might expect, that Engineering Science students identify specific characteristics of Berkeley's program as influencing their choice. It is interesting that Civil Engineering students were more likely to point to the anticipated work environment as influencing [illegible]

Table 14 is the first of three tables that exam[illegible]e the percentage of students agreeing with each of a series of state[illegible]s about choosing a program

or career in engineering. (The number associated with each statement indicates the order in which the statements actually appeared on pages 5 and 6 of the questionnaire. The statements are re-ordered here to facilitate the interpretation of the results.) Questions of how and why such decisions about one's program in engineering are made are obviously of central interest in trying to understand the undergraduate experience in engineering as well as the feasibility of any modifications in the College's curriculum. Here, as elsewhere, it might be recalled, our results suggest that differences by program appear much more significant than differences by year of entry or timing of program choice.

The first statement in Table 12, "If I couldn't be in the program I'm in, I probably wouldn't be in engineering at all," one might recall, was used to define in part one's pattern of commitment to engineering. Agreement or disagreement with a statement of this sort, one would assume, provides a highly useful summary indicator of a student's attitude concerning his or her choice of program. The differences among the various programs are dramatic and unequivocal: only one student in Engineering Science agrees with the statement as do roughly one in every five of the students in Mechanical and Civil Engineering. The figure is higher for Other EECS (38%) and IEOR (50%) students. But fully 73% of the students in Computer Science suggest that their enrollment in engineering is contingent on being in computer science.

Statements reflecting other aspects of program choice do reveal differences among the various programs, though none perhaps as dramatic as for the first statement. Financial considerations are reported as more important in the choice of Computer Science and Other EECS than Engineering Science or IEOR, for example. One might note that, regardless of program, students report looking forward to working with computers in their employment. Only in the case of Engineering Science (67%) is the figure less than 70%. Likewise, with

the exception of IEOR (55%), from 75% to 96% of the graduating seniors indicate that possibilities for technical problem solving was a major reason for choosing the program they had. In contrast, IEOR student (91%) are more likely to stress the importance of working with other people and opportunities for eventual managerial leadership as a reason for choosing one's program. A third of the students indicated that their families had been an important positive influence in their choice of program. The only significant variation by program for family influence appears to be the higher percentage for Civil Engineering seniors (52%) and the slightly lower percentage for IEOR seniors (20%). Almost no students identify their high school counselor as an important influence.

These results do suggest rather clear and interesting differences among the factors that influence a choice or program and the importance of that choice. Perhaps quite significant, and certainly consistent with other results examined thus far, is the contrast between Computer Science students and Other EECS students demonstrated in the responses to the first statement on the table. It would appear that, by and large, Computer Science students are more adamant about the importance of being in their program if they are to remain in engineering at all.

Financial Support

Major sources of financial support for one's undergraduate education are displayed in Table 15. Slightly less than half of the students report earnings or savings and parental or family resources as two important sources. About a fourth of the students identify two additional major sources, loans and grants or scholarships. About one in ten report the co-op work program as a major source. Variation in funding sources by program, while not dramatic, does appear to be consistent with the results concerning the background of the students. For example, Engineering Science seniors report more reliance on parental resources and less on loans and earnings.

TABLE 15. REPORTED SOURCES OF FINANCIAL SUPPORT FOR JUNIOR AND SENIOR YEARS BY PROGRAM: % INDICATING "MAJOR SOURCE" FOR EACH OF SIX SOURCES

"MAJOR SOURCE"	Civil (25)	Comp. Sci. (31)	Other EECS (48)	Eng. Sci. (12)	IEOR (11)	Mech. (49)	Other (12)	Total (188)
Earnings, Savings (Non-Coop)	56%	61%	40%	25%	36%	51%	58%	48%
Parents, Family Resources	56%	39%	58%	75%	27%	31%	33%	45%
Loans	24%	26%	23%	8%	27%	33%	33%	26%
Grants, Scholarships	24%	26%	29%	17%	36%	10%	25%	22%
Co-op Program	4%	10%	8%	25%	27%	10%	8%	11%
Other	4%	3%	6%	0%	9%	14%	8%	7%

Note: n's in parentheses.

TABLE 16. REPORTED AMOUNT OF LOANS FOR EDUCATIONAL PURPOSES OWED UPON GRADUATION BY PROGRAM

AMOUNT OF REPORTED LOANS	Civil (25)	Comp. Sci. (31)	Other EECS (48)	Eng. Sci. (12)	IEOR (11)	Mech. (49)	Other (12)	Total (188)
None	56%	58%	52%	67%	63%	63%	42%	57%
$1-4,999	32	29	31	33	27	22	33	29
$5,000 or more	12	13	16	0	9	14	25	14

Note: n's in parentheses.

TABLE 17. PERCENT BY PROGRAM REPORTING HAVING RECEIVED FINANCIAL AID THROUGH THE BERKELEY FINANCIAL AID OFFICE

(n)	Civil (25)	Comp. Sci. (31)	Other EECS (48)	Eng. Sci. (12)	IEOR (11)	Mech. (49)	Other (12)	Total (188)
Received Financial Aid	40%	48%	42%	25%	46%	39%	67%	43%

Note: n's in parentheses.

Reported amount of loans and receipt of financial aid are examined in Tables 16 and 17. While the majority of students (57%) report that they will have no loan debt upon graduation, about thirty percent will have moderate (i.e., less than $5,000) loans outstanding and an additional one in seven of the students will owe $5,000 or more. Again, Engineering Science students are less likely to have loan obligations. Students in the very small programs ("Other" in the tables) are most likely to report loans and having received financial aid through the Berkeley financial aid office.

EVALUATION OF THE UNDERGRADUATE EXPERIENCE

Results thus far have examined students' reconstruction of their decisions to enter engineering and to choose a specific program within engineering. We now turn to the students' evaluation of experiences within the College of Engineering generally and their program of choice specifically. Table 18 presents these results by program, and, as can be seen, the first three statements are identically worded assessments of satisfaction with one's education in engineering in general, in one's specific program and with faculty advising within engineering. The results here are both impressive and dramatic. Almost 90% of the graduating seniors in our survey report that they are generally satisfied with their education in engineering in general and specific program. In contrast, only half of the seniors report satisfaction with the faculty advising they have received.

These ratings of satisfaction are fairly uniform across programs but some differences might be noted. The undergraduate experience in Civil Engineering appears to be perceived as an especially satisfactory one: 100% of the Civil Engineering students agree with the first two statements, and the percentage satisfied with its faculty advising (80%) is significantly higher than that for any other program. At the other end of the scale, Engineering Science students report somewhat less satisfaction with all three aspects of their

TABLE 18. Reported Degree of Satisfaction and Related Outcomes of Undergraduate Education in Engineering by Program
(% Agreeing or Strongly Agreeing with Each Statement)

Statement Appearing on Questionnaire	Civil (25)	Comp. Sci. (31)	Other EECS (47)	Eng. Sci. (12)	IEOR (11)	Mech. (45)	TOTAL (187)
20. Overall I am satisfied with my education within the College of Engineering.	100	90	81	75	91	92	89
21. Overall I am satisfied with the education I have received in my specific program.	100	90	79	75	82	92	88
14. Overall I am satisfied with the faculty advising I have received in engineering.	80	45	46	33	40	45	49
24. Upon completion of my program in engineering, I will have good career prospects.	77	90	94	55	100	94	87
16. I have found that most of my instructors in engineering were good teachers.	92	87	60	75	36	69	71
18. My program was quite competitive academically.	100	100	98	92	64	96	96
19. For me the level of academic competition in my program has been helpful.	76	61	74	83	64	86	75
25. The equipment and facilities for students in my program are good.	80	36	61	58	64	65	62
26. Students in my program have adequate access to the College's equipment and facilities.	72	42	43	60	73	76	60
17. My program has given me enough opportunity for individual research.	24	52	43	50	40	28	37

Note: n's in parentheses.

undergraduate experience. Other EECS students may be slightly less likely than average to see themselves as satisfied with their education as well.

Seven out of every eight graduating seniors believe that career prospects associated with completion of their particular program will be good, though again Engineering Science students may not make as favorable a judgment as students in other programs. The majority of the students report that most of their instructors have been good teachers, though IEOR students are a dramatic exception (36%). IEOR students are also the only ones not to share the nearly unanimous perception that they have been going through a competitive program. Interestingly, three-quarters of the students agree that the level of competition has been helpful. Computer Science students may be least sure of this.

Computer Science students also appear significantly less likely to judge their program's equipment and facilities as good, and they share with Other EECS students the perception that student access to it may not be adequate. Only one in every three students agrees that their program has given them enough opportunity for research with even fewer students in Civil and Mechanical Engineering reporting this to be the case.

Overall, then, the levels of reported satisfaction with one's program and with one's undergraduate education in general appear to be quite impressive. This is especially the case since students do specify areas (e.g., advising, equipment and facilities, opportunity for individual research) that are more problematic.

Tables 19 and 20 provide the seniors' assessments of the program or department of both the "best teacher" and the instructor from whom "you have learned the most" here at Berkeley. Seventy percent of the seniors identify as their best teacher an instructor in their own program; the figure for

TABLE 19. PROGRAM OR DEPARTMENT OF PERSON IDENTIFIED AS "BEST TEACHER" ONE HAS HAD AT BERKELEY BY PROGRAM

PROGRAM OR DEPARTMENT	Civil (24)	Comp. Sci. (27)	Other EECS (46)	Eng. Sci. (11)	IEOR (11)	Mech. (47)	Other (12)	Total (178)
Own Program	92%	85%[1]	74%[1]	--	36%	75%	50%	70%
Other Engineering	8	0	4	46	9	17	42	13
Physical Sciences	0	4	11	55	18	6	0	10
Soc. Sciences/ Humanities	0	11	9	0	36	2	0	7
Business Administration	0	0	2	0	0	0	8	1
Number Left Blank	1	4	2	1	0	2	0	10

Note: n's in parentheses.

[1]EECS overall (i.e., either Comp Science or Other EECS).

TABLE 20. PROGRAM OR DEPARTMENT OF FACULTY MEMBER IDENTIFIED AS ONE "FROM WHOM YOU HAVE LEARNED THE MOST" AT BERKELEY BY PROGRAM

PROGRAM OR DEPARTMENT	Civil (23)	Comp. Sci. (26)	Other EECS (43)	Eng. Sci. (11)	IEOR (11)	Mech. (44)	Other (12)	Total (170)
Own Program	87%	89%[1]	86%[1]	--	55%	80%	50%	77%
Other Engineering	9	0	5	46	9	7	33	8
Physical Sciences	4	8	7	55	9	7	8	10
Social Sciences/ Humanities	0	4	2	0	18	5	8	4
Business Administration	0	0	-	0	9	0	0	1
Number Left Blank	2	5	5	1	0	5	0	18

Note: n's in parentheses.

[1]Any EECS program (i.e., either Comp. Science or Other EECS).

instructor from whom learned the most is 77%. It might be noted that less than half of the IEOR and Engineering Science students have experienced their best teacher within engineering per se. These results are consistent with a slightly more critical stance toward engineering evidenced by students in these programs. A slightly higher proportion of the students in Computer Science did not nominate an instructor in either case.

Students actually identified their best teacher and instructor from whom they had learned the most by name. It would be interesting, therefore, to tabulate by hand these nominations. There may be a few outstanding instructors who have received several nominations apiece. Because the students in our study were graduating seniors, their nominations at the end of their undergraduate careers might be particularly meaningful.

SUMMARY EVALUATIONS AND CURRICULUM REVISIONS

Results for ten additional items relevant to the undergraduate experience and curriculum evaluation are presented in Table 21. Again keep in mind that where large percentage differences occurred they were among the various programs. Significant differences were not observed between students entering Berkeley engineering as freshmen and those transferring in later, though one exception will be noted.

The first two statements provide an interesting comparison of aspects of certitude concerning a career evolving from one's program. Note the early relative clarity of Civil Engineering in contrast to Engineering Science and IEOR. The second and fourth statements, on the other hand, illustrate the distinctly specific program commitment of Computer Science students. Both the unanimous expression of career certainty and the dramatically smaller percentage indicating an interest in learning about other programs in engineering again suggest that Computer Science students are quite set on their particular career course. With the exception of Computer Science students,

TABLE 21. Reported Experiences and Recommendations Concerning Program and Curriculum by Program (% Agreeing or Strongly Agreeing with Each Statement)

Statement Appearing on Questionnaire	Civil (25)	Comp. Sci. (31)	Other EECS (47)	Eng. Sci. (12)	IEOR (11)	Mech. (45)	TOTAL (187)
4. When I began the engineering program I am now completing, I had a good idea of what its graduates actually do.	80	65	43	8	9	44	47
7. I have a clear idea of the kind of career I am likely to have in engineering.	76	100	75	33	70	71	74
8. I can easily imagine myself in a career other than engineering.	68	52	50	92	73	53	60
5. I wish I had known more about the various programs in engineering before I chose the one I did.	48	21	45	58	50	61	47
6. I wish I could have taken more courses in the humanities and social sciences.	40	44	48	50	73	73	50
22. It would be a good idea if engineering students began with a two-year common curriculum and then chose their specific programs.	60	29	48	67	73	73	57
23. It would be a good idea if the first year of engineering were ungraded.	28	19	35	0	27	27	26
15. It is more important to have an advisor in engineering who has enough time for you even if he is outside your specialty area than to have an advisor in your area with little time to see you.	73	73	78	78	82	77	78
31. In almost all fields of engineering, engineers need good writing skills to get ahead.	100	87	77	83	82	96	89
32. I have good writing skills.	76	87	81	83	91	79	81

Note: n's in parentheses.

about half of the graduating seniors do agree that they wished they had known more about other programs before choosing the one they did.

Directly related to the preference for more familiarity with other programs is the judgment that a two-year common curriculum would be desirable. A majority of all seniors agree this would be a good idea. But Computer Science students are much less enthusiastic about this proposal (29%). Other EECS students, while more likely to endorse the idea than Computer Science students, are also not as favorably disposed as students in other programs. It is on this issue that transfer students do differ from freshmen entrants. Specifically, 73% of those students transferring into Berkeley's College of Engineering as a junior or senior and also deciding on a specific program as a junior or senior endorse the idea of a common curriculum, a figure equal to that of the highest programs (IEOR and Mechanical).

Majority support for a two-year common curruculum contrasts with the relative lack of support for an ungraded first year. On the other hand, there is consistently high support across all programs for the notion that the time an advisor has or does not have to see you is more critical than whether his or her specialty corresponds to yours. These results might be considered in conjunction with the relatively low level of expressed satisfaction with faculty advising as currently practiced.

Some have expressed a concern that the writing skills of engineering graduates are sometimes relatively underdeveloped. Almost 90% of the seniors agree that in almost all fields of engineering writing skills are necessary for career advancement. More than 80% of the seniors rate their own writing skills as good. One might compare these self-perceptions with the general impressions of faculty and the assessments of firms employing Berkeley graduates.

Table 22 presents a categorization of responses to a request to the students to identify the person, office, service or experience outside of formal coursework

TABLE 22. Coded Responses by Program to Question "OUTSIDE OF YOUR FORMAL COURSE-WORK, WHAT PERSON, OFFICE, SERVICE OR EXPERIENCE WAS/HAS BEEN MOST HELPFUL TO YOU IN COMPLETING YOUR ACADEMIC PROGRAM?" (% Mentioning Source of Help)

Source of Help	Civil (25)	Comp. Sci. (31)	Other EECS (48)	Eng. Sci. (12)	IEOR (11)	Mech. (49)	TOTAL (188)*
Myself or Blank	16	39	33	17	27	29	28
Work Experience	32	13	10	42	36	10	19
Faculty, Administrative Services	8	19	19	8	9	18	17
Family, Friends	24	16	8	8	18	23	16
Engineering Students	0	10	19	17	0	10	11
Other	20	3	11	8	9	10	10

*Includes 12 students in smaller programs.

that was or has been most helpful in completing their program. Recall (Table 18) the relative low ratings for faculty advising. While apparently not so low as to preclude a general satisfaction with one's undergraduate education, they might be the source of some concern. Here explicit mention of faculty advising was conspicuous in its absence. In fact, in no program was the percentage of students mentioning any kind of faculty, staff, or administrative assistance whatsoever as high as 20%, and in three programs, Civil, Engineering Science and IEOR, it was actually lower than 10%. (However, these are the three programs where a significant proportion of students identified their work experience as being most helpful.)

Perhaps the most intriguing results are the responses of students in the other three main programs. A greater percentage of graduating seniors in the Computer Science, Other EECS and Mechanical Engineering programs either left this question blank or answered "myself." This is most striking in the case of Computer Science where 39% of the responses were of this sort. One would want to be cautious in assigning any particular significance to this failure to identify any meaningful source of help. For example, it may simply incidate very little experienced need for any assistance rather than any judgment concerning the availability of assistance. Nonetheless, these findings may be the basis for discussion, and it may be useful to consider the verbatim responses to this question.

Verbatim responses to the two other items (Questions 13 and 14, page 3 of the questionnaire) would also be very interesting to read through program by program. These items asked each student to describe those aspects of one's program that were most and least liked. Because the responses were extremely varied, i.e., answers could not be classified into a relatively few categories, no results are presented in this analysis.

Students were also asked for suggestions to improve the quality of the undergraduate education. Answers were categorized relatively easily and are presented by program in Table 23. Almost equal numbers of the seniors (about 30%) offered suggestions for improvement in each of two broad areas: courses and instructors In the first category, less rigid academic requirements and more appropriate allocation of units for particular courses were most frequently mentioned. Students in EECS programs other than Computer Science were most likely to have suggestions for course-related improvements (40%), Computer Science students the least (9%). Suggestions for improvements in the area of instructors were made by more than one in every four students in each program except Civil. Most frequently mentioned were the need for better teaching skills and more favorable attitudes and greater accessibility of individual professors. The lesser perceived need for improvement in the instructor area for Civil Engineering seniors is consistent with their high rating of satisfaction with their education.

About a tenth of the students singled out advising explicitly as the one area of suggested improvement. This figure suggests that dissatisfaction with advising per se is not more salient generally than issues of particular course requirements, teaching ability and access to individual instructors. Nonetheless, for 17 students better advising was seen as a priority. Computer Science is the only program where a significant number of students expressed the need for improved facilities. Again, the verbatim responses, grouped by program, might be quite helpful in interpreting the significance of the suggested improvements. On a very impressionistic basis, however, it would appear that the suggestions do not indicate any perception of fundamental inadequacies in the undergraduate experience in engineering.

TABLE 23. Coded Responses by Program to Question: "WHAT SUGGESTIONS DO YOU HAVE FOR THE FACULTY AND ADMINISTRATION SO THAT THEY MIGHT IMPROVE THE QUALITY OF UNDERGRADUATE EDUCATION?"

SUGGESTED AREA	Civil (25)	Comp. Sci. (31)	Other EECS (48)	Eng. Sci. (12)	IEOR (11)	Mech. (49)	Other (12)	Total (188)
Courses[1]	24%	9%	40%	34%	21%	21%	50%	30%
Instructors[2]	12	26	27	33	36	39	33	29
Advising	12	10	6	17	9	10	0	9
Facilities	0	23	4	0	0	2	0	5
Other	20	0	6	8	0	4	0	6
Left Blank	32	32	17	8	27	14	17	21

Note: n's in parentheses.

[1] Most frequently mentioned were academic requirements and units allocated for particular courses.

[2] Most frequently mentioned were teaching skills and attitudes and accessibility of professors.

CONCLUSIONS AND IMPLICATIONS

Two conclusions may be drawn from the responses of the graduating seniors in our survey. First, the overall evaluation of their undergraduate experience in engineering appears to be a favorable one. Though there are some areas where improvements might be warranted (e.g., advising), there is a high level of general satisfaction with engineering. Second, within a pattern of broad general agreement one can identify distinct constellations of differences among students in certain of the programs. Students in Mechanical Engineering and EECS programs other than Computer Science appear to have profiles that do not deviate markedly from the overall sample. But Computer Science, Engineering Science, and IEOR students each have a pattern of responses that is particularly interesting.

Recall that part of the concern leading to this survey was the disproportionate amount of student interest in EECS. Our results are not encouraging if one is looking for clear signs of student disenchantment with this area of engineering. (Do keep in mind, however, that our data do not address directly the feasibility of encouraging students away from EECS before they begin the program. On the other hand, there is simply not much in our results that might be cited to convince beginning students that their experience in EECS might be an unsatisfactory one.)

Yet the survey has uncovered an important pattern of differences between the sentiments of students in Computer Science and those in the other EECS programs. The perceived employment prospects and stability of program choice in both instances are high. But there are items on which students in Computer Science differ dramatically from the overall sample, while those in the other EECS programs do not. These items include the likelihood of not remaining in engineering if one could not be in one's program, career certainty, and anticipated MBA degree. On

the critical issue of support for the two-year common curriculum before choosing a program, only 29% of Computer Science students but 48% of other EECS agree it would be a good idea. This contrasts with two-thirds support by students in the remaining programs.

The distinctive profiles of the smaller Engineering Science and IEOR programs represent, as might be expected, departures from the mainstream engineering programs. Because the numbers of students in these programs are small, these results should be interpreted with extra caution. For example, the disturbing finding that less than half of the original entrants in Engineering Science would choose the program again may either be unique to this particular group of individuals and their experiences or reflect an ongoing problem of attrition with this program. Not surprisingly, Engineering Science students are oriented toward scientific research, while IEOR students appear headed toward corporate management and believe they have excellent career prospects. Both are critical of the advising they have received, and IEOR students are critical of the quality of their teachers in engineering as well.

It should be emphasized that the observed differences among the programs reported here represent only the most straightforward and elementary rendition of these data. More sophisticated and pointed analyses of the survey responses are possible, especially if the results in this report prompt specific questions or raise additional issues. For example, Appendix C contains a brief analysis of a highly specific but suggestive question, namely, what happens to those few students who indicated an original preference for EECS but did not actually enter EECS? (The results suggest that they are nonetheless satisfied with their undergraduate experience in engineering.) Other questions could be defined and pursued with equal facility.

One should keep in mind that verbatim responses to several questions are also available for analysis. Finally, the limitation of the design of the survey,

i.e., retrospective and summary views of graduating seniors, only means that the results should be interpreted with caution. Certain specific conclusions are probably warranted, e.g., the relatively less favorable views of advising compared with one's overall education in engineering or the contrast between Computer Science and non-EECS students in their views of the two-year common curriculum. But to gain a more complete understanding of how and why even these relatively unambiguous results occurred might require interviewing or surveying students at earlier points in their undergraduate careers.

If the limitations of the present data are understood, however, the results can and should be used to clarify the terms and directions of further inquiry and administrative deliberation.

REFERENCES

AMAZIGO, J., ET. AL. A program for high risk freshmen, Engineering Education, 1973, 63:596-598.

ATHANASIOU, R. Selection and socialization: a study of engineering student attrition, Journal of Educational Psychology, 1971, 62:157-166.

BECKER, H. and R. MOWSESIAN. Examining engineering students by sex and ethnic background, Engineering Education, 1976, 67:162-166.

BRAINARD, A.J. A new freshman engineering program, Engineering Research and Methods, 1974, 7:29-30.

DURCHHOLZ, P. Women in a man's world: the female engineers, Engineering Education, 1977, 67:292-299.

ELKINS, R.L. and J.F. LUETKEMEYER. Characteristics of successful freshman engineering students, Engineering Education, 1974, 64:189-191.

ELTON, C.F. and H. A. ROSE. Personality characteristics of students who transfer out of engineering, Personnel and Guidance Journal, 1967, 45:911-915.

MORGAN, L.B. Improving the retention of engineering students, Engineering Education, 1974, 65:166-170.

OTT, M.D. The men and women of the class of '79, Engineering Education, 1976, 67:226-232.

SMITH, L.G. What caused students to study engineering, Journal of Engineering Education, 1960, 50:537-540.

TAYLOR, R.G. and G.R. HANSON. Interest and persistence, Journal of Counseling Psychology, 1970, 17:506-509.

APPENDIX

APPENDIX A

THE QUESTIONNAIRE AND OVERALL RESULTS

Appendix A contains the actual questionnaire as distributed to each participating senior. Each question displays the percentages (not actual numbers) of responding students who chose each of the possible answers. Students who did not respond to a particular question are not included in the number on which the percentage is calculated. The questionnaire and percentages follow this page.

For most questions there were very few students who did not provide an answer. In a couple of instances, however, this is not the case, and caution should be exercised to avoid a misinterpretation of the results. For example, Question 31 asks students to indicate the amount of loans they have received. It may appear as if 34% of the students surveyed owe loans of $5,000 or more. This is erroneous, because the percentages are calculated only for those students answering the question. Most students (47%) report no loans (see Question 32) and hence did not answer the question.

A tabulation of open-ended questions is not included here. One may refer to the tables in the body of the report for this information for all except two of these questions.

College of Engineering APPENDIX A Office of Student Research

SURVEY OF GRADUATING SENIORS IN ENGINEERING April 1982

This is a survey about your undergraduate educational experience in Engineering here at Berkeley and the development of your interests in the field. The information you provide will assist the College and future students. Please answer each question as best you can; do not skip items because you are unsure of your answer. We are interested in your perceptions and impressions for each of the areas in the questionnaire.

Q1. When did you decide on a career in... PERCENTAGES

engineering?

16 Some time before the 10th grade
6 In the 10th grade
25 In the 11th grade
21 In the 12th grade
33 After the 12th grade

your program within engineering?

33 Some time before your freshman year in college
18 In your freshman year
29 In your sophomore year
19 Some time after your sophomore year

Q2. Please circle your response to each of the following questions.

Very Certain (4) Certain (3) Somewhat Uncertain (2) Uncertain (1)

How certain...

Were you in your initial choice of Engineering as a career? . . . . . 32 . . 37 . . 24 . . 7.

Are you now about your choice of Engineering as a career? . . . . . 58 . . 25 . . 14 . . 4

Were you in your initial choice of specialty within Engineering? . . . . . 24 . . 35 . . 26 . . 15

Are you now about your choice of specialty within Engineering? . . . . . 52 . . 33 . . 10 . . 5

Q3. What do you expect to be your primary activity next year?

67 Employment, engineering-related
2 Employment, unrelated to engineering
23 Graduate study in engineering
2 MBA program
3 Other graduate study (specify: _____)
4 Other (specify: _____)

Q4. Preferred type of work in the long run (check one):

Production engineering (manufacturing)	2 [ ]
Engineering research and development	26 [ ]
Engineering design	23 [ ]
Engineering management	22 [ ]
Sales (technical marketing)	1 [ ]
Corporate management	11 [ ]
Teaching	4 [ ]
Other (please specify) _____	11 [ ]

(CONTINUED)

Q5. Which, if any, of the following degrees are you likely to earn here or elsewhere at some time in the future?

66 MS, M.Eng. 18 PhD/D.Eng. 36 MBA 3 LL.B./J.D.(law)

3 Other (Specify:_____) 5 No further degree work

Q6. Work experience during junior and senior years of college: (Check ALL that apply)

On-campus	Off-campus
11 Readership	15 Engineering co-op program
12 Other related to engineering	56 Other related to engineering
21 Non-related to engineering	32 Non-related to engineering

Q7. Describe the most important influence(s) that affected your decision to enter the field of engineering.

Q8. If you had not gone into engineering, what career (occupation) would you probably have chosen? Please check ONE.

- 18 Administration/management/accounting/business/sales
- 6 Architecture/urban planning
- 4 Arts/performing arts/design/writing/publishing
- 13 Computer industry
- 1 Education - college level
- 2 Education - primary or secondary level
- 6 Law
- 10 Medicine (M.D., D.D.S., D.V.M.)
- 2 Other health-related area
- 16 Scientific research
- 8 Skilled trade (technician, mechanic, etc.)
- 2 Social service/counseling
- 7 Other (Specify:_____)
- 4 Undecided

Q9. Describe the most important influence(s) that affected your choice of specific program within engineering.

Q10. Outside of your formal coursework, what person, office, service or experience was/has been most helpful to you in completing your academic program?

(CONTINUED)

Q11. Please indicate by checking (✓) the program in engineering you (A) wanted to enter when starting your engineering program at UCB; (B) actually did enter; (C) are graduating in now; (D) would choose if you were starting again. Assume you can enter or could have entered any area you wish.

	A Wanted to Enter	B Actually Entered	C Graduating In	D Would Choose Now
Civil				
Electrical Engineering & Computer Science				
Engineering Science				
Industrial Engineering & Operations Research				
Manufacturing				
Materials Science				
Mechanical				
Mineral				
Naval Architecture				
Nuclear				
Petroleum				
EECS/MSE				
EECS/NE				
IEOR/NE				
ME/MSE				
ME/NE				
MSE/NE				
MSE/Chemical				
NE/Chemical				

Q12. If you are in EECS, indicate which option you began in and which you are graduating in:

	Began In	Graduating In
Bioelectronics	5	3
Computer Science	40	39
Electronics	25	30
General	22	17
Systems	8	11

Now, please go back and put a "2" in columns A and D to indicate your second choice of program when you entered and now.

Q13. Describe the aspect(s) you have liked most about your program in engineering. _____

Q14. Describe the aspect(s) you have liked least. _____

(CONTINUED)

Q15. Please name the one faculty member who was the best teacher you had at Berkeley.

Name:_____ Department:_____

Q16. Name the one faculty member from whom you learned the most during your studies at Berkeley. (This may or may not be the faculty member who was the best teacher.)

Name:_____ Department:_____

Q17. Rate the distinctive characteristics of each area of engineering. If an area requires a special amount of one of the listed skills and abilities, or if one of the employment attributes is particularly true for it, put a check in the appropriate space. Check as many as apply. We are interested in your impressions of all areas of engineering. For example, if you leave a space blank it will mean you believe an area of engineering does not require a special amount of that skill or ability.

SKILLS & ABILITIES	Civil	EECS	Engineering Science	IEOR	Manufacturing	Materials Science	Mechanical	Mineral	Naval Architecture	Nuclear	Petroleum
Math skills	55	79	59	48	31	42	75	27	44	65	43
Writing skills	50	30	37	60	44	30	41	28	28	34	28
Mechanical abilities	48	20	18	20	53	22	75	18	41	22	29
Originality	38	55	34	40	35	24	50	18	34	28	21
EMPLOYMENT ATTRIBUTES											
Good initial employment prospects	25	86	12	26	32	26	57	14	9	32	64
Good long-term employment prospects	49	73	19	39	43	36	62	21	18	27	42
High initial salaries	12	82	11	12	11	16	37	10	9	32	67
Computer applications	44	88	41	52	42	24	52	19	34	53	36
Rapid career advancement	11	55	10	20	16	8	21	5	3	15	30
Good long-term advancement	40	52	17	28	32	17	44	14	13	18	34
Variety of work	40	51	35	27	29	21	53	12	11	7	9
Prestige	29	56	16	11	9	12	36	9	11	19	28

(CONTINUED)

Attachment 3

Q18. Indicate how strongly you agree or disagree with each of the following statements:

Disagree strongly (4) Disagree somewhat (3) Agree somewhat (2) Agree strongly (1)

AGREE #	Column #					
1	41	A major reason for choosing my particular program in engineering was my preference for solving challenging technical problems.	40	45	12	3
2	42	A major reason for choosing my particular program in engineering was the probability that it will provide opportunities for eventual managerial leadership.	21	33	27	20
3	43	Financial considerations played an important role in my choice of program within engineering.	11	32	30	27
4	44	When I began the engineering program I am now completing, I had a good idea of what its graduates actually do.	17	30	34	19
5	45	I wish I had known more about the various programs in engineering before I chose the one I did.	22	24	32	22
6	46	I wish I could have taken more courses in the humanities and social sciences.	26	24	20	30
7	47	I have a clear idea of the kind of career I am likely to have in engineering.	30	44	18	8
8	48	I can easily imagine myself in a career other than engineering.	33	27	27	13
9	49	If I couldn't be in the program I'm in, I probably wouldn't be in engineering at all.	17	16	36	31
10	50	One of the reasons I chose my program is that it leads to a career where I can help maintain or improve the quality of the environment.	25	28	28	19
11	51	The opportunity to work with computers is something I will be looking for in future jobs.	41	36	18	5
12	52	One of the reasons I chose my program is because of the good probability it would lead to a job in the Bay Area.	16	26	24	34
13	53	The opportunity to work with other people is a priority for me.	35	39	22	4
14	54	Overall I am satisfied with the faculty advising I have received in engineering.	10	39	25	25
15	55	It is more important to have an advisor in engineering who has enough time for you even if he is outside your specialty area than to have an advisor in your area with little time to see you.	47	31	17	5
16	56	I found that most of my instructors in engineering were good teachers.	20	51	22	6
17	57	My program has given me enough opportunity for individual research.	6	31	41	22
18	58	My program was quite competitive academically.	64	32	3	1
19	59	For me the level of academic competition in my program has been helpful.	30	45	21	4
20	60	Overall I am satisfied with my education within the College of Engineering.	47	42	10	2
21	61	Overall I am satisfied with the education I have received in my specific program.	46	42	10	2
22	62	It would be a good idea if engineering students began with a two-year common curriculum and then chose their specific programs.	22	36	25	15
23	63	It would be a good idea if the first year of engineering were abandoned.	11	15	28	46
24	64	Upon completion of my program in engineering, I will have good career prospects.	54	33	9	4
25	65	The equipment and facilities for students in my program are good.	22	40	28	11
26	66	Students in my program have adequate access to the College's equipment and facilities.	14	46	31	9

(CONTINUED).

Disagree strongly (1)
Disagree somewhat (2)
Agree somewhat (3)
Agree strongly (4)

AGREE # / Column #	Q18 (continued).					
27	67	My high school counselor was an important positive influence in my choosing engineering.	2	10	21	6
28	68	My high school counselor was an important positive influence in my choice of specific program within engineering.	1	2	18	8
29	69	My family was an important positive influence in my choosing engineering.	25	34	21	2
30	70	My family was an important positive influence in my choice of specific program.	16	17	30	3
31	71	In almost all fields of engineering, engineers need good writing skills to get ahead.	58	30	7	4
32	72	I have good writing skills.	31	50	13	3

Q19. What suggestions do you have for the faculty and administration in the College of Engineering so that they might improve the quality of undergraduate education? Please feel free to offer any comments or observations you have. _____

Q20. School or college you attended just prior to starting engineering at Berkeley College of Engineering:

46 High school
8 Other College at Berkeley
34 Community College
3 Other UC campus
3 California State College/University
2 Private college/University
__ Other (specify: _____)

Q21. 88 U.S. citizen 7 Foreign student
8 Immigrant or refugee

Q22. Were you born in the United States?
71 yes 29 no Note: 48 missing cases

Q23. How do you describe yourself?

2 Black/Afro Amer
__ Chicano/Mexican Amer
23 Chinese/Chinese Amer
1 East Indian/Pakistani
1 Filipino/Pilipino
4 Japanese/Japanese Amer
1 Korean
2 Latino/Other Spanish Amer
__ Native Amer/Amer Indian
__ Polynesian
2 Thai/Other S.E. Asian
64 White/Caucasian
1 Other (specify: _____)

Q24. 85 Male 15 Female
Note: 35 missing cases

(CONTINUED)

Q25. How old will you be on Dec. 31 of this year?

2	20 or younger	16	24-26
7	21	5	27-29
44	22	3	30 or older
24	23		

Q26. Marital status:

- 87 Single, never married
- 3 Engaged, planning to be married
- 7 Married
- 2 Living together
- 1 Separated, widowed or divorced

Q27. Do you have children?

___yes (how many____) ___no

Q28. What is the highest level of education attained by each of your parents?

	Mother	Father
Less than high school	16	9
High school	20	13
Associate degree/Technical school	9	3
Some college	14	11
Bachelor's degree	29	35
Master's degree	9	8
Professional degree (MBA, MD, JD, etc.)	2	11
Ph.D., Ed.D.	1	9

Q29. Do any of your family members have a degree in engineering?

37 yes, father 2 yes, mother 30 yes, other relative(s)

Q30. How did you finance your junior, and senior years in college? Indicate (with a check) the degree to which you relied on each source:

	Not a Source	Minor source	Major source
Parental and family resources	20	35	45
Co-op program earnings	84	5	11
Earnings &/or savings, excluding Co-op	21	31	48
Loan(s)	62	12	26
Grants, scholarships	60	18	22
Other source(s) (specify:_____)	91	1	8

Q31. If you have received loans for educational purposes during your undergraduate years, what is the total dollar amount you will owe upon graduation?

19	$1-999	19	$5,000-6,999
27	$1,000-2,999	11	$7,000-8,999
21	$3,000-4,999	4	$9,000 or greater

Q32. Did you ever receive any form of financial aid through the Berkeley Financial Aid Office? 43 yes 57 no

Q33. What is your GPA in your program? _____

Q34. What is your overall GPA in engineering at Berkeley? _____

(CONTINUED)

54

Q35. Your class level when you entered engineering at Berkeley? 36 freshman 17 sophomore 45 junior 2 senior

Q36. Number of quarters at Berkeley, through this spring? _____

Thank you very much for your help. Please fold your questionnaire and put it in the envelope provided. We would very much appreciate receiving your completed questionnaire by FRIDAY, APRIL 23rd. You may leave it in the Dean's Office or put it in the campus mail. If neither is convenient, you may use U. S. mail -- no postage is required.

THANK YOU!

APPENDIX B

TWO ALTERNATIVE MODES OF DATA ANALYSIS

As was noted in the beginning of this report, the program in which one is graduating appeared to be a major basis for significant differences among the engineering seniors on a number of questions of interest. Two other methods of classifying students did not. Results in terms of these methods of classification have not been presented.

However, interest in one of these, point of entry into Berkeley's College of Engineering, has been expressed. Therefore, some of the details of this procedure and associated results are presented here. Point of entry and its possible significance were examined as follows:

> Class level when entered engineering at Berkeley (Question 35) was compared with time of decision on a career associated with a specific program in engineering (Question 1). The distribution of students on these two variables were used to establish four groups of roughly equal size. Forty-six students entered as freshmen and reported having decided on a program-related career before or during their freshman year (Group A). On the other hand, 51 students also reported a program-related career decision before or during their freshman year but entered Berkeley's engineering after their freshman year (Group C). Students who reported making their program-associated career decision after their freshman year were divided into two troups: 36 students who had entered Berkeley engineering as freshmen or sophomores (Group B) and 52 students who entered as juniors or seniors (Group D).
>
> Thus, a sharp contrast exists between the students of Group A and Group D. In the first instance students both entered engineering at Berkeley as freshmen and reported a career decision by their freshman year, whereas in the other instance students entered as juniors or seniors and reported not having made the career decision by the end of their freshman year. Groups B and C also provide an interesting contrast, i.e., between those who report a program-associated career decision after entering Berkeley (Group B) and those who report making the decision before entering (Group C). More general comparisons can be made between early and late entrants (Groups A and B versus Groups C and D) and between early and late decision making (Groups A and C versus Groups B and D). Therefore, if either or both time of entry and decision on a specific career have a major effect on reported undergraduate experience it should be readily discernible.

As indicated, neither point of entry and timing of decision on a program-specific career had a major discernible effect on reported undergraduate experience. Certainly no differences approaching the magnitude of those associated with the program in which one is graduating were observed. Table B1 displays the results across the four groups for 31 statements, and the reader can verify the general pattern of "no differences."

It might be useful to keep in mind, however, that these results only indicate the experiences of seniors who are in the process of successfully completing their respective programs. They do not tell us directly, for example, whether the freshman entrants come in with the same attitudes as the junior transfer students but only that, for this particular graduating class, freshmen and junior entry graduates go out with similarly expressed attitudes.

The other method of classifying students that did not yield results as meaningful as those associated with specific programs was based on the students reported career commitment to engineering. As with the timing of entry and career decision classification above, four distinct groups were defined as follows:

> Three items were used to define the groups. First, responses to two statements ("I can easily imagine myself in a career other than engineering," Statement 7, page 5 and "If I couldn't be in the program I'm in, I probably wouldn't be in engineering at all," Statement 8, page 5) were compared. A third of the students agreed or strongly agreed with the second statement--their commitment to engineering was designated as Specific Program . On the other hand almost 30% of the students disagreed or strongly disagreed with both statements. These students were designated as committed to Engineering in General. Almost half of the seniors disagreed with the statement about being in a particular program but agreed or strongly agreed that they could easily imagine being in a career other than engineering. These students were divided into two groups on the basis of the third item, namely the indication of probable career had one not entered engineering (Question 8, page 2 of the questionnaire). Students who indicated a career choice in business administration, law, medicine and other traditionally high status professions were designated as pre-professional in orientation, while those who chose research, computers, skilled trades and miscellaneous were designated as pre-research/technical.

APPENDIX B

TABLE B1. Attitudes of Students According to Year of Entry and Decision of Specific Program Within Engineering (% Agreeing or Strongly Agreeing with Each Statement)

A - Both Early (Entered as Freshman, decided on program by end of Freshman year.)

B - Entered First (Entered as Freshman or Sophomore, decided on program after entry.)

C - Decided First (Entered Sophomore or later, decided on program before entry.)

D - Both Later (Entered as Junior or Senior, decided on program after Freshman year.)

Statement Appearing on Questionnaire	A. Both Early (46)	B. Entered 1st (36)	C. Decided 1st (51)	D. Both Later (52)	TOTAL (185)
1. A major reason for choosing my particular program in engineering was my preference for solving challenging technical problems.	84	83	88	82	84
2. A major reason for choosing my particular program in engineering was the probability that it will provide opportunities for eventual managerial leadership.	65	53	49	48	53
3. Financial considerations played an important role in my choice of program within engineering.	37	47	47	34	43
4. When I began the engineering program I am now completing, I had a good idea of what its graduates actually do.	44	48	57	37	45
5. I wish I had known more about the various programs in engineering before I chose the one I did.	52	47	37	48	46
6. I wish I could have taken more courses in the humanities and social sciences.	54	44	45	50	48
7. I have a clear idea of the kind of career I am likely to have in engineering.	71	75	76	73	74
8. I can easily imagine myself in a career other than engineering.	46	61	72	55	59
9. If I couldn't be in the program I'm in, I probably wouldn't be in engineering at all.	27	25	44	36	33
10. One of the main reasons I chose my program is that it leads to a career where I can help maintain or improve the quality of the environment.	51	63	56	44	53

TABLE B1, continued

Statement Appearing on Questionnaire	A.	B.	C.	D.	TOTAL
11. The opportunity to work with computers is something I will be looking for in future jobs.	74	77	76	83	77
12. One of the reasons I chose my program is because of the good probability it would lead to a job in the Bay Area.	43	42	45	40	43
13. The opportunity to work with other people is a priority for me.	76	89	70	69	75
14. Overall I am satisfied with the faculty advising I have received in engineering.	48	58	51	44	50
15. It is more important to have an advisor in engineering who has enough time for you even if he is outside your specialty area than to have an advisor in your area with little time to see you.	78	78	80	74	78
16. I found that most of my instructors in engineering were good teachers.	74	72	79	69	71
17. My program has given me enough opportunity for individual research.	39	29	39	40	37
18. My program was quite competitive academically.	95	94	96	94	95
19. For me the level of academic competition in my program has been helpful.	70	78	77	81	76
20. Overall I am satisfied with my education within the College of Engineering.	9	94	86	89	89
21. Overall I am satisfied with the education I have received in my specific program.	89	92	90	81	88
22. It would be a good idea if engineering students began with a two-year common curriculum and then chose their specific programs.	48	61	48	73	57
23. It would be a good idea if the first year of engineering were ungraded.	33	26	20	23	25
24. Upon completion of my program in engineering, I will have good career prospects.	83	92	84	90	88
25. The equipment and facilities for students in my program are good.	56	69	63	60	61
26. Students in my program have adequate access to the College's equipment and facilities.	58	69	54	59	59
27. My high school counselor was an important positive influence in my choosing engineering.	9	8	15	14	12
28. My high school counselor was an important positive influence in my choice of specific program.	4	3	2	2	3
29. My family was an important positive influence in my choosing engineering.	54	64	52	63	58
30. My family was an important positive influence in my choice of specific program.	39	31	32	27	32
31. In almost all fields of engineering, engineers need good writing skills to get ahead.	91	89	80	94	88
32. I have good writing skills.	76	86	76	85	81

Of particular interest was the extent to which those students committed to a specific program may differ in their evaluation of the undergraduate experience from those with an expressed commitment to engineering in general. Possible differences among all four groups were examined.

Though classification according to expressed commitment to engineering as a career was an intriguing procedures, it did not, as indicated, yield results as meaningful as straightforward program differences.

The relationships between timing of entry and program decision and both program at graduation and basis for commitment to engineering are presented in Tables B2 and B3. These results are largely non-consequential. As can be seen, the magnitude of the relationship between program and timing of entry and program related career decision is modest, though variation by program is evident.

The relationship between timing of entry and career decision and basis for commitment to engineering is even less striking. Quite unsurprisingly, we do find that those reporting a decision on a program-specific career before entering engineering at Berkeley are less likely to express a commitment to engineering in general, while those who entered before a career decision are less likely to express a specific program basis for commitment.

There is a more pronounced relationship between program at graduation and basis for commitment to engineering (Table B4). Because we have already noted the relationship between program and alternative career choice (Table 7, page 17) and between program and the statement "If I couldn't be in the program I'm in, I probably wouldn't be in engineering at all" (Table 14, page 24), this is not unexpected. The composite basis for commitment variable does sharpen some of the contrasts among the programs, however. For example, 64% of the Computer Science students indicate that they would not be in engineering at all if they were not in the CS program and an additional 20% reported that they were in engineering regardless of program and could not easily imagine

TABLE B2. Timing of Entry to College of Engineering and Program Decision by Program in Which Student is Graduating (% within each program indicating each entry type)

Timing of Entry and Program Decision	Program at Graduation						
	Civil (25)	Comp. Sci. (30)	Other EECS (41)	Eng. Sci. (12)	IEOR (11)	Mech. (48)	TOTAL (173)
Both Early	28 %	27 %	26 %	17 %	27 %	23 %	25 %
Entered 1st	12	10	24	8	18	29	20
Decided 1st	40	30	28	42	27	18	28
Both Later	[illegible]	33	[illegible]	33	27	[illegible]	27

Note: n's in parentheses.

TABLE B3. Pattern of Commitment to Engineering by Timing of Entry to College of Engineering and Program Decision (% within each entry type indicating each commitment pattern)

Basis for Commitment to Engineering	Timing of Entry and Program Decision				
	A. Both Early (44)	B. Entered 1st (34)	C. Decided 1st (49)	D. Both Later (52)	TOTAL (179)
Engineering in General	39%	32%	18%	31%	30%
Pre-Professional	18	18	14	15	16
Pre-Research	16	29	25	19	22
Specific Program	27	16	43	35	32

Note: n's in parentheses.

TABLE B4. Pattern of Commitment to Engineering by Program in Which Student is Graduating (% within each program indicating each commitment pattern)

Basis for Commitment to Engineering	Program at Graduation: Civil (26)	Comp. Sci. (29)	Other EECS (44)	Eng. Sci. (11)	IEOR (10)	Mech. (49)	TOTAL (181)
Engineering in General [1]	24%	20%	38%	9%	20%	39%	29%
Pre-Professional [2]	27	7	9	18	30	16	16
Pre-Research [3]	27	7	16	64	0	29	22
Specific Program [4]	23	64	36	9	50	16	33

Note: n's in parentheses.

[1]Students who disagreed with both statements "I can easily imagine myself in a career other than engineering " and "If I couldn't be in the program I'm in, I probably wouldn't be in engineering at all."

[2]Students who agreed with just the first statement and indicated an alternative career in business administration, law, medicine or other high status profession.

[3]Students who agreed with just the first statement and indicated an alternative career in scientific research, technical or computer area, skilled trades, etc.

[4]Students who agreed with second statement.

another career. In contrast, Engineering Science students are unlikely to indicate either a program specific commitment to engineering (9%) or the engineering in general commitment (9%) as most (64%) report a pre-research orientation to engineering. Mechanical students (39%) and those in Other EECS (38%) are somewhat more likely than average to express an unqualified commitment to engineering, while a half of IEOR students express the specific program commitment. Graduating seniors in Civil Engineering are dispersed fairly widely across all four commitment patterns, though more (27%) are "pre-professional" than average.

APPENDIX C

A TEST CASE OF COMMITMENT TO EECS

The high degree of commitment to EECS demonstrated by EECS graduates suggests that it would not be easy to redistribute students away from EECS. However, our results confound two effects: first choosing to enter EECS and then the actual experience of going through the EECS program. We do not know, therefore, what would happen to students who were originally committed to EECS were they to actually switch (or be switched) to a non-EECS program.

We do have data, however, for a very small group of students (seven) who reported that they did in fact want to be in EECS originally but who are graduating in another program. Of the seven, only two report that EECS would be their first choice if they could choose their program now. We also have data for fifteen students who, through graduating in another program, indicated that EECS was their second choice upon entry. Of these fifteen, only one indicated that EECS would now be the first choice.

The reported experiences of the seven students who expressed an original preference for EECS but did not graduate in it may be suggestive. Though only two of the seven (contrasted with an overall survey figure of 74%) agreed that they had a clear idea of the kind of career they were likely to have, all seven (higher than the overall survey figure of 88%) thought they had good career prospects. For both education in Engineering and in one's specific program, six of seven students expressed satisfaction--a proportion close to the overall survey figure in both cases. Five of the seven agreed that a two-year common curriculum would be desirable--a proportion somewhat higher than the overall figure.

Despite evidence of considerable stability and commitment within EECS, therefore, the very fragmentary evidence we have does not suggest dire consequences for those students who were originally committed to EECS but ended up outside the program.