

TOWARD EDUCATIONAL IMPROVEMENT:
ENGINEERING 45

Earl R. Parker
Principal Investigator
Professor of Metallurgy
College of Engineering
University of California, Berkeley

John W. Frease
Project Coordinator
Assistant Development Engineer
College of Engineering
University of California, Berkeley

James W. Trent
Project Evaluator
Associate Professor of Higher Education,
and Associate, Center for the Study of Evaluation
University of California, Los Angeles

CSE Report No. 61

November 1970

Center for the Study of Evaluation
UCLA Graduate School of Education
Los Angeles, California

CONTENTS

	Page
Acknowledgements	i
Introduction	1
Development of the Instructional Media	3
Procedures for Evaluation	4
Results	10
Examination scores	
Media-related scores	
Perceived learning	
Attitude toward learning	
By-products	20
Student Characteristics	
Measurement and prediction	
Concluding Recommendations	33
References	37
Appendix A	
Appendix B	
Appendix C	
Appendix D	
Appendix E	
Appendix F	

ACKNOWLEDGEMENTS

A large number of individuals contributed to the accomplishment of the Engineering 45 Learning Study reported herein. Not the least contribution came from the participating students. We are grateful to each person who assisted with the project, particularly those following who made special contribution to the project. Dr. Barbara Kirk, Director of the Counseling Center at the University of California, Berkeley, generously undertook the testing and surveying of the students examined in the project. She was ably assisted by Miss Virginia Squire. Mr. Richard Davis, Mr. Clyde B. Smith, and Mr. Mark Smith had leading roles in the production of the slides, films, and art work used in the project. Mrs. Janet Ruyle, invaluable to the evaluator in the past, continued to be so by setting up the coding scheme and tabular formation for the survey instruments and other data collected. Dr. Kenneth Sirotnik and Dr. Ann Morey, in collaboration with Mr. Donald Long, were indispensable in their assistance with the data processing and analyses. Miss Sonja Jacobson and Miss Shirley Boncheff were most helpful in preparing the data for the report of the project. Mr. James Burry, in collaboration with Mrs. Barbara Vizents and Mrs. Jane Beer, were equally helpful in reviewing and overseeing the production of the report. Greatest ovation of all, however, goes to Professors Robert B. Williamson, Frederick S. Ravitz, and Theodore Camins who committed themselves and their classes to the project, including the prerequisite scrutiny of their efforts.

INTRODUCTION

The main objectives of the undergraduate engineering curricula at the University of California at Berkeley are to provide students with strong backgrounds in basic sciences and engineering subjects and to promote their ability to adapt to changing needs in the field of engineering. The undergraduate engineering curricula begin with basic courses in mathematics, chemistry, and physics. From these background courses the student advances to basic engineering courses such as Computers and their Applications, Introduction to Design, and Mechanics and Materials. Specialized courses relevant to chosen branches of engineering are taken during the junior and senior years.

Prerequisite to the specialized courses is the basic materials course, Engineering 45, which is usually taken in the sophomore year. The course objectives are to provide students with an understanding of the relationship between the internal structures and the properties of engineering materials, and to promote students' understanding of how internal structures can be altered to produce desired properties.

The importance of the course to the curriculum, together with indication that students were not sufficiently mastering all aspects of the course, led to the introduction of multi-media, audio-visual techniques designed to improve the course. A brief description of these innovations and the evaluation of their effectiveness comprise the primary content of this report of the Engineering 45 Learning Study.

This project was initiated because the course examinations repeatedly revealed that students were experiencing difficulty in grasping certain new concepts. Also, differences in answers to questions on midterms and

who has the ability to demonstrate the relevance of the subject matter to the long-term educational objectives of the students. Unfortunately, not all instructors can provide such inspiration, particularly in the traditional lecture situation; therefore, means for providing motivation to enhance student learning must be sought through teaching methods other than the lecture. This can be accomplished in a variety of ways, including the use of well-designed slides, movies, demonstrations, laboratory exercises, student-centered discussion and query groups, field trips, guest lecturers, and personal consultations.

In this context the decision was made by the project staff to devise a series of films and slides to facilitate understanding of those engineering materials whose mastery had consistently been found to be problematic. The decision was also made to provide ample opportunity for some students to discuss these materials and related presentations in situations beyond what would normally result from a teacher-centered lecture. Finally, the decision was that some students should have the opportunity to review the slides as often as they wished outside formal class presentation in an audio-visual laboratory established for this purpose.

DEVELOPMENT OF THE INSTRUCTIONAL MEDIA

Members of the faculty collaborated with the University Extension Media Center in the production of two films and four slide sets for the purposes of the study. The films were on: (1) Crystal Structure and (2) Transistor Fundamentals. The slides were on: (1) Crystal Structure, (2) Transistor Fundamentals, (3) Planar Technology, and (4) Portland Cement. Only two films were used because of the prohibitive developmental costs, a

complete, which were shown in student operated booths set up in the Engineering Library specifically for this purpose. Supplementary text material was prepared and made available for students to study while viewing the slides, and the students could view the materials as often as they wished. The intention was also that the students in this second experimental group receive special guidelines before observing the materials as well as the opportunity to discuss and clarify them in class afterwards.

The obvious hypothesis was that the second (Spring Quarter) "experimental" group would perform significantly better on measurable criteria compared with the first "experimental" group and the "control" group, and that the latter--which had none of the special instructional materials--would exhibit the poorest performance. Performance criteria included: (1) the course grades; (2) scores on the final examinations; (3) scores on the laboratory problems; and (4) scores on individual items in the final examination specifically related to the media materials. Additional criteria included the students' perceptions of their learning experience and, in the case of the Spring Quarter experimental students, their perceptions of the value of the multimedia materials.

The students could not be assigned randomly to the three classes, which meant that any differences found among the groups on the criterion variables might be attributable to some systematic difference on other variables such as academic aptitude, motivation, or disposition toward learning. Therefore, each quarter before classes began, all students were pretested on a variety of background variables and personal traits or attitudes commonly known to influence learning behavior. Measurements

Figures Test, a high level difficulty test which requires the subject to discern a specified geometrical pattern out of five in a complex pattern. Both this and the Visualization Test, noted below, measure traits deemed highly relevant to engineering aptitude since they presumably indicate field independence, ability of mechanical movement, and mechanical comprehension.

4. Visualization (Vz), measured by several of the Tests for Cognitive Factors. The subject taking these tests must rotate, turn, fold, or invert representations of objects or their parts on the basis of specific directions and then compare the resultant manipulated representations with drawings. The specific test used to measure this ability was the Form Board Test which requires the subject to discern which of five shaded drawings of pieces will form a specified outline when fitted together.
5. Thinking Introversion (TI), a scale from the Omnibus Personality Inventory (OPI), which measures the subject's preference for reflective, abstract thinking, particularly in the area of art, philosophy, literature, and music.
6. Theoretical Orientation (TO), from the OPI, measures the subject's disposition toward critical, analytical thinking and scientific inquiry and interests.
7. Complexity (Co), from the OPI, measures the subject's tolerance for the ambiguous, openness to new experiences, and general intellectual curiosity.
8. Autonomy (Au), from the OPI, measures the subject's degree of

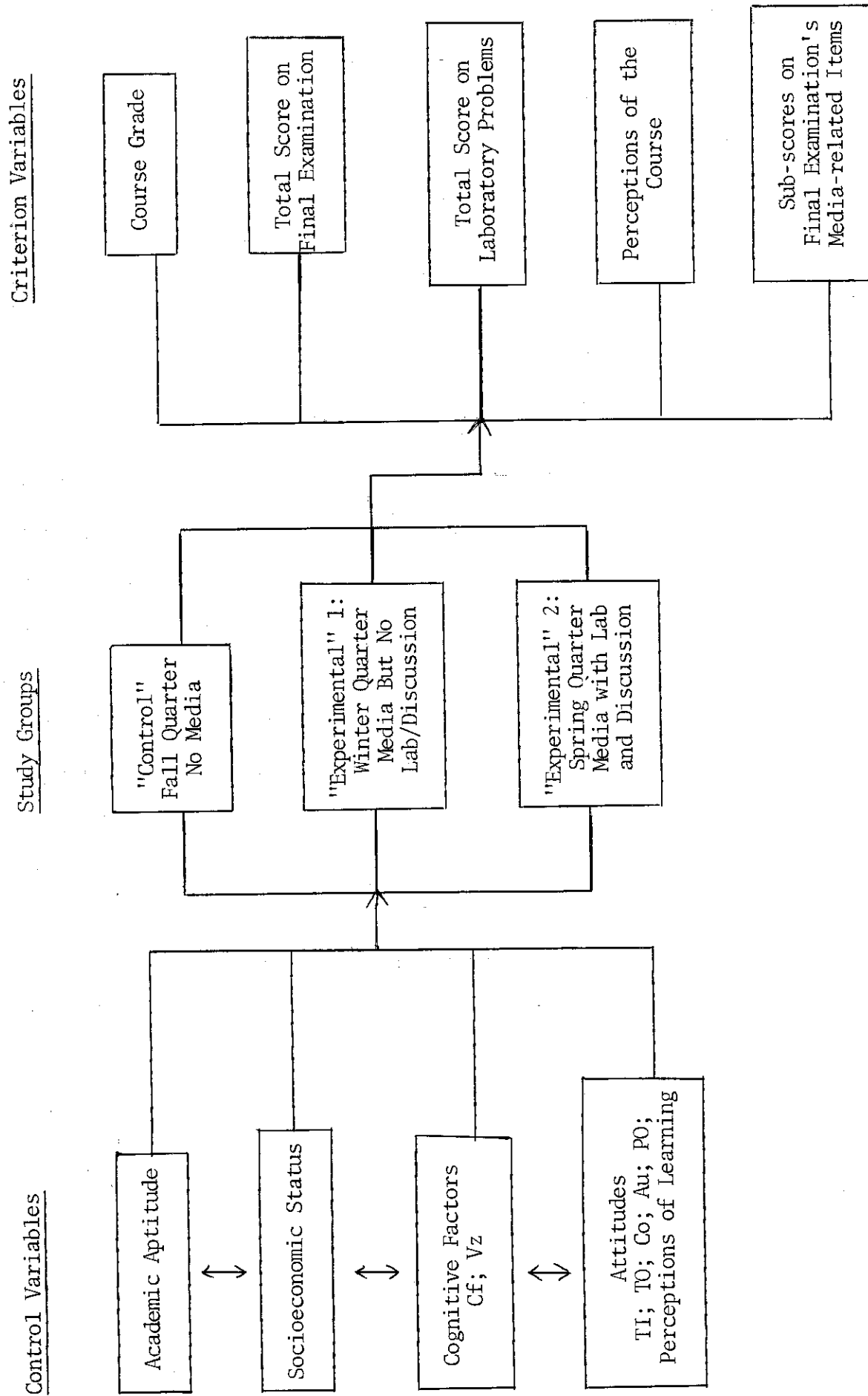


Figure 1. Schematic of the Basic Research Design for the Evaluation of Engineering 45

refer to the specific items contained in the final examination which may be found in Appendix C.

The scores of the three groups were significantly different on 19 out of the 35 items, or in a little more than half (54%) of the cases. Eleven out of 19 significant differences (60%) were in the predicted, desirable direction. Five of the differences were in the reverse of the predicted direction, and three were curvilinear in nature. To state the proportions in another way one sees that out of the 35 media-related items, the scores of the 3 groups were significantly different in the predicted direction in 31% of the cases, in the reverse direction in 14% of the cases, and curvilinear in 9% of the cases.

The evidence indicates a trend toward a positive relationship between multimedia instruction and performance on media-related examination tasks. The relationship is certainly not perfect, however, which suggests that the exceptions to the expected outcome warrant close scrutiny. For this purpose the items that resulted in the groups' scoring in a reversed or curvilinear direction are indicated by the arrows next to the related significance level notations in the right column of the table.

Instructor "A" was responsible for the course material that contained the first eight media-related items in the final examination. Of these, only one resulted in significant differences in the predicted direction among the groups. Yet, three of the five items which resulted in significantly reversed scores were among these first eight items. Instructor "C's" materials covered only four of the media-related items. Of these, only one resulted in significant differences in the scores of the three groups, and these were curvilinear, favoring the Winter Quarter group, but not the Spring Quarter groups.

the Winter Quarter students generally performed as well as and sometimes better than, the Spring Quarter students on the media-related items. Whatever special "treatment" presumably was provided in the Spring Quarter by way of preparation, discussion, and review had no discernible effect in the present context. If continued, its format, content, process, and values should be made evident.

The predicted differences that did result obviously were not enough to affect the total scores of the groups on the final examination. This may be true partly because the reverse scores may have negated the effect of the predicted scores and partly because the media-related items were too few to have contributed manifestly to the overall variance of scores on the final examination as a whole. There is some promise that this situation could change with the incorporation of more media material pertinent to more of the course content

Perceived learning. How a student feels about his learning can be as important as what he is known to have learned from specified measurements. Tables 2 through 6 indicate the students' perceptions of their learning as indicated from the survey instrument they completed at the end of each quarter (see Appendix D). In most cases the students were asked to express their opinions about each unit of the course--Mechanical, Electrical, and Concrete properties--as well as the course as a whole.

Chi-squares were computed to determine the statistical significance of differences between groups and categories of responses in the table. Few differences pertaining either to the course units or the whole course were significant, with the 5% level considered the minimum criterion. Nevertheless, some apparent trends did emerge from the data. Table 2 serves as a good case in point.

pointed out gaps in their comprehension of the material, regardless of class or unit considered. This is particularly the case in reference to the course as a whole, where the Fall Quarter students in greater proportion than the others considered gaps in their understanding to be pointed out often, as indicated in the combined responses in the first two columns of Table 4. Of course, possibly the innovations in the Winter and Spring Quarters closed the gaps rather than simply indicating them.

Whatever the gaps in their learning, a majority of the students felt that Engineering 45 increased their theoretical understanding of the content of the course, as is indicated by the responses to the first two categories in Table 5. Depending upon the quarter or the unit in reference, between 52 and 74% of the students felt that the course made a positive contribution to their understanding. Again, this left a sizeable minority that did not agree. And, once again, the Electrical unit was the exception in that the Fall Quarter students in greater proportion than the Winter or Spring experimental quarter students considered the course to contribute positively to their theoretical understanding. Between 62 and 68% of the students in all three classes felt that the course as a whole contributed positively to their understanding. Although differences were nominal in this respect among the three classes, the Spring Quarter students in largest proportion felt the course contributed to theoretical understanding.

The Spring Quarter students also reported in greatest proportion (approximately 44%) at the end of the term that they felt they possessed a great deal of understanding of all the courses they had completed up to that time, as noted in Table 6. Here again, however, differences among the three classes were nominal, and it is not at all clear that Engineering 45 contributed to

- (2) A majority of students also agreed with the questionnaire statement that emphasis should be placed on independent study (Table 8). A larger proportion of students, however, disagreed with this position compared with the proportion disagreeing about the superiority of the lecture system. Differences among classes remained nominal, although a noticeably higher proportion of the Spring Quarter students agreed that emphasis should be placed on independent study compared with the other students. A majority of the three classes of students also agreed that they were encouraged to think independently by the course on the whole and in the Mechanical unit (categories 1 and 2 in Table 9). But this was not true for either the Electrical or Concrete units. Questions may be raised about whether the lecture system and prescribed laboratory problems provide the best way to promote independent thinking. Nevertheless, the students generally considered the trait important and by and large felt they were encouraged in this direction.
- (3) The students were not nearly so sanguine about their own attention in class (Table 10). Sixty-two % of the Winter Quarter students and 47% of the Spring Quarter students rated their attention positively in reference to the Concrete unit, combining categories 1 and 2. Otherwise, only a minority of students felt this way, regardless of class or unit. With the exception of the Electrical unit, the Winter and Spring Quarter students in greater proportion than the Fall Quarter students rated their attention positively. Without comparative data to indicate otherwise, the overall attention reported by the students may be as good as can be expected from students generally, even if not ideal.

Spring Quarter students. All in all, then, relatively few students were very negative about the course, and a significant proportion were quite positive, particularly among the Spring Quarter students.

A natural interpretation of Tables 12 and 13 is that the media techniques did contribute to the students' finding the course stimulating and of value compared with other courses. Another interpretation might be that the instructors were trying harder or that they were more practiced by the end of the year--although the latter point weakens in face of the fact that they had experience teaching the course previously. The possibility that the instructors might have elicited more favorable impressions from their students by trying hard might also bear on the students' better performance on the selected media-related items noted in Table 1.

Although the causes of differences in performance and perception among the three classes cannot be determined precisely, there is good reason to consider them as being at least in part influenced by the media techniques. But even if this should not prove true according to the present criteria through replication and additional evaluation, there remains the issue of how the students regarded the materials apart from content related performance. The data in Table 14 show that the Spring Quarter students who used the media laboratory almost unanimously considered the experience favorable.

The students were asked to evaluate three slide sets (examples from which may be found in Appendix A): Crystal Structure; Planar Technology, and Transistor Fundamentals. At least 95% of those students who filled out evaluation forms found the slides helpful regardless of the set of slides; at least 92% found them easy to understand; at least 95% had a favorable overall impression of the experience. At least 84% of the students also found the related text

use in future evaluation, however, and they comprise "by-products" of the project important to a more comprehensive evaluation of the program that goes beyond the handling of Engineering 45, as such. Included in the products are an assessment of student characteristics which have implications for the entire engineering program, and the basis for devising measurements to predict such important outcomes as achievement, persistence, and creative or scholarly potential.

Student characteristics. Figure 2 shows graphically the personality characteristics of the three classes combined as determined by selected scales from the Omnibus Personality Inventory. The scales, described in the Introduction, were originally included as control variables. They were omitted from the three-class evaluative analyses since they did not distinguish among the classes in a way that would have suggested interaction with the "treatment". The students' scores on the scales bear closer scrutiny, however, in terms of what they suggest about Berkeley engineering students generally and their educational program.

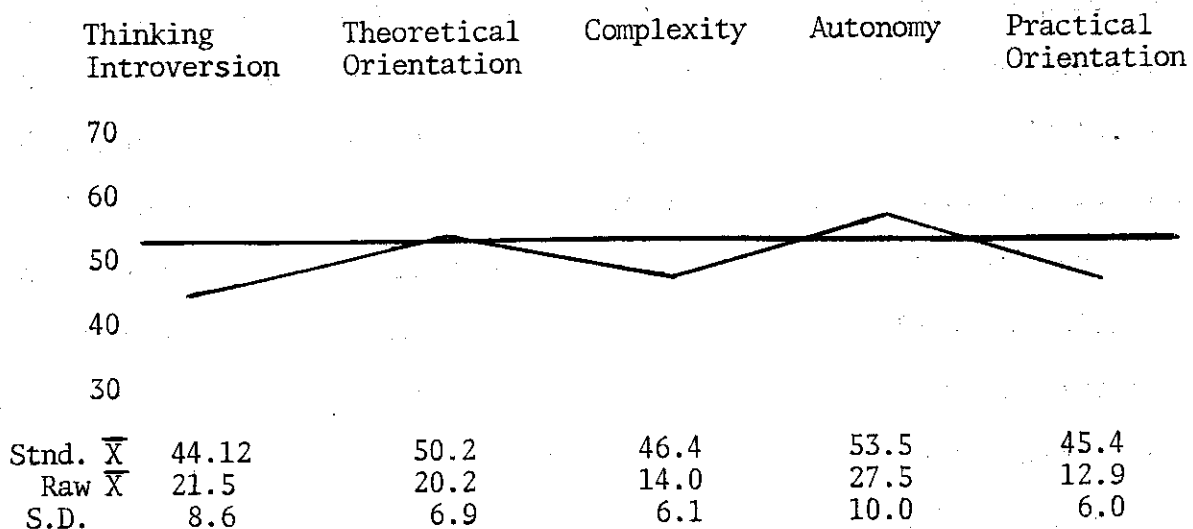


Figure 2. Standard mean scores of Engineering 45 students on selected OPI scales (N=236)

typically (Cf. Heist, 1968; Snyder, 1968; Trent, in press, 1970; Trent & Medsker, 1968).

This group of engineering students' Autonomy and Practical Orientation scores suggests they are open to new ideas and that they are looking for more than mere technical competence, unlike so many technological majors who are quite authoritarian and inflexible in outlook and who are preoccupied with vocational training. The practioner-oriented program, therefore, will probably not be sufficiently satisfying for these students. Yet, they were not disposed toward interest in ideas, scientific, critical thinking or intellectual curiority as measured by the other scales. Perhaps given the relatively high Autonomy scores, they could change their attitudes on the other dimensions if they were presented with the right educational experiences and environment; depending upon the Engineering program's objectives, this possibility is worth considering. This is true especially since studies reported in the OPI manual and elsewhere (Heist, 1968; Heist & Yonge, 1968; Snyder, 1968) indicate that combined high scores on the Theoretical Orientation, Complexity and Autonomy scales, along with relatively low scores on the Practical Orientation scales, are predictive of creative, scientific scholarship, surely a desired outcome of an engineering program such as that at the University of California at Berkeley.

In order to examine more closely characteristics of the students manifesting different degrees of intellectual, scholarly or creative disposition, they were assigned to an Intellectual Disposition Category (IDC) based upon their combined scores on relevant OPI scales. An adaptation of the scoring scheme for determining IDC scores noted in the OPI Manual (Heist & Yonge, 1968) was used. The Manual provides for eight categories; they were combined

the students classified by the Intellectual Disposition Categories that may indicate some effects of increased intellectual disposition among engineering students. For this purpose the four groups were compared on the following variables: (1) their scores on their final examination's media-related items; (2) their perception of their relationship to their environment in the College of Engineering; (3) their perceptions of the benefits of education; and (4) their perception of the occurrence and desirability of changes in society.

The variables were chosen in order to gain some notion of the differences in learning behavior of engineering students of different levels of intellectual disposition as well as their attitudes toward their education and from different strata of society. These variables were deemed important for the information they could contribute regarding the relationship between engineering students' dispositions and what they may gain from and contribute to their education as well as society, apart from their profession in itself.

Information of this kind, in turn, is useful in deciding the directions and objectives of educational programs--including the decision regarding the advisability of deliberately encouraging the development of intellectual disposition among engineering students. Tables 16 through 20 contain summaries of the results of the analysis of the Engineering 45 students in this context. Data regarding all variables except the final examination item came from the Survey of Engineering 45 instruments shown in Appendix D.*

*These data are based on the responses of the 222 students who completed all of the OPI scales rather than the total number of 236 students who took final examinations in Engineering 45. Analysis of variance was employed to test the significance of differences among the four groups on the variable considered. The small frequencies found in Groups I and IV, however, raises some doubt about the legitimacy of this type of analysis in the present instance. Therefore the findings may better be regarded as suggestive rather than conclusive. Alpha coefficients computed for the indices discussed--

on the Practicality or Community scales (not shown in Table 17). Expectations were that Groups III and IV more than the others would be concerned with the practical matters pertaining to academic issues and authority, manifest in the first four items on page 5 of Survey II. No judgements were made about differences on the Community scale, comprised of the next four items dealing with supportive relationships among students and faculty. As anticipated, the more evident and significant differences among the groups occurred on the Awareness scale, the first scale noted in Table 17, comprised of the third set of four items. High scores indicate the students' strong desire to participate actively in their education and to have ample opportunity to deal with esthetic, political, and intellectual issues. The means and standard deviations indicate that a majority of students in Group II and especially Group I endorsed at least three of the items and that many of these students endorsed all four of the items. They were also more likely to find desirable principles and procedures conducive to a high degree of scholarship. This is evident from their Scholarship scores derived from their responses to the last four items on page six, indicating an interest in intellectual challenge, and high standards of achievement, study, and scholarly communication. Groups III and IV showed a greater preoccupation with conformance to good conduct, rules, and regulations, manifested by their scores in the Propriety scale, derived from the four items on page six preceding the Scholarship scale.

(3) Benefits of education. Three indices assessing students' views on the major benefits of education were derived from the items included on pages 13 and 14 of the Survey of Engineering 45 under the heading "Views on Education." One had to do with stress on vocational development, including concern over training for jobs, specialization, terminology, and parts of

(4) Changes in society. One objective of a College of Engineering such as that at Berkeley is to train students to be competent engineering scientists. But another viable objective may be also to assure that the students become aware of changes in society, their possible contribution to these changes, and the possible positive and negative repercussions of the changes and their contributions to them. With this thought in mind the students were asked to respond to the item contained on pages three and four of Survey II (Appendix D). The items were constructed from the conclusions of various social critics regarding changes occurring in the social, political, occupational, and economic patterns of society. The students were asked to indicate which changes they agreed were occurring and, in selected instances, which changes they felt were desirable. Tables 19 and 20, respectively, summarize the results. Only three items distinguished among the groups with statistical significance: agreement that there is an increasing movement toward intercity government; that business and industrial organizations are moving more toward collaborative rather than competitive relationships; and that business is becoming more international in nature. The groups appeared to differ on four other items noted in Table 19, but their F ratios did not quite reach the five per cent level of significance. Total scores, determined by the numbers of items on the two pages checked "generally true", distinguished among the groups beyond the one per cent level of statistical significance. Although the differences were not striking, particularly by individual items, a relationship existed between Intellectual Disposition Category and Changing Society Index scores, with those students highest in intellectual disposition most agreeing to changes occurring and those lowest in intellectual disposition least agreeing. Agreement to the desirability

open to them. Questions that result are whether it is desirable to recruit more students of this calibre and to provide them with more of the experiences they would prefer in addition to their heavy schedule of engineering science courses. These are not new questions, but they may gain in relevance in the face of the nature of contemporary society and the role of the engineering scientist in society.

Measurement and prediction. Currently underway are analyses which, when completed, should contribute information basic to determining what kind of student should be recruited in reference to the observed or desired outcomes of the program. The analyses test the reliability, independence and, to some extent, the predictive validity of a number of measurements embedded in both parts of Survey of Engineering 45. Some of the measurements were drawn from the Higher Education Evaluation Project of the Center for the Study of Evaluation for their relevance to the present project. Others were developed specifically for the purposes of the project.

They include indices or scales to measure the following:

- (1) School involvement
- (2) Study habits
- (3) Academic problems
- (4) Academic motivation and aspiration
- (5) Learning sets
- (6) Learning styles
- (7) Perception of education benefits
- (8) Perception of subject field areas
- (9) Perception of college and department environments
- (10) Preferred environment

CONCLUDING RECOMMENDATIONS

The data that resulted from the Engineering 45 Learning Study suggest several possibilities indicated by the following recommendations:

1. Extension of multimedia techniques. The evidence--although inconclusive--was that the multimedia techniques adopted for the Engineering 45 Project may well have contributed positively to students' content mastery and attitudes toward learning in selected areas. Clearly, the students appreciated its techniques regardless of their subject mastery. Therefore, the recommendation is that the techniques be extended to cover many more content areas both within and beyond the course at hand.

2. Expansion of the use of the techniques. Most of the students who had access to the media laboratory and who filled out evaluation forms indicated that they reviewed the slide sets only once outside of class and also that they rarely discussed them with others. Had the students reviewed each slide set several times and determined their understanding of them through discussions with other students, quite possibly they would have learned much more from the materials than they did, compared with the "control" group. Therefore, the recommendation is that students in future make repeated use of the slide sets and test their understanding of them through discussions with fellow students and instructors.

3. Instructional modes. The data indicated the possibility that students' subject mastery varied according to the instructor involved. Indications were that the students were not oriented to make the most of a multimedia course, nor of one involving discussion techniques apart from the traditional lecture and laboratory experience. Yet, the student generally expressed an appreciation for independent study, theoretical understanding and critical thinking.

creative, theoretical, and applied contributions to engineering science as they move through their curricula and into their careers. Therefore, the recommendation is that evaluation continue at regular intervals to deal with these and the other issues raised in the discussion of the other recommendations, that the present data base be further examined and built upon for that purpose, and that a professional staff member of the department be released part-time--guided by a consultant versed in this area--to undertake the evaluation to assure that it is accomplished promptly and at critical intervals.

5. Follow-up study. Further investigation of the sample of students studied in the present project in their senior year, and again two or three years after their graduation, would yield information that can be gained in no other way. Such a longitudinal study can provide answers to questions concerning the long-range effects of various instructional modes and techniques; characteristics of students who leave the field of engineering, factors related to withdrawal and the results of withdrawal, and outcomes such as vocational development, professional achievement, and societal contributions, together with educational factors related to these outcomes. The recommendation, therefore, is multifold; namely: that the sample of Engineering 45 students in the project at hand, originally studied in the academic year 1968-1969 be examined again in the Spring Quarter of 1971, presumably their final senior quarter for a majority of the students in the sample; that this study be repeated on the same sample in 1974; that a new study of this kind be initiated with a representative sample of incoming students at regular intervals of every two or three years to keep abreast of changing situations, new student needs or characteristics, and the effectiveness of new programs;

REFERENCES

- Cairne, C. Intellectual disposition - I. D. C. Calculation, Form Fx.
Berkeley: Center for Research and Development in Higher Education,
University of California, 1966. (Mimeo)
- French, J.W., Ekstrom, R.B., & Leighton, A.P. Manual for kit of reference
tests for cognitive factors. Princeton: Educational Testing Service,
1963.
- Heist, P. Creative students: college transients. In Heist, P. (Ed.),
The creative college student: An unmet challenge. San Francisco:
Jossey-Bass, 1968.
- Heist, P., & Yonge, G. Omnibus personality inventory manual. New York:
Psychological Corporation, 1968.
- Pace, C.R. CUES college & university environment scales technical manual.
Second ed., Princeton: Educational Testing Service, 1969.
- Pace, C.R. CUES college and university environment scales technical manual.
Princeton: Educational Testing Service, 1963.
- Pace, C.R., Trent, J.W., & Morey, A.I. Higher education evaluation
instruments. Preview ed.; Los Angeles: Center for the Study of
Evaluation, University of California, August, 1970.
- Snyder, B.R. The education of creative science students. In Heist, P.
(Ed.), The creative college student: An unmet challenge. San
Francisco: Jossey-Bass, 1968.
- Trent, J.W., & Medsker L.L. Patterns of college attendance. Berkeley: Center
for Research and Development in Higher Education, University of
California, 1968.
- Trent, J.W. In and out of college. San Francisco: Jossey-Bass, in press.
- Trent, J.W. Revolution, reformation, and reevaluation. In Sampson, E.E.,
Korn, H.A. and Associates, Student activism and protest. San Francisco:
Jossey-Bass, 1970.

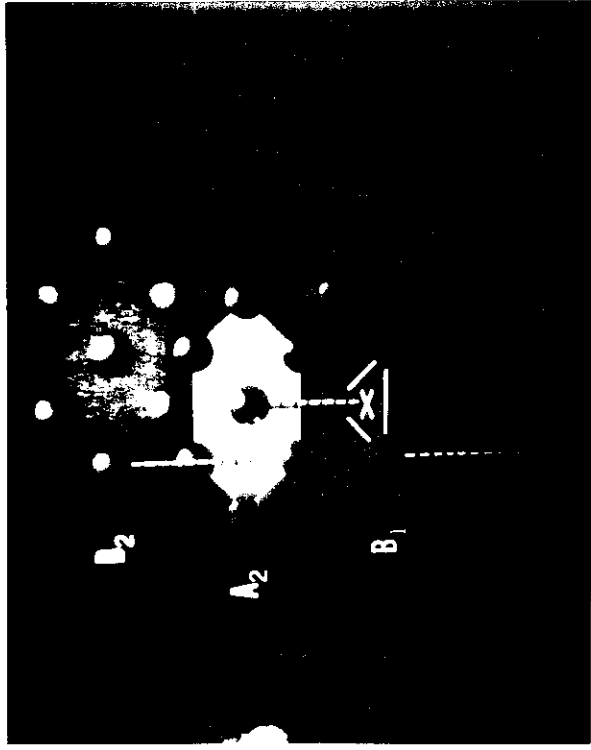
APPENDIX A

Specifications of Film and Slide
Sets Developed for Engineering 45
Learning Study

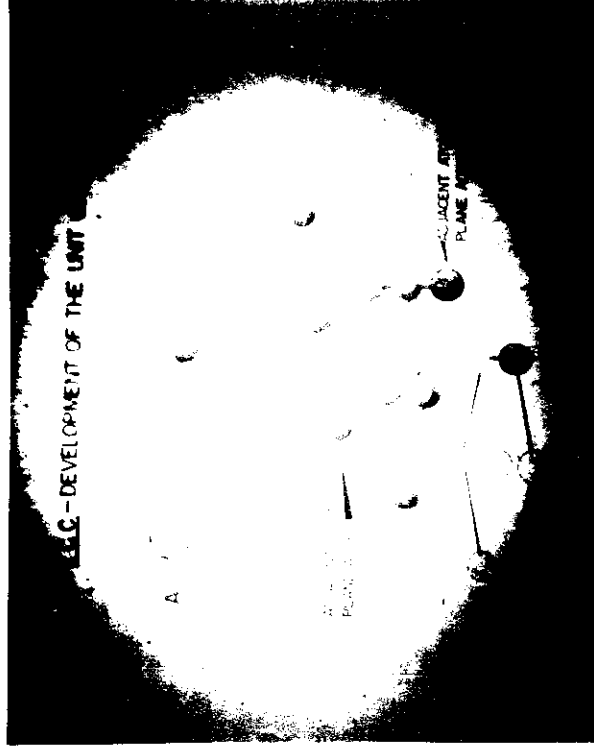
Films and Slide Sets Developed for
Engineering 45 Learning Study

Title	Content	Development
<u>Films:</u>		
1. Crystal structure	Crystallography of hexagonal close packed structure. (Used in Material Science lecture section on crystallography).	Sequence and visuals developed by faculty and Mr. Richard Davis, a high school Chemistry instructor familiar with media development; animation and film production by University Extension Media Center.
2. Transistor fundamentals	Energy levels and use of PN and NPN junctions in semi-conductors. (Used in Electrical Engineering lecture section on semi-conductors).	Sequence and visuals developed by Prof. Theodore Kamins, film produced by University Extension Media Center.
<u>Slide Sets:</u>		
1. Crystal structure	Crystallography of hexagonal close-packed, body-centered cubic, face-centered cubic and diamond cubic structures. (Used in library in connection with Material Science section on crystallography; example follows).	Text and visuals developed by faculty and Mr. Richard Davis; slides produced in part by Department and in part from Crystal Structure film by University Extension Media Center.
2. Transistor fundamentals	Energy levels and use of PN and NPN junctions in semi-conductors. (Used in library in connection with Electrical Engineering section on semiconductors; an example follows).	Text and visuals developed by Prof. Theodore Kamins; slides made from Transistor Fundamentals film by University Extension Media Center.
3. Planar technology	Construction of integrated circuits. (Used in library in connection with Electrical Engineering section on semiconductors).	Text developed by Prof. Theodore Kamins, visuals copied from film Prof. Kamins had; slides produced by University Extension Media Center.
4. Portland cement	Structure and use of Portland cement (Used in library in connection with Civil Engineering section on cement).	Text and visuals developed by Prof. Robert Williamson; slides produced by Prof. Williamson.

Examples of Slides from Crystal Structure and Transistor Fundamentals Sets

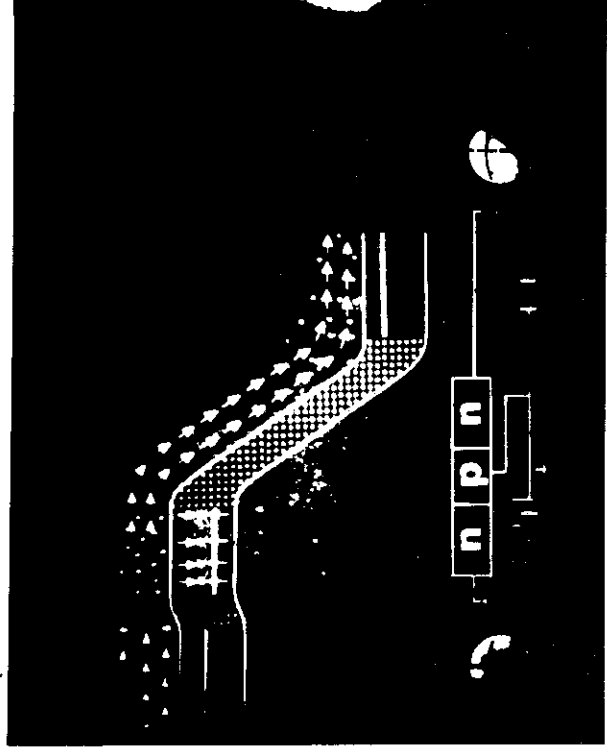


1. From Crystal Structure Set



2. From Crystal Structure Set

GENERAL PRINCIPLES OF THE TETRAHEDRA



3. From Crystal Structure Set

4. From Transistor Fundamentals Set

APPENDIX B

Data Presentation of the Evaluation
of the Engineering 45 Learning Study

TABLE 1

Mean Scores of Engineering 45 Students on
Media-Related Final Examination Items

Instructor	Item ^a	Quarter			F Ratio	p	
		Fall (N=89)	Winter (N=73)	Spring (N=74)			
A	2a	3.1	3.9	4.0	12.13	$\leq .01$	
A	2b	2.3	3.0	3.0	2.99	N.S.	
A	4a	2.9	1.7	2.6	5.71	$\leq .01$	←
A	4b	3.5	3.4	3.5	0.13	N.S.	
A	5	3.8	4.0	4.0	0.10	N.S.	
A	7b	1.8	1.7	1.9	1.70	N.S.	
A	8e	1.5	0.9	0.5	46.22	$\leq .01$	←
A	9b	2.3	1.4	1.4	10.87	$\leq .01$	←
B	10a	3.9	3.9	2.4	24.79	$\leq .01$	←
B	10b	1.5	1.8	1.9	5.02	$\leq .01$	
B	10c	1.9	2.1	2.2	2.10	N.S.	
B	10d	1.1	1.5	1.2	3.33	$\leq .05$	→ ←
B	11a	2.5	2.4	1.7	4.39	$\leq .05$	←
B	11b	2.9	3.0	3.8	4.98	$\leq .01$	
B	11c	3.2	3.2	3.6	1.62	N.S.	
B	12a	0.6	0.5	0.6	0.94	N.S.	
B	12b	0.9	0.9	0.9	1.22	N.S.	
B	12c	0.9	1.0	1.0	0.05	N.S.	
B	12d	0.7	0.9	0.8	6.33	$\leq .01$	

TABLE 1 (Continued)

Instructor	Item ^a	Quarter			F Ratio	p	
		Fall (N=89)	Winter (N=73)	Spring (N=74)			
B	12e	0.7	1.0	0.8	9.82	$\leq .01$	
B	12f	0.9	0.9	0.9	0.07	N.S.	
B	12g	0.7	0.7	0.7	1.11	N.S.	
B	12h	0.9	0.9	0.9	0.03	N.S.	
B	13a	3.1	2.8	3.1	4.10	$\leq .05$	$\leftarrow \rightarrow$
B	13b	2.9	3.2	3.4	5.12	$\leq .01$	
B	13c	2.5	2.6	2.7	0.81	N.S.	
B	13d	2.1	2.5	2.6	5.57	$\leq .01$	
B	14a	2.2	2.8	2.9	8.08	$\leq .01$	
B	14b	2.4	2.9	3.0	6.10	$\leq .01$	
B	14c	2.0	2.9	2.7	16.17	$\leq .01$	
B	14d	2.1	3.1	3.0	23.36	$\leq .01$	
C	16	3.6	3.5	3.5	0.07	N.S.	
C	17	2.8	3.1	3.4	1.54	N.S.	
C	18	2.7	3.2	2.5	3.09	$\leq .05$	$\leftarrow \rightarrow$
C	19	1.3	1.1	1.4	0.36	N.S.	

^aThe specific items may be found in the final examination reproduced in Appendix C.

TABLE 2

Extent Engineering 45 Students Considered Their
Course Informative in Percent (Post-Test)

Course unit and Quarter	(N)	<u>Very Informative</u>			<u>Not Informative</u>
		1	2	3	4
Mechanical					
Fall	(88)	13	28	32	27
Winter	(72)	17	33	31	19
Spring	(70)	17	40	31	11
Electrical					
Fall	(88)	22	35	26	17
Winter	(72)	11	26	36	25
Spring	(70)	13	37	21	29
Concrete					
Fall	(89)	15	12	13	7
Winter	(72)	38	10	7	2
Spring	(70)	27	14	5	3
Entire Course					
Fall	(87)	9	32	45	14
Winter	(71)	10	39	38	13
Spring	(70)	13	51	27	9

TABLE 3

Understanding of Course Objectives Expressed by
Engineering 45 Students, in Percent (Post-Test)

Course unit and Quarter	(N)	<u>Very well</u> 1	2	3	<u>Not well</u> 4
Mechanical *					
Fall	(88)	11	34	39	16
Winter	(72)	17	47	24	13
Spring	(69)	23	46	25	6
Electrical *					
Fall	(88)	28	42	19	10
Winter	(73)	11	41	26	22
Spring	(70)	20	27	21	31
Concrete *					
Fall	(87)	21	37	29	14
Winter	(73)	40	43	15	3
Spring	(70)	36	47	14	3
Entire Course *					
Fall	(88)	9	46	34	11
Winter	(70)	3	61	34	1
Spring	(69)	13	55	28	4

* Chi-square indicates significant differences, with minimum criterion = $p < .05$.

TABLE 4

Extent to Which Engineering 45 Students Felt Their
Course Pointed out Gaps in Their Comprehension of the
Material, in Percent (Post-Test)

Course unit and Quarter	(N)	<u>Very Often</u>			<u>Seldom</u>
		1	2	3	4
Mechanical					
Fall	(88)	14	24	35	27
Winter	(71)	4	24	35	37
Spring	(67)	6	24	42	28
Electrical					
Fall	(88)	10	19	40	23
Winter	(71)	9	25	35	17
Spring	(67)	9	24	40	21
Concrete					
Fall	(87)	12	15	46	20
Winter	(71)	3	30	38	16
Spring	(66)	11	23	41	23
Entire Course					
Fall	(87)	6	20	40	21
Winter	(71)	2	14	34	21
Spring	(66)	4	14	31	17

TABLE 5

Extent Engineering 45 Students Felt Their Course In-
creased Their Theoretical Understand in Percent
(Post-Test)

Course unit and Quarter	(N)	<u>Greatly</u> 1	2	3	<u>Did not</u> 4
Mechanical					
Fall	(87)	14	38	32	16
Winter	(73)	18	51	21	11
Spring	(69)	23	39	25	13
Electrical					
Fall	(87)	23	45	20	12
Winter	(73)	21	34	25	21
Spring	(68)	18	35	25	9
Concrete					
Fall	(87)	20	43	24	14
Winter	(73)	26	48	14	12
Spring	(68)	31	40	19	10
Entire Course					
Fall	(88)	14	48	28	10
Winter	(73)	15	49	22	14
Spring	(68)	19	49	21	12

TABLE 6

Amount of Understanding of Major Courses
Completed Reported by Engineering 45 Students
(Post-Test)

	A Great Deal		Some	
	(N)	%	(N)	%
Fall	(35)	39.8	(53)	60.2
Winter	(29)	40.3	(43)	59.7
Spring	(31)	43.7	(40)	56.3

TABLE 7

Percentage of Engineering 45 Students Who
Agreed Lecture Classes are Superior to Group
Discussion Classes (Post-Test)

	Strongly Agree		Agree		Disagree	
	(N)	%	(N)	%	(N)	%
Fall	(30)	35	(45)	52	(12)	14
Winter	(18)	25	(44)	61	(10)	14
Spring	(19)	30	(37)	54	(12)	18

TABLE 8

Percentage of Engineering 45 Students who
Agreed Emphasis Should be Placed on Inde-
pendent Study (Post-Test)

	Strongly Agree		Agree		Disagree	
	(N)	%	(N)	%	(N)	%
Fall	(7)	8	(51)	58	(30)	34
Winter	(6)	8	(37)	51	(30)	41
Spring	(7)	10	(44)	64	(18)	26

TABLE 9

Extent Engineering 45 Students Felt Their Course
Encouraged Them to Think Independently, in Percent
(Post-Test)

Course unit and Quarter	(N)	<u>Greatly</u> 1	2	3	<u>Did not</u> 4
Mechanical					
Fall	(88)	23	34	26	17
Winter	(71)	27	32	15	25
Spring	(68)	31	34	25	10
Electrical					
Fall	(88)	11	31	24	34
Winter	(71)	6	21	32	41
Spring	(67)	8	21	42	30
Concrete					
Fall	(88)	11	19	38	32
Winter	(71)	6	18	44	32
Spring	(68)	6	25	37	32
Entire Course					
Fall	(88)	22	48	23	8
Winter	(71)	24	42	23	11
Spring	(68)	29	41	21	9

TABLE 10

Rating of Attention in Class by Engineering
45 Students, in Percent (Post-Test)

Course unit and Quarter	(N)	<u>Excellent</u> 1	2	3	<u>Poor</u> 4
Mechanical					
Fall	(87)	6	25	40	29
Winter	(73)	8	33	32	27
Spring	(69)	10	29	39	22
Electrical					
Fall	(88)	13	28	36	23
Winter	(73)	7	29	33	32
Spring	(69)	10	28	41	22
Concrete					
Fall	(87)	9	31	40	20
Winter	(73)	22	40	21	18
Spring	(69)	17	30	38	15
Entire Course					
Fall	(88)	5	31	48	17
Winter	(72)	8	38	33	21
Spring	(69)	15	29	39	17

TABLE 11

Extent Engineering 45 Students Felt Their Course Encouraged Critical Thinking in the Solution of Problems, in Percent (Post-Test)

Course unit and Quarter	(N)	<u>Greatly</u> 1	2	3	<u>Did not</u> 4
Mechanical					
Fall	(87)	30	33	26	10
Winter	(73)	27	30	29	14
Spring	(68)	31	41	13	15
Electrical					
Fall	(87)	41	28	22	9
Winter	(73)	29	33	23	15
Spring	(68)	28	41	15	16
Concrete					
Fall	(87)	32	36	26	6
Winter	(73)	26	32	27	15
Spring	(67)	24	48	19	9
Entire Course					
Fall	(86)	30	40	23	7
Winter	(73)	25	40	22	14
Spring	(67)	25	48	19	8

TABLE 12

Percentage of Engineering 45 Students Reporting
How Stimulating They Found Their Course (Post-Test)

Course unit and Quarter	(N)	<u>Very</u> 1	2	3	<u>Not</u> 4
Mechanical*					
Fall	(89)	20	28	35	17
Winter	(72)	28	29	15	28
Spring	(70)	37	37	21	4
Electrical*					
Fall	(88)	10	27	35	27
Winter	(72)	4	19	31	46
Spring	(70)	7	24	23	44
Concrete*					
Fall	(88)	6	42	24	28
Winter	(72)	33	29	21	17
Spring	(70)	19	57	17	7
Entire Course*					
Fall	(86)	1	19	54	27
Winter	(70)	1	27	44	27
Spring	(70)	6	41	40	13

*Chi-square indicates significant differences, with minimum criterion = $p \leq .05$.

TABLE 13

Value Engineering 45 Students Placed on Their Course Compared with Other College of Engineering Courses, in Percent
(Post-Test)

Course unit and Quarter	(N)	<u>Exceptional</u> 1	2	3	<u>Little</u> 4
Mechanical*					
Fall	(88)	10	24	28	38
Winter	(72)	13	32	31	25
Spring	(67)	16	36	37	10
Electrical*					
Fall	(88)	22	31	24	24
Winter	(72)	10	31	31	29
Spring	(66)	26	24	41	9
Concrete*					
Fall	(87)	9	39	23	29
Winter	(72)	14	38	32	18
Spring	(66)	23	29	36	12
Entire Course*					
Fall	(88)	7	32	41	21
Winter	(71)	11	32	37	20
Spring	(67)	15	36	43	6

*Chi-square indicates significant differences, with minimum criterion = $p < .05$.

TABLE 14

Summary of Spring Quarter Students' Evaluation
of Their Media Laboratory Experience

Set	Slides helpful	Slides easy to understand	Overall impression favorable	Related text easy to under- stand	In booth alone	Student discussion helpful	Slides viewed twice or more
	(N) %	(N) %	(N) %	(N) %	(N) %	(N) %	(N) %
Crystal Struc- ture	(62) 100	(61) 98	(62) 97	(60) 95	(62) 51	(28) 89	(62) 42
Planer Tech- nology	(19) 95	(19) 100	(19) 95	(18) 95	(19) 90	(2) 100	(18) 44
Transistor Fun- damentals	(25) 96	(25) 92	(26) 96	(25) 84	(27) 86	(3) 67	(26) 38

TABLE 15

Proportion of Total Engineering 45 Students
in each Intellectual Disposition Category

	I	II	III	IV	Total
(Number)	(12)	(64)	(127)	(19)	(222)
Percent	5	29	57	9	100

TABLE 16

Total Engineering 45 Students' Media-related Final
Examination Scores on Item 8e by Intellectual Disposition
Category

Intellectual Disposition Category	(N)	Mean	S. D.
I	(12)	1.333	0.89
II	(64)	1.063	0.79
III	(127)	0.961	0.79
IV	(19)	0.579	0.69
F ratio	2.69		
p	.05		

TABLE 17

Total Engineering 45 Students' Scores on College
Environment Scales Scored "Greatly True for Me"
by Intellectual Disposition Category

Intellectual Disposition Category	Environment scale		
	Awareness	Scholarship	Propriety
I (N=12) Mean (S.D.)	3.667 (0.492)	3.750 (0.622)	1.667 (0.985)
II (N=64) Mean (S.D.)	3.453 (0.942)	3.484 (0.926)	1.859 (1.180)
III (N=127) Mean (S.D.)	3.197 (1.047)	3.346 (1.019)	2.220 (1.119)
IV (N=19) Mean (S.D.)	2.474 (0.964)	2.789 (1.316)	2.789 (1.316)
F ratio	5.61	2.98	4.19
p	.01	.05	.01

TABLE 18

Total Engineering 45 Students' Scores on
Educational Benefits Indices by Intellectual Disposition
Category

Intellectual Disposition Category	Liberal Education		Personal and So- cial Development	
	Mean [*]	S. D.	Mean [*]	S. D.
I (N=12)	10.7	2.6	7.3	2.4
II (N=64)	12.0	2.6	7.5	2.2
III (N=127)	13.3	2.8	8.2	2.4
IV (N=19)	14.5	2.7	8.7	2.5
F ratio	8.10		2.42	
p	.01		N.S.	

* For each index the lowest score indicates the greatest importance placed on the item; the highest score, the least importance.

TABLE 19

Total Engineering 45 Students' Scores on Selected
and Total Items of Changing Society Index (Occurring)
Intellectual Disposition Category

Intellectual Disposition Category	Item Scores							Total score
	Intercity govern- ment	Industrial collab- eration	Inter- national market	Partici- pative politics	Value of self expression	Industrial community resources	Community related production costs	
I (N=12) Mean (S.D.)	0.667 (0.492)	0.750 (0.452)	1.000 (0.0)	0.833 (0.389)	0.750 (0.452)	0.417 (0.515)	0.917 (0.289)	19.667 (3.420)
II (N=64) Mean (S.D.)	0.734 (0.445)	0.563 (0.500)	0.906 (0.294)	0.609 (0.492)	0.547 (0.502)	0.141 (0.350)	0.906 (0.294)	18.469 (4.364)
III (N=127) Mean (S.D.)	0.433 (0.497)	0.433 (0.497)	0.811 (0.393)	0.504 (0.502)	0.417 (0.495)	0.173 (0.380)	0.811 (0.393)	16.449 (3.646)
IV (N=19) Mean (S.D.)	0.421 (0.507)	0.263 (0.452)	0.684 (0.478)	0.474 (0.513)	0.526 (0.513)	0.105 (0.315)	0.684 (0.478)	16.316 (4.001)
F ratio	6.15	3.40	2.89	2.13	2.30	2.05	2.21	5.79
p	.01	.05	.05	N.S.	N.S.	N.S.	N.S.	.01

TABLE 20

Total Engineering 45 Students' Scores on Selected
and Total Items of Changing Society Index (Desireable)
by Intellectual Disposition Category

Intellectual Disposition Category	Item Scores							Total score
	Partici- pative politics	Value of self Expression	Value of interde- pendence	Influence of sci- entists & profes- sionals	Intercity govern- ment	Industrial collab- eration	Devaluation of individ- ual success	
I (N=12) Mean (S.D.)	1.000 (0.0)	1.000 (0.0)	0.500 (0.522)	0.917 (0.289)	0.833 (0.389)	0.0 (0.0)	0.417 (0.515)	8.583 (2.065)
II (N=64) Mean (S.D.)	0.813 (0.393)	0.672 (0.473)	0.453 (0.502)	0.766 (0.427)	0.563 (0.500)	0.359 (0.484)	0.219 (0.417)	7.391 (2.592)
III (N=127) Mean (S.D.)	0.606 (0.491)	0.528 (0.501)	0.260 (0.440)	0.559 (0.498)	0.409 (0.494)	0.181 (0.387)	0.142 (0.350)	5.945 (2.586)
IV (N=19) Mean (S.D.)	0.632 (0.496)	0.211 (0.419)	0.474 (0.513)	0.737 (0.452)	0.316 (0.478)	0.263 (0.452)	0.211 (0.419)	5.895 (2.183)
F ratio	5.01	8.27	3.44	4.45	4.24	3.96	2.16	7.74
p	.01	.01	.05	.01	.01	.01	N.S.	.01

APPENDIX C

Final Examination Media-Related Items Used in the
Engineering 45 Learning Study

ENGINEERING 45
Final Examination
Part 1

-
2. a. Make sketches showing the close-packed planes in both fcc and hex c.p. crystal structures.
- b. How many differently oriented sets of close-packed planes are there in each of the two structures?
- fcc _____
- hcp _____
4. a. How much pearlite would there be in a 0.40% C steel that had been cooled slowly from the austenite temperature range to room temperature?
- b. How much martensite would there be in 0.40% C steel that had been quenched rapidly in cold water from the austenite range to room temperature? Assume that the piece being quenched was small, e.g. a 1/4 inch diameter cylinder.
5. The melting point of lead is 327° C. The melting point of antimony is 630° C. Lead-antimony form a eutectic at 250° C and at 17.5% Sb. The solubility of Sb in solid Pb at the eutectic temperature is 5.3%. Sketch cooling curves (from liquid state to room temperature) for the following metals and alloys:
- a. 100% Pb
 - b. 100% Sb
 - c. 95% Pb - 5% Sb
 - d. 90% Pb - 10% Sb
 - e. 82.5% Pb - 17.5% Sb
 - f. 77% Pb - 23% Sb

The cooling curves should be sketched neatly and unambiguously, and important temperatures should be specified on each.

7. What kind of bonds hold the atoms together in each of the following:
-
- b. Diamond _____
-

8. a. Define the term "a ceramic material".
.....
- e. Why is glass amorphous? Can a glass crystallized? If so, how?
9. b. Why are the crystal structures of ceramics more complex than those of metals?
10. a. (6) Compare and contrast the two classifications of polymerizations
Condensation (also known as step) polymerization
Addition (also known as chain) polymerization
- b. (2) Which kind of polymerization is characterized by the need for initiation and has rapid propagation to yield a high molecular weight polymer?
- c. (3) Which of the following three characteristics are favorable to the formation of polymer crystals (underline your choice):
A linear polymer or a network polymer?
An atactic polymer or an isotactic polymer?
A polymer showing the trans arrangement (where the unsaturated positions are on opposite sides of the chain) or the cis (same side)?
- d. (3) Define the glass transition temperature for a polymer.
11. a. What are the differences between the following two models of polymer crystals: The fringed micelle model and the chain-folded model.
- b. What are the characteristics of a thermoplastic? What kind of bonding exists between its polymer molecules?
- c. What are the characteristics of a thermosetting plastic? What kind of bonding exists between its polymer molecules?
12. In a tree:
- a. Moisture and minerals from the soil move up from the roots through the
_____.

- b. The cambium layer is the zone where _____.
- c. Annual growth rings are made up of two kinds of wood:
_____ and _____.
- d. Tracheids are long slender cells that make up 90% of _____.
- e. Which kind of wood is called porous? _____.
- f. The major chemical constituent of wood is _____.
- g. The binder between the cells is _____.
- h. The rate of growth can be determined by _____.

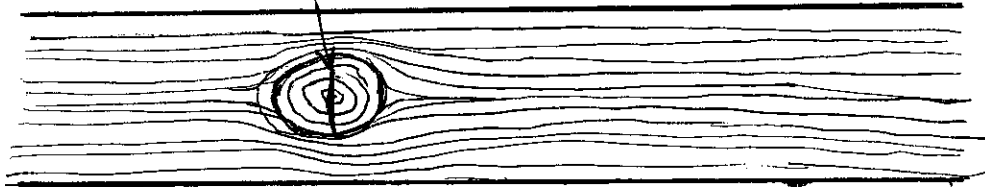
13. a. What steps must be taken to prevent the "decay" of wood?

b. Cross out the incorrect word:

The ultimate strength of wood is (sensitive/insensitive) to free water, and it is (sensitive/insensitive) to bound water. Explain your answers.

c. How does the drying shrinkage of wood vary in the longitudinal, radial and tangential directions?

d. It is often observed that cracks appear across knots in dried lumber as shown:



Use your knowledge of the shrinkage of wood to explain this cracking.

14. a. How are capillary pores formed in portland cement paste?

b. Why is water sprayed on concrete for approximately one to seven days after it has been placed?

c. Sketch the microstructure of a completely hydrated portland cement paste that has a gel space ratio of 1.0.

d. Why would the compressive strength of cement paste with gel space ratio of 0.8 be different from the cement paste with a gel space ratio of 1.0?

16. We have seen that two back-to-back p-n junctions in a single crystal of silicon can give us transistor action. Can two p-n junctions in separate pieces of silicon also produce transistor action? Explain.

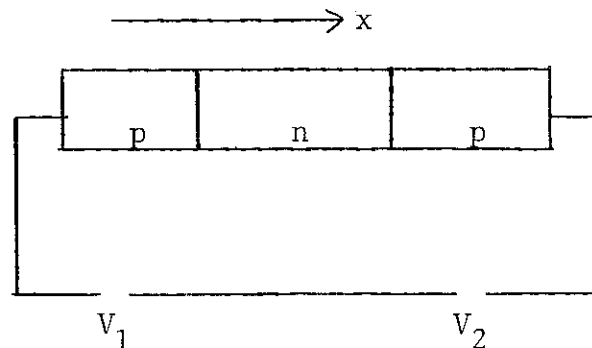
17. Outline the steps necessary for the construction of a p-n junction diode using a planar process (i.e., the same process used for integrated-circuit fabrication). Start with a clean, polished semiconductor wafer (p-type silicon) and assume that the photographic masks have been previously prepared. The finished diode should be ready to be soldered into a discrete (non-integrated circuit).

18. In a Si pnp transistor biased for amplification, the excess hole concentration p_1 in the base region can be described by the relation

$$p_1 = p_0 (e^{V_1/V_T} - 1) (1 - \frac{x}{W})$$

if the base is very narrow. V_1 is the bias across the emitter-base junction, V_T is a voltage related to the thermal energy and equals 0.026V at 300°K, and P_0 is the thermal equilibrium hole density in the base ($p_0 = 10^{11}/m^3$). Note that almost all of the applied voltage is dropped across the p-n junctions.

If the doping in the 10^{-6} m-wide base is $10^{21}/m^3$ and 0.52 V is applied between emitter and base, find the current in the base region. The cross-sectional area of the transistor is $10^{-7} m^2$. In which direction does the current flow? Indicate the polarity of V_1 and V_2 for this type of the operation on the diagram below.



19. We have seen that light incident on a laser can be amplified by stimulated emission. The expression we derived for the attenuation of incident light in a normal medium still holds, but the absorption coefficient becomes negative. Assuming that a fraction R of the light is reflected at each end of a laser length L , find the magnitude of the "absorption coefficient" at the threshold of the laser action (i.e., the intensity of the light must not be attenuated in one complete pass through the system).

APPENDIX D

Survey of Engineering 45



SURVEY OF ENGINEERING

45



COLLEGE OF ENGINEERING
UNIVERSITY OF CALIFORNIA, Berkeley

ID Number _____
(71-76)

SURVEY OF ENGINEERING 45

In the items to follow you are asked to evaluate your experiences, interests, and goals in college. This is an important source of information in any assessment of an instructional program. Again, you are reminded that all information is confidential, that no individual's responses will be reviewed by the faculty, and that your name is requested only so that all information obtained from you may be combined. Nevertheless, you are free to skip items you prefer not to answer.

1. What is
your
name? _____

2. Your sex?

(1) 1__ Male

2__ Female

3. Your age?

(2) 1__ 17-18

2__ 19-20

3__ 21-22

4__ 23-24

5__ 25 or over

4. How many units have you had...

In the College of
Engineering?

(3) 0__ 30 or fewer

1__ 31-35

2__ 36-40

3__ 41-45

4__ 46-50

5__ 51-55

6__ more than 55 units

In the College of
Letters & Science?

(4) 0__ 4 or fewer

1__ 5-8

2__ 9-14

3__ 15-21

4__ 22-28

5__ more than 28 units

9. Indicate the relative frequency with which you engaged in the following in an average month during your last term, by circling appropriate number.

In an average month, I. . .	<u>Not at all</u>	<u>Once or twice</u>	<u>Three or more times</u>	
Spent an hour or more reading course-related but unrequired material.	1	2	3	(10)
Went to a doctor's office or hospital for treatment.	1	2	3	(11)
Studied on a Saturday or Sunday morning.	1	2	3	(12)
Read an assignment without understanding it.	1	2	3	
Got very interested in a course-related lecture or discussion.	1	2	3	
Missed a meal because of study.	1	2	3	
Presented a new idea or plan of action in a lab or class discussion.	1	2	3	
Got left behind in a course-related lecture or discussion section.	1	2	3	(17)
Started a lively discussion among student friends.	1	2	3	
Got discouraged and talked it over with a friend or instructor.	1	2	3	
Turned in an assignment late.	1	2	3	
Browsed through the library.	1	2	3	
Sat through a class discussion without saying anything.	1	2	3	(22)
Had an interview or session with a counselor, psychologist or psychiatrist.	1	2	3	
Socialized with an instructor (over coffee, coke, beer, etc.).	1	2	3	
Had trouble concentrating while trying to study.	1	2	3	
Wrote a paper or report with which I was very pleased.	1	2	3	
Had fun with some friends when I still had work to do.	1	2	3	(27)
Missed class because of sickness.	1	2	3	(28)

12. To what extent do the following create difficulties for you in college?
(Please circle your response)

	<u>Very much</u>	<u>Quite a lot</u>	<u>Some</u>	<u>Very little</u>	
Work outside school.	1	2	3	4	(64)
Time spent commuting	1	2	3	4	
Learning how to study.	1	2	3	4	
Methods of instruction	1	2	3	4	
Being on my own too much	1	2	3	4	
Keeping up with high academic standards	1	2	3	4	(69)
Personal problems	1	2	3	4	(70)
					(71-79)
					(80)1
Poor study facilities.	1	2	3	4	(1)
Extracurricular and social activities	1	2	3	4	
Writing papers in my own field	1	2	3	4	(3)
Writing papers outside my own field.	1	2	3	4	
Not enough interest.	1	2	3	4	
Not enough challenge	1	2	3	4	
Insufficient reading speed	1	2	3	4	
Other; specify: _____					(8)

13. How important are the following to your motivation to study:
(Please circle your response)

	<u>Very important</u>	<u>Fairly important</u>	<u>Unimportant</u>	
Grades	1	2	3	(9)
To please my parents	1	2	3	
To do my best	1	2	3	
To keep my scholarship	1	2	3	
Interest in subject	1	2	3	
Desire to graduate	1	2	3	(14)
Career plans	1	2	3	
Faculty pressure	1	2	3	
To get into graduate school.	1	2	3	
Sheer interest in learning	1	2	3	(18)

CURRICULUM INTERESTS

18. When you made your choice of engineering as a major, from how many possible fields did you choose: i.e., as well as you can remember, how many fields were you interested in when you made your present choice, however tentative?

- (28) 1 ☐ One - the only field I have ever really been interested in
2 ☐ Two
3 ☐ Three
4 ☐ Four or more

19. What is your particular major field of engineering?

- (29) 1 ☐ Electrical
2 ☐ Mechanical
3 ☐ Civil
4 ☐ Other (Please specify: _____)
5 ☐ Have not yet decided

20. How sure are you of this?

- (30) 1 ☐ Very sure
2 ☐ Fairly sure
3 ☐ Unsure, tentative

21. When did you decide on your college major?

- (31) 1 ☐ 6th grade or earlier
2 ☐ 7th through 9th grade
3 ☐ 10th through 12th grade
4 ☐ After high school but before college
5 ☐ After entering college
6 ☐ Have not yet decided

24. Several courses follow in which large numbers of students tend to enroll. Under each course are listed a variety of topics, information, and tasks to be accomplished.

Assume that you are enrolled in these courses and therefore must learn about each of the items listed below.

The items are listed in groups of three. For each group mark a . . .

- "1" by the item that you would like most;
 "2" by the item in which you would have an intermediate interest; and a
 "3" by the item that would interest you least.

Examples:

Business and Economics

A

1. 2 The functions of the Securities and Exchange Commission
2. 3 Factors operating to diminish the size of the U.S. gold reserve.
3. 1 When an "easy money" policy may be unsound public policy

B

4. 2 The names of the components of the "Gross National Product."
5. 1 The meaning of an "odd lot" in stock purchases.
6. 3 The purpose underlying agricultural price supports.

In Group A the respondent indicates that he is most interested in item 3 ("When an 'easy money' policy may be unsound public policy"); least interested in item 2 ("Factors operating to diminish the size of the U.S. gold reserve"); and has an intermediate interest in item 1 (The functions of the Securities and Exchange Commission."). Of the three items in Group B he is most interested in 5, least interested in 6, and has an intermediate interest in 4.

Be sure to rank each item in each group accordingly, and do not assign the same rank to two items in a single group.

Geography

(52) A

- The factors responsible for westward population migration in the U.S.
 The names of the capitals of the European countries.
 The names and locations of the 10 largest rivers in the world.

(1 = most, 2 = intermediate, 3 = least)

(60) C _____

_____ Formula for converting centigrade temperature readings to fahrenheit readings.

_____ The difference in chemical structure between H_2O (water) and H_2O_2 (hydrogen peroxide).

_____ The distinction between "anode" and "cathode."

(61) D _____

_____ Chemical factors associated with transmitting neural impulses.

_____ Why thrust is generated by a jet engine.

_____ The chemical structure of penicillin.

(62) E _____

_____ The relative conductivity of certain substances (e.g., iron, copper, zinc, wood).

_____ The meaning of "specific gravity."

_____ The effect of increased pressure upon the boiling point of a liquid.

(63)

English

(64) A _____

_____ Write a report on the novel entitled 1984.

_____ The names of Shakespeare's comedies.

_____ The reason why Hedda Gabler (in Ibsen's Hedda Gabler) kills herself.

(65) B _____

_____ The names of 10 contemporary authors and their most important works.

_____ Write a biographical sketch based upon library research of any author (no longer living) of your choice.

_____ The effects of 19th century American history upon the American literature of the period.

(66) C _____

_____ The elements in a play that lead to its classification as a "tragedy."

_____ The correct spelling for the word meaning "to pay" (i.e., is it "renumerate" or "remunerate").

_____ Write a theme about the most interesting person you have ever met.

VIEWS ON EDUCATION

27. In thinking about your undergraduate education at U.C., how important do you consider each of the following benefits of a college education? For each of the items listed below, circle the number in the:

VI column if it is very important to you, in the
 SI column if it is somewhat important, in the
 U column if it is unimportant, or in the
 VU column if it is very unimportant to you.

	<u>VI</u>	<u>SI</u>	<u>U</u>	<u>VU</u>
Vocational training--skills and techniques directly applicable to a job.	1	2	3	4 (54)
Background and specialization for further education in some professional, scientific or scholarly field.	1	2	3	4
Broadened literary acquaintance and appreciation.	1	2	3	4
Awareness of different philosophies, cultures, and ways of life.	1	2	3	4
Social development--experience and skill in relating to other people.	1	2	3	4
Personal development--understanding one's abilities and limitations, interests, and standards of behavior.	1	2	3	4 (59)
Critical thinking--logic, inference, nature and limitations of knowledge.	1	2	3	4
Aesthetic sensitivity--appreciation and enjoyment of art, music, drama.	1	2	3	4
Writing and speaking--clear, correct, effective communication.	1	2	3	4
Science and technology--understanding and appreciation.	1	2	3	4
Citizenship--understanding and interest in the style and quality of civic and political life.	1	2	3	4 (64)

28. Please indicate how you feel about each of the following statements.
For each statement listed below, circle the number in the:

SA column, if you strongly agree, in the
A column, if you generally agree, in the
D column, if you generally disagree, or in the
SD column, if you strongly disagree.

	<u>SA</u>	<u>A</u>	<u>D</u>	<u>SD</u>	
An authoritative textbook is superior to reliance upon original readings.	1	2	3	4	(1)
It is a good learning experience for the student to be left with ambiguous or conflicting opinions so that he must arrive at the solution to a given problem on his own.	1	2	3	4	
Self-responsibility is best taught students by establishing definite rules of behavior (e.g., visitation privileges, study hours, and style of dress).	1	2	3	4	
I prefer to follow course work which emphasizes retention of facts.	1	2	3	4	
Students should participate significantly in the organization of courses and development of academic policy.	1	2	3	4	(5)
Students should be given great freedom in choosing their courses of study.	1	2	3	4	
I learn best when course presentation includes visual aids such as plates, models, and slides.	1	2	3	4	
Class assignments which depend upon the student's own initiative are preferable to definite, structural assignments.	1	2	3	4	
It is a good idea for faculty to mix informally with students by inviting them to their homes or by joining them in student lounges or snack bars.	1	2	3	4	
Students should be encouraged to seek their own answers to their questions.	1	2	3	4	(10)
Lecture classes are superior to group discussion classes.	1	2	3	4	
Emphasis should be placed on independent study.	1	2	3	4	(12)

PERSONAL INFORMATION

29. We all have different preferences and personal characteristics. We would like to know more about the relationship of different choices and traits to important college and subsequent career experiences. On the left please check all the items below that you generally find to your liking. On the right, please check all the adjectives that you think are generally descriptive of you. (Please check all items that apply.)

I generally like:

- (28) ☐ Unquestioning obedience
- ☐ Strict law enforcement
- ☐ The tried and true
- ☐ Determination and ambition
- ☐ Strong family ties
- (33) ☐ Unwavering patriotism
- ☐ Perfect balance in composition
- ☐ Novel experiences
- ☐ Predictable outcomes to problems
- ☐ Original work
- (38) ☐ A set schedule of activities
- ☐ A proper place for everything
- ☐ The one right answer to questions
- ☐ Friends without complex problems
- ☐ Straight-forward reasoning
- (43) ☐ Dealing with new or strange ideas
- ☐ The perfectly completed object
- ☐ Quick unhesitating decisions
- ☐ Original research work
- ☐ To draw my own conclusions
- (48) ☐ Solving long, complex problems
- ☐ Critical consideration of theories
- ☐ Science and mathematics
- ☐ Contemplating the future of society
- ☐ Men of ideas
- ☐ Discovering how things work
- ☐ Scientific displays
- (55) ☐ Detecting faulty reasoning

I generally am:

- (56) ☐ Well-organized
- ☐ Practical
- ☐ Individualistic
- ☐ Questioning
- ☐ Predictable
- (61) ☐ Open-minded
- ☐ Introspective
- ☐ Experimental
- ☐ Creative
- ☐ Undistracted
- (66) ☐ Analytical
- ☐ Critical-minded
- ☐ Scientific
- ☐ Socially-minded
- (70) ☐ Contemplative
- (71-79)
- (80)4
- (1) ☐ Dutiful
- ☐ Determined
- ☐ Conventional
- ☐ Unrestrained
- (5) ☐ Adaptable
- ☐ Permissive
- ☐ Worried
- ☐ Happy
- ☐ Calm
- (10) ☐ Self-confident
- ☐ Nervous
- ☐ Anxious
- (13) ☐ Restless

32. In thinking about your future occupations, what is your chief area of interest? (Check one.)

- (21) 0 ☐ Undecided
 1 ☐ Manufacturing
 2 ☐ Design
 3 ☐ Management
 4 ☐ Sales
 5 ☐ Research and development
 6 ☐ Teaching
 7 ☐ Other (Specify: _____.)

33. In what kind of organization do you wish to work? (Check one.)

- (22) 0 ☐ Undecided
 1 ☐ Self-employed
 2 ☐ Business or industrial firm
 3 ☐ Educational agency
 4 ☐ Government agency
 5 ☐ Other non-profit agency
 6 ☐ Other (Specify: _____.)

34. Which of the following things do you wish to do fairly regularly in your work? (Check as many as apply.)

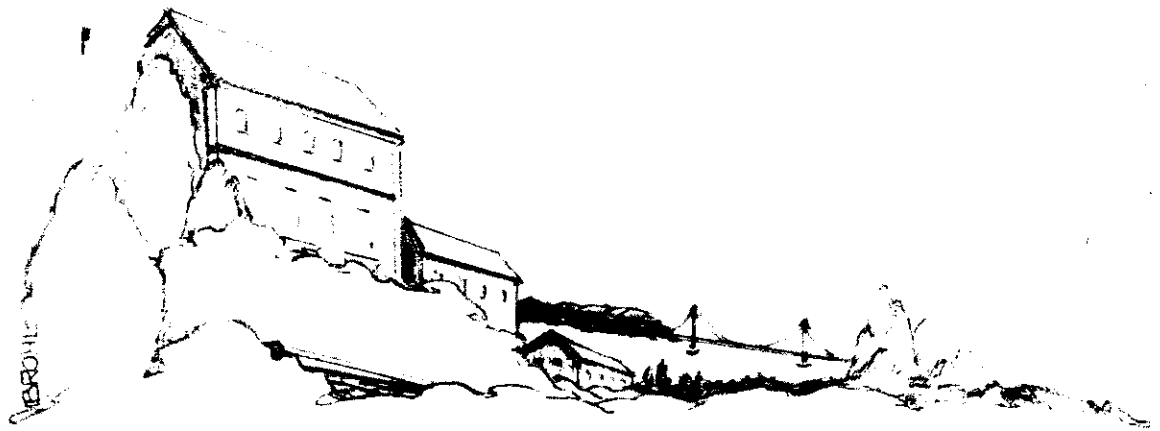
- (23) ☐ Plan your own work
☐ Supervise others
☐ Make policy decisions
☐ Write reports
☐ Do original research or writing
 (28) ☐ Keep records
☐ Instruct others
☐ Counsel or advise others
☐ Make speeches or present reports
☐ Organize operations
☐ Attend meetings
 (34) ☐ Analyze data

35. Which of the following characteristics do you associate with satisfaction in your future occupations? (Check as many as apply.)

- | | |
|---|--|
| (35) <input type="checkbox"/> Initiative | (45) <input type="checkbox"/> Independence |
| <input type="checkbox"/> Responsibility | <input type="checkbox"/> Regularity |
| <input type="checkbox"/> Creativity | <input type="checkbox"/> Stimulation |
| <input type="checkbox"/> Stability | <input type="checkbox"/> Pressure |
| <input type="checkbox"/> Prestige | <input type="checkbox"/> Financial Reward |
| (40) <input type="checkbox"/> Recognition | <input type="checkbox"/> Pleasant surroundings |
| <input type="checkbox"/> Security | (51) <input type="checkbox"/> Interesting associates |
| <input type="checkbox"/> Opportunity | |
| <input type="checkbox"/> Risk | |
| (44) <input type="checkbox"/> Variety | |



SURVEY II
OF
ENGINEERING
45



COLLEGE OF ENGINEERING
UNIVERSITY OF CALIFORNIA, Berkeley

UNIVERSITY OF CALIFORNIA
College of Engineering
Department of Mineral Technology

Survey II of Engineering 45

At the beginning of the term you were asked to evaluate your experiences, interests, and goals in college. Now that you have completed this term we are asking you for an additional evaluation of your experiences and for your evaluation of Engineering 45 in particular. This is one major way that we can most efficiently evaluate the quality of the course and its relevance to your interests. Again, you are reminded that all information is confidential, that no individual's responses will be reviewed by the faculty, and that your name is requested only so that all information obtained from you may be combined. Nevertheless, as before, you are free to skip items you prefer not to answer.

Name _____

Section Number _____

THE CHANGING SOCIETY

3. There are periods of history when change seems to be more turbulent than others. Often the directions of change seem unclear; and people differ in their judgment about whether particular trends or tendencies are desirable or undesirable. We have listed below a number of statements that describe changes or tendencies which may or may not be occurring in the United States. For each statement indicate first, in the left hand columns, whether you think the change or trend it describes is or is not occurring -- by circling the number if generally True, Don't know, or generally Not true. Then, after some of these statements, and in the right hand columns, you will find space for an additional response. For this response, indicate whether you think the change described would be desirable or undesirable if it in fact occurred or is occurring.

<u>Occurring</u>				<u>Desirable</u>			
Generally true	Don't know	Generally not true		Generally desirable	No opinion	Generally undesirable	
(58)	1	2	3	1	2	3	(1)
	1	2	3				
	1	2	3	1	2	3	(2)
	1	2	3				
	1	2	3				
(62)	1	2	3				
	1	2	3				
	1	2	3				
	1	2	3				
	1	2	3				
	1	2	3				
	1	2	3	1	2	3	(3)
	1	2	3	1	2	3	(4)
	1	2	3	1	2	3	(5)
(70)	1	2	3	1	2	3	(6)

THE COLLEGE ENVIRONMENT

4. Facilities, procedures, policies, requirements, attitudes, etc., differ from one campus to another. What is characteristic at the University? As you read each statement below consider 1) Whether it is true of U.C. generally, 2) Whether it is true of the College of Engineering, and 3) Whether you feel it is generally desirable or not. In the left hand columns circle the number under TRUE (T) if the statement describes a condition you think generally characteristic of the University at large, or FALSE (F) if you do not think it is characteristic.

Then look at the statements again, and in the first two columns in the right circle numbers under TRUE if you think the statement is characteristic of the College of Engineering specifically, and FALSE if not.

Finally, in the last two columns circle the number under DESIRABLE (D) if the statement describes a condition which you regard as a good characteristic, or NOT DESIRABLE (ND) if it is something you hope would not be characteristic of a college environment. Please answer every statement.

<u>Generally at U.C.</u>			<u>Generally in Engineering</u>			<u>Generally for me</u>	
T	F		T	F		D	ND
(31) 1	2	Frequent tests are given in most courses.	1	2 (41)		1	2 (51)
1	2	The college offers many really practical courses such as typing, report writing, etc.	1	2		1	2
1	2	The most important people at this school expect others to show proper respect for them.	1	2		1	2
1	2	There is a recognized group of student leaders on this campus.	1	2		1	2
(35) 1	2	Many upperclassmen play an active role in helping new students adjust to campus life.	1	2 (45)		1	2 (55)
1	2	The professors go out of their way to help you.	1	2		1	2
1	2	This school has a reputation for being friendly.	1	2		1	2
1	2	It's easy to get a group together for card games, singing, going to the movies, etc.	1	2		1	2
1	2	Students are encouraged to criticize administrative policies and teaching practices.	1	2		1	2
(40) 1	2	The school offers many opportunities for students to understand and criticize important works in art, music, and drama.	1	2 (50)		1	2 (60)

5. Several courses follow in which large numbers of students tend to enroll. Under each course are listed a variety of topics, information, and tasks to be accomplished.

Assume that you are enrolled in these courses and therefore must learn about each of the items listed below.

The items are listed in groups of three. For each group mark a . . .

- "1" by the item that you would like most;
 "2" by the item in which you would have an intermediate interest; and a
 "3" by the item that would interest you least.

Examples:

Business and Economics

A

1. 2 The functions of the Securities and Exchange Commission.
2. 3 Factors operating to diminish the size of the U.S. gold reserve.
3. 1 When an "easy money" policy may be unsound public policy.

B

4. 2 The names of the components of the "Gross National Product."
5. 1 The meaning of an "odd lot" in stock purchases.
6. 3 The purpose underlying agricultural price supports.

In Group A the respondent indicates that he is most interested in item 3 ("When an 'easy money' policy may be unsound public policy"); least interested in item 2 ("Factors operating to diminish the size of the U.S. gold reserve"); and has an intermediate interest in item 1 (The functions of the Securities and Exchange Commission."). Of the three items in Group B he is most interested in 5, least interested in 6, and has an intermediate interest in 4.

Do not assign the same rank to two items in a single group.

Geography

(21) A

- The factors responsible for westward population migration in the U.S.
 The names of the capitals of the European countries.
 The names and locations of the 10 largest rivers in the world.

Q. 5. continued

(1 = most, 2 = intermediate, 3 = least)

(29) C _____

_____ Formula for converting centigrade temperature readings to fahrenheit readings.

_____ The difference in chemical structure between H_2O (water) and H_2O_2 (hydrogen peroxide).

_____ The distinction between "anode" and "cathode."

(30) D _____

_____ Chemical factors associated with transmitting neural impulses.

_____ Why thrust is generated by a jet engine.

_____ The chemical structure on penicillin.

(31) E _____

_____ The relative conductivity of certain substances (e.g., iron, copper, zinc, wood).

_____ The meaning of "specific gravity."

_____ The effect of increased pressure upon the boiling point of a liquid.

(32)

English

(33) A _____

_____ Write a report on the novel entitled 1984.

_____ The names of Shakespeare's comedies.

_____ The reason why Hedda Gabler (in Ibsen's Hedda Gabler) kills herself.

(34) B _____

_____ The names of 10 contemporary authors and their most important works.

_____ Write a biographical sketch based upon library research of any author (no longer living) of your choice.

_____ The effects of 19th century American history upon the American literature of the period.

(35) C _____

_____ The elements in a play that lead to its classification as a "tragedy."

_____ The correct spelling for the word meaning "to pay" (i.e., is it "renumerate" or "remunerate").

_____ Write a theme about the most interesting person you have ever met.

7. Please indicate how you feel about each of the following statements.
For each statement listed below, circle the number in the:

SA column, if you strongly agree, in the
A column, if you generally agree, in the
D column, if you generally disagree, or in the
SD column, if you strongly disagree.

	<u>SA</u>	<u>A</u>	<u>D</u>	<u>SD</u>	
An authoritative textbook is superior to reliance upon original readings.	1	2	3	4	(46)
It is a good learning experience for the student to be left with ambiguous or conflicting opinions so that he must arrive at the solution to a given problem on his own.	1	2	3	4	
Self-responsibility is best taught students by establishing definite rules of behavior (e.g., visitation privileges, study hours, and style of dress).	1	2	3	4	
I prefer to follow course work which emphasizes retention of facts.	1	2	3	4	
Students should participate significantly in the organization of courses and development of academic policy.	1	2	3	4	
Students should be given great freedom in choosing their courses of study.	1	2	3	4	(51)
I learn best when course presentation includes visual aids such as plates, models, and slides.	1	2	3	4	
Class assignments which depend upon the student's own initiative are preferable to definite, structural assignments.	1	2	3	4	
It is a good idea for faculty to mix informally with students by inviting them to their homes or by joining them in student lounges or snack bars.	1	2	3	4	
Students should be encouraged to seek their own answers to their questions.	1	2	3	4	
Lecture classes are superior to group discussion classes.	1	2	3	4	
Emphasis should be placed on independent study.	1	2	3	4	(57)

8. You are asked to rate each unit of Engineering 45 and the course as a whole in reference to the questions raised below. Please circle the one most appropriate number for each unit and for the total course.

How well did you understand the objectives of the course? (Scale: (1) Very well to (5) Not at all)

Internal Structure and Mechanical Properties section	1	2	3	4	5	(3)
Electrical section	1	2	3	4	5	
Cement and Concrete, Wood, Plastics section	1	2	3	4	5	
The course as a whole	1	2	3	4	5	

How well did the course sessions altogether seem to you to form a cohesive unit? (Scale: (1) Very well to (5) Not at all)

Int. Structure and Mech. Properties section	1	2	3	4	5	(7)
Electrical section	1	2	3	4	5	
Cement and Concrete, Wood, Plastics section	1	2	3	4	5	
The course as a whole	1	2	3	4	5	

How stimulating did you find the class sessions? (Scale: (1) Very stimulating to (5) Not at all)

Int. Structure and Mech. Properties section	1	2	3	4	5	(11)
Electrical section	1	2	3	4	5	
Cement and Concrete, Wood, Plastic section	1	2	3	4	5	
The course as a whole	1	2	3	4	5	

How informative did you find the class sessions? (Scale: (1) Very informative to (5) Not at all)

Int. Structure and Mech. Properties section	1	2	3	4	5	(15)
Electrical section	1	2	3	4	5	
Cement and Concrete, Wood, Plastic section	1	2	3	4	5	
The course as a whole	1	2	3	4	5	

To what extent were you encouraged to think independently? (Scale: (1) Greatly encouraged to (5) Not at all)

Int. Structure and Mech. Properties section	1	2	3	4	5	(19)
Electrical section	1	2	3	4	5	
Cement and Concrete, Wood, Plastics section	1	2	3	4	5	
The course as a whole	1	2	3	4	5	

Q. 8. continued

How much did the course enrich your personal learning experience? (Scale: (1) Very much to (5) Not at all)

Int. Structure and Mech. Properties section	1	2	3	4	5	(47)
Electrical section	1	2	3	4	5	
Cement and Concrete, Wood, Plastics section	1	2	3	4	5	
The course as a whole	1	2	3	4	5	

To what extent did you prepare for your classes? (Scale: (1) Very much to (5) Not at all)

Int. Structure and Mech. Properties section	1	2	3	4	5	(51)
Electrical section	1	2	3	4	5	
Cement and Concrete, Wood, Plastics section	1	2	3	4	5	
The course as a whole	1	2	3	4	5	

How well, on the average, would you rate your own attention and involvement in class? (Scale: (1) Excellent to (5) Very poor)

Int. Structure and Mech. Properties section	1	2	3	4	5	(55)
Electrical section	1	2	3	4	5	
Cement and Concrete, Wood, Plastics section	1	2	3	4	5	
The course as a whole	1	2	3	4	5	

How much, on the average, have your classes in this course pointed out gaps and inadequacies in your comprehension of material? (Scale: (1) Very often to (5) Seldom)

Int. Structure and Mech. Properties section	1	2	3	4	5	(59)
Electrical section	1	2	3	4	5	
Cement and Concrete, Wood, Plastics section	1	2	3	4	5	
The course as a whole	1	2	3	4	5	

To what extent did the course encourage critical thinking in the solution of problems? (Scale: (1) Greatly to (5) Not at all)

Int. Structure and Mech. Properties section	1	2	3	4	5	(63)
Electrical section	1	2	3	4	5	
Cement and Concrete, Wood, Plastics section	1	2	3	4	5	
The course as a whole	1	2	3	4	5	

To what extent has the course increased your theoretical understanding? (Scale: (1) Greatly to (5) Not at all)

Int. Structure and Mech. Properties section	1	2	3	4	5	(67)
Electrical section	1	2	3	4	5	
Cement and Concrete, Wood, Plastics section	1	2	3	4	5	
The course as a whole	1	2	3	4	5	(70)

Elaborate on any of the previous questions.
(21-22)

What do you feel are the strengths and weaknesses of individual units
or of the course in general?
(23-24)

How do you feel the course could improve?
(25-26)

(71-79)5

Thank you for your cooperation!

APPENDIX E

Intellectual Disposition Category Calculation

INTELLECTUAL DISPOSITION CATEGORY CALCULATION*

CATEGORY

1	Average above 61 TI and TO above 54 TI or TO above 64 AU above 54	If any of these criteria not met, then category 2
2	Average above 53 TI or TO above 54 AU above 44	If not, then category 3
3	Average above 41 TI and TO below 55 AU below 55	If not, category <u>2</u>
4	Average below 41 TI and TO below 55	If not, category 3

*Adapted from Cairne (1966) and Heist and Yonge (1968).

APPENDIX F

Brief description of CUES

Description of CUES Scale

The 1963 version of CUES is a 150-item inventory; students respond with "true" or "false" to each item, depending on whether they feel the item is typical of their school. The inventory is scored to yield 5 primary scales with each scale composed of 30 items. The scales are described by Pace (1963, pp. 24-25) in the CUES manual as follows:

Scholarship: "The items in this scale describe an academic scholarly environment. The emphasis is on competitively high academic achievement and a serious interest in scholarship. The pursuit of knowledge and theories, scientific or philosophical, is carried on rigorously and vigorously. Intellectual speculation, an interest in ideas as ideas, knowledge for its own sake, and intellectual discipline—all these are characteristic of the environment." Sample items are: "Students set high standards of achievement for themselves"; and "Most of the professors are very thorough teachers and really probe into the fundamentals of their subject."

Awareness: "The items in this scale seem to reflect a concern and emphasis upon three sorts of meaning—personal, poetic and political....What seems to be evident in this sort of environment is a stress on awareness, an awareness of self, of society, and of esthetic stimuli. Perhaps...these features of a college atmosphere can be seen as a push toward expansion and enrichment." Sample items measuring Awareness are: "Students are actively concerned about national and international affairs"; and "The school offers many opportunities for students to understand and criticize important works in art, music, and drama."

Practicality: "This combination of items suggests a practical, instrumental emphasis in the college environment. Procedures, personal status, and practical benefits are important....Order and supervision are characteristic of the administration and of the classwork. Good fun, school spirit, and student leadership in campus social activities are evident. The college atmosphere described by this scale appears to have an interesting mixture of entrepreneurial and bureaucratic features." Sample items are: "Education here tends to make students more practical and realistic"; and "Student organizations are closely supervised to guard against mistakes."

Community: "The combination of items in this scale describes a friendly, cohesive, group-oriented campus. The environment is supportive and sympathetic. There is a feeling of group