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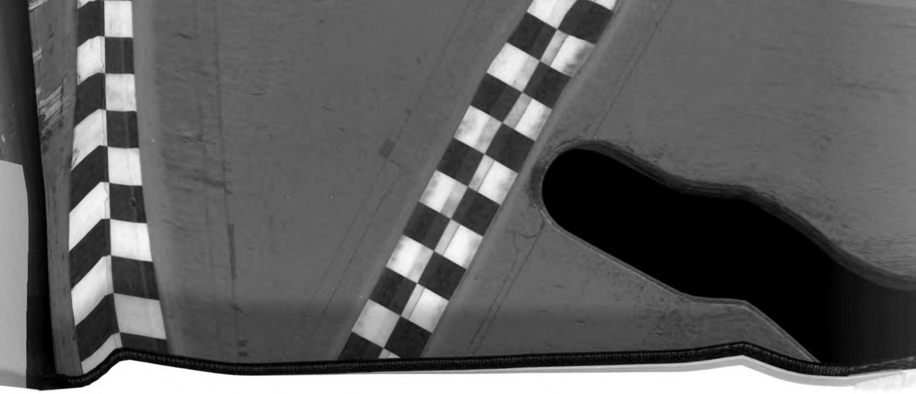

ABSTRACT

EFFECTS ASSOCIATED WITH TECHNICAL SUMMER EMPLOYMENT OF ENGINEERING STUDENTS

by Donald Carl Waterstreet

Educators, representatives of industry and students have expressed a need for technical summer employment for engineering students. The changing emphasis in Engineering Education, from a detailed set of specific skills to a more generalized mathematics-science oriented program, has made it more difficult for educators to communicate or interpret to students what to expect in an engineering job.

Claims are made that engineering students who have had summer technical employment are positively affected by the experience. An extensive review of literature pertaining to summer employment revealed little research which quantified the associate effects of technical work on students. As a result, the study was conceived to determine the associate effects of technical summer employment on the attitudes of engineering undergraduate students.

The population was designated as the junior engineering class at Michigan State University during Spring term, 1968. Junior class membership was defined as students who were enrolled in the required junior engineering classes. The sample was divided into two groups. The technical group was comprised of those subjects (126) who were employed in a summer technical job. Students (154) who were not technically employed were designated as the non-technical group. The final sample (280) was eighty-two percent of the population.

Two questionnaires (pre- and post-measures) were developed to evaluate and study the associative effects of the summer experience on the two groups. The null hypothesis which provided direction for the study:

> No disproportionality will be found in engineering or personal attitudes between the technical and non-technically employed groups as measured by the questionnaire.

The chi-square statistic was used where appropriate to determine whether the students' attitudes were affected by the summer experience. Analysis of Covariance was used to determine whether Fall term grades were affected by the summer experience. Frequency counts and percentile distributions were used to present the data when tests of significance were inappropriate.

Wholehearted support was indicated for technical summer employment by the technical group. They cited many personal and academic benefits derived from the technical job.

Two differences between the groups in engineering attitudes were identified before the summer. The technical group indicated technical summer employment was more essential than the non-technical group. The non-technical group relied more heavily on the advice of faculty and advisors on the choice of elective courses than the technical group. These group differences were also evident on the post-test. Post-test differences between technical and non-technical groups were found on the following self-reported variables:

1. reported ability to solve engineering problems
2. reported academic assertiveness toward a classmate
3. reported academic assertiveness toward a professor in class

4. reported anticipation of their first full-time engineering job
5. reported knowledge of what an engineer does on the job
6. reported expectation for their senior year-receive knowledge of what an engineer does on the job

Group differences on the first five variables were caused by increased ratings after the summer by the technical group, but group differences found for number six were related to high post-test expectations from the non-technical group.

The students responded to a word rating list in the last section of the questionnaire. Pre-test differences between the groups were observed on the responses to the following words: skilled, efficient, logical, curious, successful, tense, above average, an achiever, and inquisitive.

The technical group rating exceeded the rating of non-technical group in each of these qualities. Post-test examination of the same traits identified only logical, efficient, and successful as characteristic of the technical group.

Post-test analysis of the responses to the remainder of the words produced nine differences between the groups. The traits were: challenging, thing oriented, a leader, confident, unsure, practical, careful, persistent, and motivated. The technical group reported that they were more challenging, confident, efficient, practical, persistent, motivated, more of a leader, and less unsure after the summer than the non-technical group. The technical group post-rating of the phrase, thing oriented was less extreme and more realistic than their pre-test rating. The non-technical group rated themselves as more careful and the technical group less careful on the post-test.

The grades of the technical group were significantly higher than the grades of the non-technical group during Fall term, 1968.

The overall findings identified a technical group that returned to the campus in the Fall with reported positive changes in their attitudes. As a group, they expressed no negative feelings toward the summer technical job.

EFFECTS ASSOCIATED WITH TECHNICAL

SUMMER EMPLOYMENT OF

ENGINEERING STUDENTS

By

Donald Carl Waterstreet

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DEDICATED TO

My Wife, Sharon

My Sons, Craig, Jeff, and Mark

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CHAPTER I

THE PROBLEM

Engineering educators have emphasized the importance of summer jobs as a logical extension of the formal academic experience for engineering students.[1] They contend that the summer job directly supplements the academic class work by providing the students with a practical laboratory in which to use their engineering skills. Engineering educators further state that students who have engaged in summer technical employment are sometimes quite different when they return to the campus in the Fall. Although the student changes are not accurately defined, the educators mention increased maturity, motivation, desire, and confidence as byproducts of technical employment.[2] Certainly the summer job program defines a method of linking the highly theoretical formal programs with the applied needs of the field. The extent of the linkage has been only conjecture to this point in time. A review of the recent history of engineering education provides substance for understanding the major forces influencing the students' academic programs.

The entire engineering education process has undergone radical change in the last few years. Engineering education has shifted from

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[1] Johnson, J. S. "Philosophy of Engineering Education," Journal of Engineering Education, 49:7, (Mar., 1959), 580-7.

[2] Engineers Joint Council. Proceedings - Summer Employment for Engineering Students Conference. Engineers Joint Council, 1965.

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an emphasis on technology[3] in the early 1940's to a theoretical approach which is prevalent in the engineering programs of today. The theoretical approach to engineering places a heavy emphasis on science and mathematics.

The American Society for Engineering Education published reports in 1940 and 1944 concerned with the narrow specialization of engineering education. As early as 1940 it was apparent that engineers could be over specialized and technically narrow. The education of engineering students was often referred to as training rather than education. In the American Society for Engineering Education 1944 report the recommendation was that twenty percent of the curriculum should be in the area of humanities and social sciences which was probably the first shift toward the development of a "total" education for engineers. The need for the inclusion of disciplines other than engineering technology into the curriculum had been recognized.

World War II led to another shift in engineering education. The total war effort brought scientists and engineers together to work on common problems. Many of the technological advances of this period were based on science and mathematics. Most engineers with a technical specialized education were unable to adjust to the rapid scientific transition.

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[3] Technology is defined as a narrow specialized approach to engineering education. This approach is characterized by the study of specific machines, laboratories, skills, and methods used to solve engineering problems. Little emphasis was placed on the theory behind the solving of problems.

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The apparent failure of engineering education to bridge the theoretical and applied gap prompted another study by the American Society for Engineering Education. This three year study, completed in 1955, emphasized the importance of mathematics and science, and reaffirmed the previous commitment for the inclusion of humanities and social science as an integral part of engineering education. It was proposed that:

> -----certain curricular areas are obviously basic to undergraduate engineering education. These areas include mathematics, physics, and chemistry, the engineering sciences, the application of these to the analysis and synthesis of engineering systems with the major field, technical courses outside the major field, and humanistic-social studies.[4]

The educational philosophy structured by the American Society for Engineering Education has affected all engineering colleges since the 1955 report. Although individual schools reflect various degrees of theoretical or applied emphasis, each school has been influenced by the modern theoretical approach. Engineering programs at Michigan State University are examples of the mathematics, science, and engineering methodology approach. In addition to the theoretical engineering program, all students are required to complete seventeen to twenty-seven percent of a four year program in humanities and social science.

The change from the applied education of the 1930's to the theoretical program of the 1960's may have ushered in a new problem for the present student. Whereas, the former program gave each

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[4]"Interim Report of the Committee on Evaluation of Engineering Education." Journal of Engineering Education, 1955, 45: p. 48.

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student a specific command of many machines, instruments, and tools, the student in todays' engineering program spends little time on specific tasks which relate the engineering theory to practical application. According to the Engineers Joint Council Report,[5] students are concerned with what an engineer actually does in industry; concerned about applying theory to practical industrial problems; and concerned about leaving the university setting and reporting to their initial engineering job. It is possible that these concerns and apprehensions may have an effect on the students' education. It would seem that a technical summer job could supplement a theoretical engineering program.

The second emphasis for technical summer employment originates from the industries who hire engineering students. Large corporations send their recruiters to Michigan State University specifically to hire undergraduate engineering students. The students often are invited to visit the company before accepting a summer job. These visits are paid for by the company which certainly exemplifies the employers commitment to employing the student. The companies are actively involved in recruiting summer employees.

Why are these companies willing to go to these measures to insure hiring engineering students? Generally, corporations are motivated by the desire to hire their summer employees on a full-time basis at graduation time.[6] The recruitment of engineers is a difficult process because there are more positions than there are engineers graduating. Last year (1968) in the placement bureau at Michigan State

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[5]EJC, Proceedings.

[6]Jensen, Jerry J. "Your Summer Job Program - A Success or Failure?" Journal of College Placement, 1964, 25:61-2.

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University there were ten requests by industry for every engineering graduate.[7]

Recruitment is not the sole reason for industry's involvement in summer hiring of engineering students. Several of the industrial representatives present during the Engineers Joint Council's Conference on Summer Employment presented their companys' views on the employment of students. Dr. Easton suggests that:

> It does not take very much of the right type of organized training in work experience to bridge the gap between theory and practice and to initiate the development of engineering judgement. However, it may take a long time for the young engineer to mature professionally if his experiences are left to chance.[8]

It is clear from this statement that industry is concerned about the overall education of engineers. The organized training mentioned by Easton is detailed in the Conference Proceedings of the Engineers Joint Council, but the guidelines presented below are helpful to understanding the industrial commitment to students and what the students gain from the industrial experience. These guidelines are:

1. Define each man's job in advance of his arrival.
2. Match the job to the man's capabilities and interests.
3. Keep the jobs at a professional level.
4. Tailor the job to the time period available.
5. Insist on a specific product.
6. Keep the program to a size that is within the capacity of available supervisors.[9]

Establishing a summer employment program, hiring the students, and then adequately supervising them takes considerable effort. The

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[7]Placement Bureau, Report of 1967-1968, Michigan State University, 1968.

[8]EJC, Proceedings, P. 34.

[9]EJC, Proceedings, P. 25-26.

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industries which are willing to become involved in an employment program must feel that both the student and the employer benefit. If there were no tangible benefits, the large corporations that operate to make a profit would not be willing to expend the finances nor the effort to develop and staff a summer employment program.

The third and perhaps most important spokesman for summer technical employment are the engineering students. It was stated above that students are willing to travel to distant corners of the country to obtain a technical summer job. To have this experience many of the students leave home for three months and pay large room and board costs. Considering that most of the students need to save money during the summer for the next school year, then the room and board costs subtracted from their possible summer savings becomes a negative factor, and still, the students seek summer technical employment.

The changing emphasis in engineering education, from a detailed set of specific skills to a more generalized mathematics-science oriented program, has made it more difficult for educators to communicate or interpret to students what to expect in an engineering job. As a result students seek summer employment to gain knowledge about engineering. Students seek and find specific answers to the question; What does an engineer do? Summer employment in an engineering firm allows the student to obtain feedback on his engineering skills. The feedback can be compared to the specific skills and laboratory experiences of the engineering student of the 1940's.

Claims are made that engineering students who have had summer technical employment are positively affected by the experience.

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It is said that the students return to the campus with a clearer picture of engineering and of their place in the field of engineering. The summer experience also seems to have a positive effect on the students desire to learn, maturity, and general attitude towards his remaining formal undergraduate education.

Need for the Study

Educators, representatives of industry and students express a need for technical summer employment for engineering students. But there is no national movement in engineering colleges to place their students in technical summer jobs. Michigan State University's College of Engineering is no exception to the national trend, which raises the question of whether there should be such a movement.

Currently, there is not enough evidence about the personal or educational benefits of technical summer employment of engineering students to support or negate a large scale summer employment program. There are numerous opinions being expressed about the effects of such a program, but there are no studies that attempt to adequately evaluate the current judgements.

There is a definite need for a study of the effects of technical summer employment on engineering students. If a controlled study supports the contentions of educators, industrial representatives and students about the effects of summer employment then engineering colleges will need to develop large scale programs to encourage students to be involved in technical summer employment. Industry would have to provide an adequate number of jobs at an appropriate educational level for engineering students. Lack of support for

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technical summer employment would have implications for engineering education also. Presently, many educators encourage their students to seek technical employment because of the theories about the positive influence employment has on students. If no positive effects are attributed to technical employment there should be no pressure to seek summer technical employment.

Purpose of the Study

The purpose of this study is to determine the associate effects of technical summer employment on the attitudes of engineering undergraduate students. The first attitude to be studied is the students' feelings about their academic classes and engineering competencies. Secondly, the students' feelings about themselves are assessed. These personal feelings are not specifically related to engineering. The combination of engineering attitudes and personal attitudes provides a broad base to describe the junior engineering students at Michigan State University.

Hypothesis

To facilitate orderly examination and discussion of the data obtained from the study a broad research hypothesis is necessary. The purpose of the study is to determine if technical summer employment affects the attitudes of undergraduate engineering students. There is no concisive evidence to support student attitude changes because of technical employment, therefore, the hypothesis is stated in null form.

> No relationship exists between summer technical employment and the engineering and/or personal attitudes of undergraduate engineering students.

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Statement and Limitations of the Study

This study is exploratory and evaluative in nature. The exploratory approach was necessary because of the rigidity of the setting. It was not possible to control those students who do or do not have technical jobs, because the students chose their own summer activities. In Chapter III a detailed analysis of the makeup of the technical and non-technical groups are presented.

The evaluative nature of the study was dictated by the lack of specific evidence about the effects of summer technical employment on engineering students. The data which supports the desirability of technical employment is generally an expressed attitude or speculation on the part of students, educators, or industrial representatives. There are no controlled studies which have categorized and analyzed the possible attitude changes in students because of summer technical employment. The specific attitudes of students about summer employment and their personal views about engineering and how it relates to their summer experience are evaluated in the study.

A questionnaire was developed to gather information from the students and was administered during the last two week of Spring term, 1968. A second questionnaire was developed and given to the students when they returned to the campus in the Fall of 1968.

The data obtained from the two questionnaires was analyzed with appropriate statistical tests. The results of the analysis were then described within the context of the study. The effect of the summer employment on the technical group was compared to the effect of the summer on the non-technical group. Based on results of the study, implications are drawn for further research. The

results of the study are important to the College of Engineering at Michigan State University, because of the involvement in undergraduate engineering education. If the results are to be meaningful, ultimately the students must benefit from the implications of the study.

Overview

To aid in the understanding of the four chapters which follow, a brief summary of their contents is presented. The relevant literature to summer employment is reviewed in Chapter II. With a knowledge of the literature as a foundation, the design of the study, the questionnaire development and data analysis plan are presented in Chapter III. The anlysis of the data from the questionnaires are reported in Chapter IV. In Chapter V the summary, recommendations and implications for further research are discussed.

The literature review in the chapter that follows examines several educational approaches that have been devised to supplement students' formal education.

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CHAPTER II

REVIEW OF THE LITERATURE

The specific direction and guidelines for the study were presented in Chapter I. The exploratory nature of the study was necessitated by the lack of information in the area of student attitude changes attributed to summer technical employment.

A review of related literature produced a limited number of studies concerned with summer jobs, but the effects of the jobs are not documented. The literature search was expanded to include several studies and reports of cooperative educational programs. Although cooperative programs have a different orientation than a regular four year program, technical employment for students is an integral part of a cooperative plan. Because of the similarity between cooperative education and a summer work program, studies of cooperative education were reviewed.

Summer Employment

The reasons most frequently cited for summer employment are the possible financial gains for the students and the opportunity for companies to attract students. Increased costs of higher education has made it imperative for most students to work during the summer. Many authors use this fact as a primary reason for students to seek summer employment.

Another traditional reason for summer employment has been recruitment; where the employer and employee have a detailed look at ea

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each other.[1] In this vein Jensen states that: "a long time rationale for summer hiring has been that it provides an excellent opportunity for student and employer to consider one another for future full-time employment."[2] The three month trial has fewer complications than a full-time job if either employer or employee is dissatisfied.

Neither the financial nor the recruitment aspects of summer employment are directly related to student attitudes about himself, except that he may have more money and a job commitment for graduation time. Presented in Chapter I, was a historical perspective of the evolution of engineering education. The theoretical position of engineering education today, emphasizes theory and actual practice of engineering skills has been lessened. The summer job would be an avenue for students to gain practical experience in engineering practice.

An article by Johnson encouraged students "- - - to take full advantage of inspection trips, and to seek summer employment in industry or with utilities."[3] He wrote that as a result of the summer experience students will obtain a greater understanding for their education. Support for this position was also found in the Engineers Joint Council on Summer Technical Employment.[4]

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[1] Engineers Joint Council. Proceedings - Summer Employment for Engineering Students Conference. Engineers Joint Council, 1965.

[2] Jensen, Jerry J. "Your Summer Job Program - A Success or Failure?" Journal of College Placement, 1964, 25:61-2, p. 61.

[3] Johnson, J. S. "Philosophy of Engineering Education." Journal of Engineering Education, 49, No. 7 (March, 1959), 580-587.

[4] EJC, Proceedings.

An industrial view of employing students to do technical work during the summer was discussed by F. J. Lockhart[5] in a provocative article about industry's involvement in engineering education. He wrote that not only should industry offer "on-the-job" (parenthesis in original) training to students, they should hire professors for the summer and offer them the same type of training. This type of approach would not only benefit the student during the summer, but would have the added advantage of professors bringing back their industrial experiences to the classroom. Therefore, even those students who were unable to obtain technical summer employment would benefit from the summer experience of the professor.

Other writers such as Stevens[6] and Pierce[7], addressed themselves to the part that industry must play in providing summer technical jobs. They felt that this was a valuable way to provide insight into the industrial problems of today, and students definitely would add a dimension to their technical education if they were employed by industry. Stevens and Stephens in their article state that: "The summer and part-time working experience of students affect their attitudes about business and government."[8]

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[5]Lockhart, F. J. "What is Industry's Responsibility in Training and Development of Engineers?" Journal of Engineering Education, 45, No. 8 (April, 1955), 598-601.

[6]Stevens, Nancy D. and Stephens, Everett W. " 'Who' and 'What' Influences Student Attitudes Toward Occupations." Journal of College Placement, 28, No. 3 (Feb. - March, 1968), 50-160.

[7]Pierce, J. R. "What Are We Doing to Engineering?" Science, 149, (July 26, 1965), 397-399.

[8]Stevens, 'Who' and 'What' p. 52.

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What personal attitude changes are evidenced in the students which are attributable to their summer employment? There were a few studies which provide some evidence. A small survey in School and Society, showed that 80% of Amherst students held summer jobs which provided income plus "a dimension of experience and education that could not be obtained otherwise."[9]

A study by Augustine of three Midwest engineering colleges referred to summer employment among students. His concern was with engineering persistors and non-persistors in the three engineering institutions. The persistors had more frequently engaged in part-time or summer employment which was technical in nature than the non-persistors. "Both persistors and non-persistors enthusiastically support summer job programs and ask that their universities aid them in finding relevant work situations."[10] The specific benefits to the students were not covered in the study. Even though the persistors had a greater frequency of technical work experience, it was difficult to assess from his study whether the employment itself affected the students commitment to engineering. Possibly the fact that they were more deeply committed to engineering led them to seek technical employment.

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[9] "Students' Summer Jobs." School and Society, 1963, 91:22 p. 91.

[10] Augustine, Roger D. "Persistence and Change in Major Field of Academically Proficient Engineering Students at Three Midwestern Universities." Unpublished Ph. D. dissertation, Michigan State University, 1966. p. 112.

Repo

One detailed study recently completed attempted to quantify results of technical summer employment on engineering students. The study was undertaken by the Engineers Joint Council and culminated in a Conference on Summer Employment for Engineering Students in November, 1965.[11]

The conference was designed to be a dialogue between engineering educators and representatives of major industrial corporations involved in summer employment programs for students. All of the proceedings, speeches, and reports of the conference are included in the report. As a part of the conference, 839 engineering students completed a questionnaire concerned with summer employment.[12] The main results of the study are summarized below:

(1) Is Summer Technical Work Valuable as Part of an Engineering Education?

	Colleges	Employers	Technically Employed Students
(a) Essential or highly desirable	97%	95%	70%
(b) Useful but not essential	3%	4%	29%

(2) What Advantages Result from Summer Technical Work?

Considered work valuable part of education

Technically Employed Students	Non-technically Employed Students
90% yes	28% yes

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[11]EJC, Proceedings.

[12]EJC, Summer Employment of Engineering Students - Final Report. Engineers Joint Council, 1965. p. 5.

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The students wholeheartedly support summer employment as a valuable part of their education. The conference did not specify the student differences attributed to summer employment.

The conference participants spoke about changes in students who had returned from a technical summer job. A sample of the statements follows:[13]

1. improved attitudes on the part of the student who have technical work
2. more satisfaction on the part of the students
3. greater retention of engineering students
4. all (students) seem to derive greater confidence with which to approach the first real job
5. thorough steaming-up to greater ambition and achievement
6. these experiences will be inspirational to the individual

These statements are good examples of the feelings which are expressed about the effects of summer employment on the attitudes of students. Jensen supported the six statements when he pointed out that summer employment adds a dimension to a students' college program.[14] The dimension was not defined by Jensen.

Several engineering educators at the College of Engineering at Michigan State University were interviewed about summer employment.[15] The topic of the interviews was the effect of technical employment on students. The selected faculty spoke about the

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[13]EJC, Proceedings.

[14]Jensen, Your Summer.

[15]College of Engineering, Michigan State University, interviews with a selected group of engineering professors.

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definite advantages of technical employment for engineering students. The students who have been technically employed are more: "mature," "realistic," "confident," "assertive," "deeply committed to engineering," and "motivated." The faculty interviews supported the contention that technical employment has an effect, but there is little documentation of the specific student changes and the extent of the attitude shifts.

Because of the lack of quantified data pertaining to the effect of summer employment the cooperative education programs were reviewed. The student in a cooperative education program spends regulated periods of time in industry. This industrial work is an integral part of the cooperative education program. The student must submit reports on his industrial experience and usually receives a college grade for his efforts. The cooperative program is at least one year longer than the traditional engineering programs. Cooperative programs have been thoroughly researched, and because the programs include technical employment for engineering students, the findings of the research are important to the study.

Related Cooperative Programs

The philosophy of the co-op program, which started in 1906 in the College of Engineering at the University of Cincinnati, was to blend the college education with industrial experience.[16] Charles Kettering has said that co-op "lap-welds theory and practice." The program,

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[16] Jones, Don Elvin. "Current Programs of Professional Cooperative Education between Selected Industries and Institutions of Higher Education." Dissertation Abstracts, 24, (1963), 1464.

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usually five or six years in duration instead of four years, provided an opportunity for the student to complete his education both at the university and in industry. Another factor which led to the cooperative program was the increasing costs of higher education and the facility of "earn as you learn" which co-op afforded each student. The institutions which offer a cooperative educational program generally have students who choose co-op and also those who take a regular program.

The transition from the summer programs reviewed above and the cooperative education discussed in this section will be aided by discussion of a unique program at Cornell University.[17] The School of Industrial and Labor Relations required that every student must complete a minimum of thirty weeks during the summers in supervised work-training. Although the program is old (1946) the concept is relevant.

The students sought, with the School's help, gainful employment during the first summer (after the freshman year). The second and third summers were spent in an industrial organization, a labor union, or a government agency. The requirement "was designed to give the trainee first hand experience with points of view, problems and procedures in industrial and labor relations."[18] The Bulletin which describes the program stated that the work experience had a

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[17]Shank, Donald J. and Ranck, Kathryn E. "Work Training for College Students in Industrial Relations." Student Personnel Bulletin No. 1, New York State School of Industrial and Labor Relations, Cornell University, December 1946.

[18]Ibid. p. 8.

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dramatic impact on the students involved. The bulletin included many pages of student reports written about their summer work. These reports support the contentionthat technical employment has a positive effect on students.

The Cornell program is akin to the cooperative programs because it was required, but differs in that the work experience was during the summer and therefore, does not lengthen the college program.

A study of <u>Work-Study College Programs</u> was incorporated into a book by Wilson and Lyons.[19] This comprehensive study of cooperative education was undertaken by the Committee of the Study of Cooperative Education. The Authors list eight educational values that the cooperative system offers the student. The following are the first three of the eight values which are relevant, they are:

1. By coordinating work experience with the campus educational programs, theory and practice are more closely related and students find greater meaning in their studies.

2. This coordination of work and study increases student motivation. As students see connections between jobs they hold and the things they are learning on the campus, greater interest in academic work develops.

3. For many students work experience contributes to a greater sense of responsibility for their own efforts, greater dependence upon their own judgements and a corresponding development of maturity.[20]

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[19] Wilson, James W. and Lyons, Edward H. <u>Work-Study College Programs</u>. Harper and Brothers, New York, 1961.

[20] <u>Ibid.</u>, p. 6.

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Tangible educational results of any cooperative program can only be surveyed if the author chose to use an equal sample of non-co-op students from the same school. A recent study by Lindenmeyer[21] was conducted with a control group of non-co-op students. There were eighty-one co-op students and thirty-one non-co-op students in his study. The students were not significantly different on their SAT scores and also in grade point averages after the first six quarters of work at Northwestern University. At graduation the co-op students had a higher grade point and they had a higher retention rate in engineering than had the non-co-op students. The author states that "---it seems that the cooperative work experience had a motivating effect on academic performance."[22] He concludes with a word of caution as he interpreted his results because there was no attempt to categorize the personality variables related to achievement in the students. The co-op students may have had more academic drive, which could account for the significant differences at graduation. He suggested the need for more research in the area of personality and attitude variables.

Several doctoral dissertations[23, 24] have been written on the results of comparative studies between co-op and non-co-op students.

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[21] Lindenmeyer, Ray S. "Comparing Academic Progress of Cooperative and Four-year Students." Journal of Engineering Education, 57, No. 10, (June, 1967), 730-731.

[22] Ibid., p. 731.

[23] Jones, Current Programs.

[24] Stack, Menzo H. "An Appraisal of the Work-Study Program at Wilmington College and the Cooperating Industry, The Randall Company," Dissertation Abstracts, 26, 5183.

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Jones[25] surveyed thirty-three engineering colleges in his study. He administered questionnaires to college coordinators, faculty, students, industrial coordinators and engineering supervisors. His study was aimed at the acquisition of data about cooperative programs which would lead to the establishment of an outline for cooperative programs. He compared the co-op and non-co-op students on ten criteria[26] and found the co-op students equal or superior to the non-co-op students on all criteria at graduation. There was no attempt to establish equality of the students before entrance into the program.

Stark[27] used groups of co-op and non-co-op students chosen at random to appraise a work-study program. He found that the co-op group initially exceeded the non-co-op on high school class rank and the traits of industry and responsibility. The two groups were equal in ability, academic preparation, recommendations for college work and the traits of leadership and concern for others. At graduation time the co-op group exceeded in the traits of industry, responsibility, and concern for others. The groups were equal in achievement, the trait of leadership, and the faculties assessment of their predicted success in the future. The author concluded that the benefit of cooperative education was increased satisfaction among the co-op

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[25] Jones, Current Programs.

[26] Ibid., The ten criteria listed by Jones are: (1) Individual research, (2) work-habit attitudes, (3) academic achievement, (4) academic ability, (5) class participation, (6) attendance, (7) supervisory ability, (8) problem solving, (9) technical achievement, (10) general engineering competency.

[27] Stark, An Appraisal.

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students.

According to several authors[28, 29, 30] the student who was involved in work-study attained a greater awareness of his own capacities and also became more mature, realistic, and self-directed. These are the same attitude variables that have been mentioned as derivatives of a summer technical work program.

A final note concerning the cooperative programs must be interjected before it is assumed that because of the stated positive effects of the cooperative program on students, all students should be involved in a mandatory work-study program. There are benefits to students, but also disadvantages and the prospect of all students being in a cooperative plan is discussed by Dr. Elmer Easton, Dean of Engineering at Rutgers University:

> In some cases the colleges and industry cooperate in presenting five-year programs throughout which the student alternates between classwork and industrial employment. At the end of five years when the student receives his B.S. degree he will have had perhaps 18 months of industrial experience much of it at a sub-professional level. In most cases it is not feasible to conduct such a cooperative work-study program because of other demands on the universities and because of limited opportunities to conduct meaningful work programs. In these cases, industrial experience during the undergraduate program is confined to the summers following the freshman, sophomore, and junior years. Note that at the end of five years the graduate of the standard four-year program will have had a year of full-time experience as a graduate engineer

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[28] Fram, Eugene Harry. "An Evaluation of the Work-Study Program at the Rochester Institute of Technology." Dissertation Abstracts, 26, 1964, 3780.

[29] Lindenmeyer, Comparing Academic Progress.

[30] Stevens, 'Who' and 'What'.

> plus summer work as an undergraduate. Those of us who favor this form of education feel that the product at the end of five years is better trained than the graduate of the cooperative program who receives his B.S. degree at that time.[31]

The effect of technical work experience on co-op students has been recognized. The traits of increased motivation, maturity, judgement, and enthusiasm are stated as byproducts of technical employment. But, as Dr. Easton stated, the cooperative plan is not feasible for all engineering colleges. The concept of a technical summer job is more realistic for the general student population, if the effects are the same as the cooperative program produced in its students.

Summary

The literature pertaining to all types of summer work for college students was reviewed. The literature review indicated that besides the documented financial gain for the students and the possible recruitment aspect of the three month job, the effects of work experience has not been defined. Terms such as greater motivation, more mature, better judgements, more realistic, and greater enthusiasm were used to describe the effects of summer technical employment on students. There has been no attempt to establish the effects of summer employment in a systematic and documented way.

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[31] EJC, Proceedings, p. 34.

The cooperative education programs were reviewed because of their similarity to technical summer employment. The programs require that the student spend a segment of his five or six year college program working in a job related to his educational program. Therefore, some analogies can be drawn between the summer and the cooperative programs.

Although cooperative programs are well established (began in 1906) the same type of opinion articles appear in defense of the co-op experience as were found for summer work experience. The objectives of cooperative programs were reviewed and studies related to how these objectives are being met were discussed. Generally the research supports the cooperative plan as advantageous when compared to a regular program for students of equal capacity and personal traits.

The cooperative students enthusiastically support their system and state that they benefited immensely from the experience. The student personality changes and attitude shifts which the authors cite as a derivative of the cooperative programs are not quantified. In the opinion of students, faculty, and industrial representatives these variables were affected by the work experience. There definitely is a need for a control group of non-co-op students to be used to sort out the effect of normal maturation and other uncontrolled variables. Only in this way will the effect of the cooperative programs on student attitudes become fact.

In Chapter III the population, sample and questionnaire design are presented. The procedures used to gather the data and the statistical models appropriate to test the hypothesis are explained.

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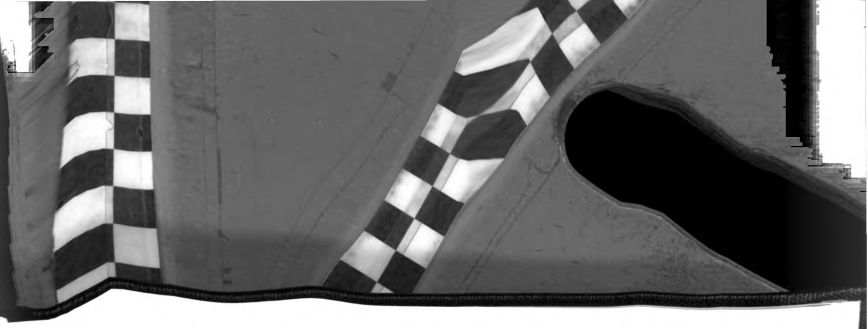

CHAPTER III

DESIGN OF THE STUDY

A description of the population and sample, the instruments which were developed specifically for the study, and the procedures used in the data collection and analysis are presented in this chapter.

Population and Sample

Engineering students in the junior class enrolled in the College of Engineering during Spring term, 1968 were the population. For the study, junior class membership was defined as students who were taking the required junior engineering courses. Those students who are considered to be juniors by the University because they have amassed sufficient credits (85), but are not enrolled in the junior engineering curriculum were excluded. A summer technical job could not be the same kind of experience for the two kinds of juniors; one who had finished his junior engineering courses and the quasi junior who had not completed his junior classes.

There were 339 juniors in the population. Initially the questionnaire was administered to 287 students in the last week of Spring classes. The students who were missed during the class visitation were contacted by mail. This mailing produced 28 more students for a total sample of 315 before the summer break (93% of the population were in the sample).

The same students were re-tested during the second week of Fall term classes. The questionnaire was administered to those

students who were present in class on the visitation day. A mailing was made to each subject who had completed a questionnaire during Spring term, but was not present in class during the Fall survey. 280 students filled out a questionnaire both in the Spring and in the Fall (82% of the population were included in the final sample).

The discrepancy between the number in the original sample and the final sample is comprised of two types of students. During the summer 10 students decided not to return to the campus to continue their engineering education. The remainder of the students who did not fill out a Fall questionnaire were not in class on the visitation day, nor did they respond to the mailed questionnaire. The number of non-respondents was quite small, therefore, the decision was made not to send a second mailing to the non-respondents.

The sample is almost entirely male, as is the total population in engineering. The several female respondents (4) were left in the sample.

Experimentation

The sample was divided into two groups. The subjects in each of the groups were self-selected, based on their plans to work during the summer.

The technical group was comprised of those subjects who stated on the post-questionnaire that they were employed in a technical summer job. The technical job was defined as a position that was commensurate with the subjects educational level.[1] The

[1] Technical work is any engineering or science oriented work appropriate to your educational level.

student made the determination of the credibility of his technical job and its relatedness to his engineering competence level. It was assumed for the purposes of the study that the students were sufficiently knowledgeable to make this decision. The Engineers Joint Council study states that students are quick to show a negative reaction to a summer position which was not technical and yet was advertised as an appropriate job for an engineering junior.[2]

The non-technical group was comprised of all subjects who were not employed in a summer technical job. Included in this category were all summer school students, those who traveled or vacationed, or held non-technical jobs during the summer. The use of a non-technical group guaranteed analysis of the questionnaires with control for the normal maturation which would occur during the three month summer break from academic classes. The technical and non-technical groups had different experiences during the summer.

Instrumentation

The relevant data necessary to reach the goals of the study were not obtainable with an existing instrument. It was necessary to design two questionnaires (pre- and post-measures) to evaluate and study the effect of the summer experiences on the two groups.[3] The design of the questionnaires was based upon the following guidelines: (1) Section I which included questions about what the students'

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[2] EJC, Proceedings.

[3] The pre-questionnaire and all instructions are in Appendix A. The post-questionnaire and all instructions are in Appendix B.

expected to do or did during the summer, (2) The intent of Section II was to assess the students' personal attitudes about engineering, and (3) Section III was a self-concept measure obtained from a word rating list.

The Spring (Pre) Questionnaire

The purpose of the Spring questionnaire was to obtain an accurate index of how the students' felt about their engineering education, summer activities, plus a personal attitude survey. The students were to project what they would be doing during the summer. On the basis of their expected activities, they were asked a series of questions designed to provide information concerning the students and their education. A description of each section of the questionnaire with a statement of its rationale follows.

The first section (I) of the questionnaire explored the students' summer plans. The students who planned to be technically employed were asked how they obtained their job and why they sought employment. Questions were asked about whether they felt summer technical employment was worthwhile and if they had been technically employed previously. Section I provided a basis for the division of the sample into two groups: Technical employed and non-technical.

In the second section (II) the students were asked a series of questions related to their feelings towards themselves, their academic classes and their engineering competencies. Each question required that the subjects rank themselves on a continuum. Each continuum was polar which provided the chance to choose between positive or negative statements. A sample question from Section II follows:

12. Define your attitude towards your engineering classes:

    (a) usually enthusiastic
    (b) sometimes enthusiastic
    (c) consider them a necessary evil (unethusiastic)
    (d) sometimes dread them

In this question the (a) response is considered positive and (d) is considered negative. All other questions are of similar design.

Several questions which are related to the students' next school year (senior) were asked in this section. These questions were designed to obtain the students' expectations for the next academic year. The students were also asked to rate the several engineering occupational areas for attractiveness.

Many of the articles reviewed in Chapter II mentioned student attitude changes which the authors speculate were derivatives of technical employment. Therefore, a word rating list comprised the last section (III).

To accurately assess the personal attitude of the respondents they were asked to rate themselves on 105 words. The format and style for the use of the words was guided by the study of motivation by Farquhar.[4] Each word is related to a general theme of "attitude about oneself" and appropriate for an engineer. Every subject rated each word on a continuum from "never describes me" to "always describes me."

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[4]Farquhar, William W. Motivational Factors Related to Academic Achievement. Office of Research and Publication, Michigan State University, 1963.

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The Fall (Post) Questionnaire

The post-measure did not differ from the pre-measure except for Section I. It was necessary to restructure Section I to include a series of questions about the summer experience. The technically employed students were asked questions related directly to their feelings about their technical job, the company that they worked for, and what they gained (or did not gain) from the employment. The non-technically employed group was asked to evaluate their summer and its possible effects on their senior year. They were also asked to evaluate the possible effects of a technical summer job even though they did not have one.

The Fall questionnaire was the ultimate determining factor in the placing of subjects into either the technical or non-technical employed groups. Twenty subjects from the pre-test who planned on technical employment did not have a technical job. The twenty students were unable to secure a technical position or they did not consider their technical job to be commensurate to their educational level.

Pilot Study

A pilot group of seniors who were not part of the original population were used as a pre-test sample to refine the instruments. Twenty-five students agreed to an individual administration of the questionnaire. The pilot subjects were instructed to note the specific number of any ambiguous or extremely difficult questions. After several students had responded, the questionnaire was revised and then administered to several more students. The final form of the revised questionnaire was administered to the regular study group.

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Analyzing the Data

The responses to the items on the questionnaire were coded so that they were readily addressable to computer programs. The goal of the study was to determine what associative effects summer technical employment has on the attitudes of engineering students. Because of the exploratory nature of the study no directional hypotheses were stated. The null hypothesis which provided direction for the study was that:

> No disproportionality will be found in engineering or personal attitudes between the technical and the non-technically employed groups as measured by the questionnaire.

Because of the kind and type of responses it was necessary to divide the questionnaire into the three different categories to adequately analyze the data.

In the first category, different questions were asked on the pre- and post-measures. Due to the varied questions and individual group items the most plausible analysis was a frequency count and percentile distribution.

In the second and third categories the technical and non-technical groups answered all questions and the items were included in both questionnaires. Both categories, therefore, lent themselves to analysis with a chi-square model.

The chi-square test and the corresponding contingency tables present the data in a form which facilitates observing specific differences between the technical and non-technical groups. All appropriate items from both questionnaires were subjected to this analysis.

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The only deviation from the use of either frequency counts or chi-square tests was in the comparison of academic achievement for the two groups. In this case analysis of co-variance, (spring grades were used as co-variant upon fall grades) was selected as the appropriate model to determine whether the academic achievement was affected by the summer experience.

The null hypothesis was rejected if the value of the chi-square or F was equal to or greater than the critical value at the .05 level with the appropriate degrees of freedom.

Summary

The junior engineering class at Michigan State University was designated as the population for the study. The criteria for including or excluding subjects from the sample was presented. Those students who were juniors by curriculum were included and quasi juniors, by University credit only, were excluded. Two questionnaires (a pre- and post-test) were necessary to follow changes in student attitudes over the summer. The ultimate decision to place a student in the technical or non-technical employment groups was determined from the post-test. The questionnaires were pre-tested, revised and then administered in the appropriate engineering classes. The analysis consisted of frequency counts, chi-square, and co-variance where appropriate.

The analysis of the data from the questionnaires will be presented in Chapter IV. The reported effects of the summer on engineering students will be discussed.

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CHAPTER IV

ANALYSIS OF THE QUESTIONNAIRE DATA

A report and analysis of the data collected by means of the questionnaires are presented in this chapter. The analysis parallels the basic format of the questionnaires. The first section includes questions about the students' plans for the summer and provides a basis for the division of the sample into two groups. Within the second section students' attitudes toward their academic programs and engineering competencies are explored. The final section constitutes an analysis of a personal attitude survey.

Summer Experiences Ratings

Frequency counts and percentile distributions were used to present the findings about summer experiences.

Presented in Table 4.1 is a summary of the students' summer activities. The figures obtained from the post-questionnaire indicated that thirteen students combined non-technical employment and summer school enrollment. Thus, the total activities of the non-technical group exceeded 100 per cent. The technical group consisted of a total of 126 students who had technical employment during the 1968 summer. The non-technical group was comprised of 154 students who were not employed in a technical job.

The non-technical group was asked to indicate why they had not sought a technical summer job. Most of the response categories in Table 4.2 were of equal attractiveness to the students, except the one which stated that a technical job was not important. Only two (2%)

Table 4.1. Summer Activities for Students of the Sample

Responses	Number
Technical Employment	
Technical Total	126
Non-Technical	
Work	112
Summer School	37
Active Military (ROTC)	5
Vacation or Travel	7
Other	6
Non-Technical Total	167

Note: The non-technical group exceeds the 154 student total by 13 students who marked multiple classifications, i.e., some attended summer school and worked.

Table 4.2. Non-Technical Group: Students' reasons for not seeking technical summer jobs

Responses	Number	%
No job available	29	30
Positions too distant from my home	23	24
More money in non-technical work	20	21
Not important to me	2	2
Other	22	23

Note: 'Other' category was typically designated as a need to attend summer school.

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out of the 96 students indicated a technical job was not important to them.

Both the technical and non-technical groups were asked to rate several reasons for seeking a technical summer job and for the purpose of this question the non-technical groups was asked to assume they were actively seeking a technical job. Virtually everyone in both groups felt they wanted experience on an engineering job and needed some feedback on their ability as an engineer (see Table 4.3). A desire to have a job with a certain company was not important to either the technical or non-technical group. More of the non-technical group felt that the summer technical experience would help them determine whether engineering was to be their lifes' work, however, the students in both groups felt that this was an important derivative of the job.

Table 4.3. Technical (T) and Non-Technical (NT) Groups: Frequency of students' rated reasons for seeking technical summer jobs

Responses	Important		Not Important	
	T	NT	T	NT
Wanted experience on an engi- eering job (to see engineering)	137	131	7	2
Wanted experience with a certain company	37	31	108	100
Wanted to obtain some feedback on my ability as an engineer	120	121	28	10
Wanted to determine whether engineering is to be my life's work	100	101	47	31

The technical group was asked how they obtained their summer job. As shown by Table 4.4, 113 (76%) students found their jobs solely through their own efforts. Those students who did not find their own jobs received help from a professor, family, or an acquaintance in the company.

Table 4.4. Technical Group: How students obtained technical summer jobs

Responses	Number	%
Solely through my own efforts	113	76
Through the efforts and prompting of a professor	9	6
Through an acquaintance in the company	12	8
Through parental or family efforts	14	9

The 1968 summer was at least the second technical experience for sixty-five (52%) students of the technical group, compared to 35 (23%) students of the non-technical group who previously had a technical job. (See Table 4.5)

Table 4.5. Number of the Students Previously Employed in a Technical Job

Groups	Yes		No	
	f	%	f	%
Technicals	65	52	61	48
Non-Technicals	35	23	115	77

The rated effects of the summer on the non-technical group are summarized in Table 4.6. Each student was offered a chance to respond to four personal or academic effects of the summer just completed. Almost two-thirds (89, 63%) of the students felt that their self-confidence was increased during the summer. Also, the engineering commitment was confirmed for 73 (51%) students who responded.

Table 4.6. Non-Technical Group: Reported effects of the summer activity on the students

Responses	Yes		No	
	f	%	f	%
Helped in choosing electives	29	20	113	80
Increased my engineering skills	42	29	102	71
Increased my self-confidence	89	63	53	37
Confirmed my engineering commitment	73	51	71	49

The non-technical group was asked to answer yes or no to the question: Do you think that a technical summer job has a positive effect on the students' engineering education? According to the non-technical group (87%) a technical summer job has a positive effect on the student's engineering education.

Students in the technical group were asked to rate eight possible effects of the technical experience. The data in Table 4.7 indicates that students rated their summer as a success as measured by this item. The students' commitments to engineering and engineering specializations were rated least influneced by the summer

Table 4.7

Table 4.7. Technical Group: Reported Effects of the Summer Activity on the Students

Responses	Yes		No	
	f	%	f	%
Supplemented my college program	111	88	15	12
I gained maturity in engineering practice	106	84	20	16
Gained confidence toward my senior year	96	76	30	24
A financial gain only	10	8	116	92
Strengthened my commitment to engineering	80	63	46	37
Influenced my engineering specialization	69	55	57	45
It was a poor experience	7	6	119	94
Disliked the engineering atmosphere-duties	10	8	116	92

experience, however, even these two attributes were supported by a majority of the technical group.

Students' Attitudes Toward Engineering

The questions in the second section were related to the students' feelings about their engineering classes and their academic competencies. A chi-square model was appropriate to test the underlying null hypothesis:

> No disproportionality will be found in engineering or personal attitudes between the technical and the non-technically employed groups as measured by the questionnaire.

Current engineering programs are portrayed as theoretical in nature by leaders in the field. Therefore, each student was asked to evaluate his engineering program on a continuum of theoretical-to-applied. No differences were found on the pre- or post-measure between the technical or non-technical groups (See Table 4.8). However, the students support the contention that engineering programs at Michigan State University are theory oriented. The engineering programs were rated more theoretical than applied by 228 (82%) students on the post-test.

All students were asked to describe how important the use of mathematics was to an engineer. No differences were found between the groups because the null hypothesis was not rejected. The data in Table 4.9 indicated students agreed that mathematics was important to an engineer.

Table 4.8. Technical (T) and Non-Technical (NT) Groups: Students' rating of engineering program--applied versus theoretical

		theoretical	1	2	3	4	5	6	applied	df	X^2
PRE	T		7	51	37	19	12				
	NT		6	67	41	17	19	←A		4	2.07
POST	T		10	64	32	14	5	←A			
	NT		8	79	35	15	16			4	4.950

Not significant at .05

A represents a collapsing of the cell frequency to the adjacent cell.

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Table 4.9. Technical (T) and Non-Technical (NT) Groups: Students' ratings of importance of mathematics for engineers

Responses	PRE		POST	
	T	NT	T	NT
Very important to an engineer	88	100	88	107
Modest importance to an engineer	32	45	31	40
Somewhat important to an engineer	6	9 ↑	7	7 ↑
Little importance to an engineer		A		A
	df = 2		df = 2	
	$X^2 = .765$		$X^2 = .191$	

Not significant at .05
A represents a collapsing of the cell frequency to the adjacent cell.

A comparison of the technical and non-technical groups was made based on their self-reported ability to use mathematics to solve engineering problems. As indicated in Table 4.10 no differences were found between the two groups. Engineering students in both groups were able to use mathematics to solve engineering problems.

The technical group was compared to the non-technical group in Table 4.11 with respect to academic assertiveness toward a classmate. The students were asked to check the appropriate response which indicated the amount of assertiveness they used in a discussion of an engineering problem and its solution. Differences between the groups were found on the post-measure. The null hypothesis was rejected. Students in the technical group were more assertive toward a classmate after the summer than the non-technical group.

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Table 4.10. Technical (T) and Non-Technical (NT) Groups: Students' reported ability to use mathematics to solve engineering problems

Responses	PRE		POST	
	T	NT	T	NT
Usually able to do so	58	71	56	58
Frequently able to do so	51	58	58	78
Sometimes able to do so	17	25	12	18
Seldom able to do so	↑ A		↑ A	↑ A
	df = 2		df = 2	
	X^2 = .487		X^2 = 1.387	

Not significant at .05

A represents a collapsing of the cell frequency to the adjacent cell.

Table 4.11. Technical (T) and Non-Technical (NT) Groups: Students' ratings of academic assertiveness toward a classmate

Responses	PRE		POST	
	T	NT	T	NT
Usually try to prove that my solution is correct	7	13	9	12
Sometimes try to prove that my solution is correct	17	18	29	17
Usually am open-minded--attempt to figure out which solution is best	100	119	86	121
	df = 2		df = 2	
	X^2 = 1.014		X^2 = 7.066*	

*Significant at .05

Note: Six students on the pre-test and five students on the post-test marked categories with insufficient frequencies to analyze.

The students had the opportunity to indicate their personal ability at solving engineering problems. (See Table 4.12) There were no differences between the technical and non-technical groups on the pre-test, but the post-measure was significant. The technical group exceeded the non-technical group in engineering ability as measured after the summer because the null hypothesis was rejected.

Table 4.12. Technical (T) and Non-Technical (NT) Groups: Students' self-rated ability to solve engineering problems

Responses	PRE		POST	
	T	NT	T	NT
Quite confident of my ability	30	28	44	28
Farily confident of my ability	78	91	71	97
Hesitant of my ability	18	35	11	29
	df = 2		df = 2	
	X^2 = 3.759		X^2 = 13.009*	

*Significant at .01

The attitudes of students toward engineering classes are illustrated in Table 4.13. No differences were observed for any of the contrasts. A majority of students were enthusiastic about their engineering classes. Over eighty percent of the respondents in the technical and non-technical groups stated that they were either "usually" or "sometimes" enthusiastic toward the classes.

No differences were found between the way the two groups responded to their engineering class assignments. The figures in Table 4.14 indicate that the students usually completed their engineering assignments. The null hypothesis was not rejected.

Table 4.13. Technical (T) and Non-Technical (NT) Groups: Students' reported attitude toward engineering classes

Responses	PRE		POST	
	T	NT	T	NT
Usually enthusiastic	37	40	21	39
Sometimes enthusiastic	73	87	97	101
Consider them a necessary evil (unenthusiastic)	16	26	8	14
Sometimes dread them	A	A	A	A
	df = 2		df = 2	
	X^2 = 1.120		X^2 = 4.358	

Not significant at .05

A represents a collapsing of the cell frequency to the adjacent cell.

Table 4.14. Technical (T) and Non-Technical (NT) Groups: Students' reported completion of class assignments

Responses	PRE		POST	
	T	NT	T	NT
Almost always complete my assignments	67	74	76	90
Usually complete my assignments	47	70	44	60
Often disregard assignments	11	10	6	4
	df = 2		df = 2	
	X^2 = 1.923		X^2 = 1.255	

Not significant at .05

The level of self-reliance which students used as they approached and solved an engineering problem is reported in Table 4.15. There were no differences between the technical and non-technical groups on the self-reliance rating. The respondents reported that they relied on their own engineering judgements rather than the judgements of a classmate.

Table 4.15. Technical (T) and Non-Technical (NT) Groups: Students' reported ways of solving an engineering problem

Responses	PRE		POST	
	T	NT	T	NT
Usually rely on my own judgements	84	108	90	103
Sometimes rely on my own judgements	42	46	36	51
Usually rely on the judgements of my classmates	↑ A			↑ A
	df = 1		df = 1	
	X^2 = .384		X^2 = .667	

Not significant at .05
A represents a collapsing of the cell frequency to the adjacent cell.

The level of enthusiasm or reluctance that the students had toward their senior year in engineering was assessed. The students were enthusiastic about their last year of undergraduate education. Since there were no differences between the groups the null hypothesis was not rejected. (See Table 4.16)

Table 4.16. Technical (T) and Non-Technical (NT) Groups: Students' ratings of enthusiasm toward senior year

Responses	PRE		POST	
	T	NT	T	NT
Enthusiastic	41	49	43	63
Mildly Enthusiastic	63	70	73	67
"Just another year"	13	19	6	12
Mildly reluctant	9	15	4	12
Reluctant	↑ A	↑ A	↑ A	↑ A
	df = 3		df = 3	
	X^2 = 1.099		X^2 = 7.30	

Not significant at .05

A represents a collapsing of the cell frequency to the adjacent cell.

Reported in Table 4.17 is the value of at least one summer's engineering or technical work as rated by the two groups. Differences were found between the groups on both the pre- and post-questionnaires because the null hypothesis was rejected. The findings from the pre- and post-measure indicated that the technical group placed more emphasis than the non-technical group on the critical value of technical summer employment. As reported earlier the students who were technically employed usually sought and found their own summer job. The technical group was more deeply committed to a summer technical job before the summer than the non-technical group and the summer did not change their position.

The amount of self-rated academic assertiveness displayed toward a professor is reported in Table 4.18. There were differences between the groups on the post-measure, therefore, the null hypothesis was rejected. The technical group was more assertive toward a professor as measured by the post-test than the non-technical group.

All students were asked to indicate how competent they felt in relation to their first full-time engineering job. Technical and non-technical group differences were found on the post-test. (See Table 4.19) The null hypothesis was therefore rejected. The post-differences were attributed to increased engineering competency felt by the technical group.

The students were asked: Do you feel that you have an understanding of what an engineer does? As shown in Table 4.20, differences between the groups were evident on the post-measure because the null

Table 4.17. Technical (T) and Non-Technical (NT) Groups: Students' reported value of technical summer employment

Responses	PRE		POST	
	T	NT	T	NT
Consider it essential	62	40	70	36
Useful but not essential	63	108	52	111
	df = 1		df = 1	
	X^2 = 14.759*		X^2 = 30.209*	

*Significant at .01

Note: Seven students on pre-test and ten students on post-test marked categories with insufficient frequencies to analyze.

Table 4.18. Technical (T) and Non-Technical (NT) Groups: Students' ratings of academic assertiveness toward engineering professors

Responses	PRE		POST	
	T	NT	T	NT
Usually try to prove my solution is correct	A ↓	A ↓	A ↓	A ↓
Sometimes try to prove my solution is correct	12	20	17	10
Usually am open-minded--attempt to figure out which solution is best	71	71	78	79
Sometimes just accept the solutions that the professor presents	28	41	26	38
Usually accept the solutions that the professor presents	14	22	5	24
	df = 3		df = 3	
	X^2 = 3.239		X^2 = 14.374*	

*Significant at .01

A represents a collapsing of the cell frequency to the adjacent cell.

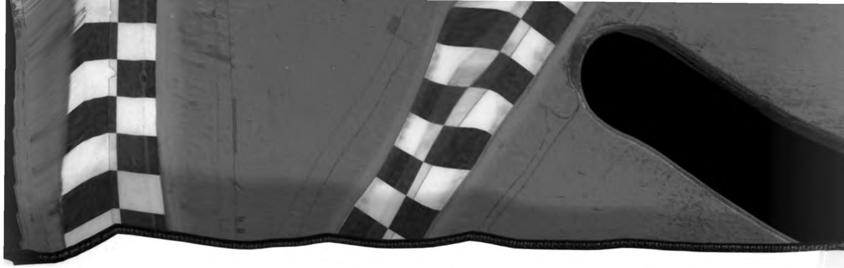


Table 4.19. Technical (T) and Non-Technical (NT) Groups: Students' reported competencies toward a future full-time engineering job

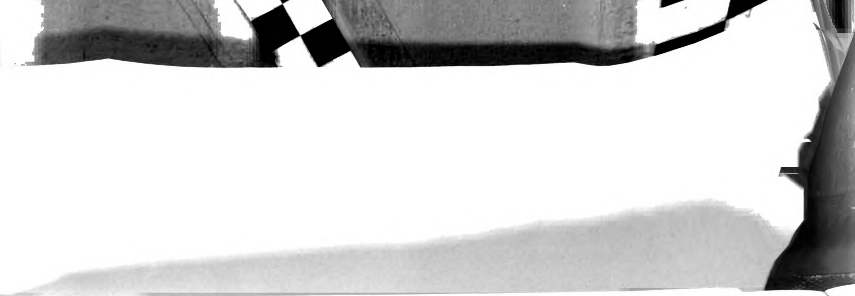
Responses	PRE		POST	
	T	NT	T	NT
Quite competent--anxious to get started	34	31	55	28
Fairly competent--concerned about what to expect	57	65	53	84
Fairly competent--very concerned about what to expect	18	34	8	22
Unsure of my ability to solve "real" engineering problems	14	23	7	18
	df = 3		df = 3	
	X^2 = 7.026		X^2 = 25.140*	

*Significant at .01

Table 4.20. Technical (T) and Non-Technical (NT) Groups: Students' reported knowledge of what an engineer does

Responses	PRE		POST	
	T	NT	T	NT
Yes -- knows what an engineer does	84	102	113	101
No -- does not know what an engineer does	42	52	11	52
	df = 1		df = 1	
	X^2 = 0.006		X^2 = 25.140*	

*Significant at .01



hypothesis was rejected. The technical group exceeded the non-technical group, feeling that they understood the duties of an engineer as measured by the post-test.

Five questions which were concerned with the students' expectations for their senior classes were asked of both groups. (See Appendix C, Table C2) Four of the chi-squares which were calculated produced no differences between the groups and the null hypotheses were not rejected.

The answers to one of the questions produced differences between the groups. The question dealt with obtaining a knowledge of what an engineer does, from the senior classes. (post $X^2 = 7.425$, $p > .05$) Differences were observed only on the post-measure as the non-technical group returned to the campus in the Fall planning on obtaining this knowledge from their senior classes.

The students were asked how they chose their elective courses. Chi-squares were calculated for all six statements about electives. Differences between the groups were observed for only one item on both the pre- and post measure. (See Appendix C, Table C3) The non-technical group reported that they relied on the advice of advisors and faculty (pre $X^2 = 6.119$, post $X^2 = 7.425$, $p > .05$) concerning their electives. The technical group welcomed help from faculty or advisors, but did not consider it essential. Extensive student support was given for electives being a broadening experience (non-technical course). Negative reactions were registered for electives if they were seen as a "must" technical course, a haphazard choice, or chosen solely to raise the grade point average. The students reserved

the right to make their own choice of elective courses.

Engineering students are usually attracted to one of the following areas of work: production,research, technical sales, engineering management, or design. The technical and non-technical groups were asked to rate the attractiveness of these job areas. There were no differences between the groups on this measure. (See Appendix C, Table C4) Production, management, research, and design were chosen as favorable work areas by the students. Technical sales was the only area that received a majority of negative response.

Student Personality Measure

A word rating list comprised the last section of the questionnaire. Included in the pre- and post-measures were 105 words used to describe a person. Words were chosen which would have meaning to an engineering student and had a positive, negative, or neutral connotation. The word rating list was used to obtain a self-concept measure of the sample.

To facilitate an orderly presentation of the data obtained from the word ratings, only the group reactions to the words are discussed that produced differences between the groups for either the pre- or post-measure. All words not included in the tables are in Appendix A and B as part of the questionnaire.

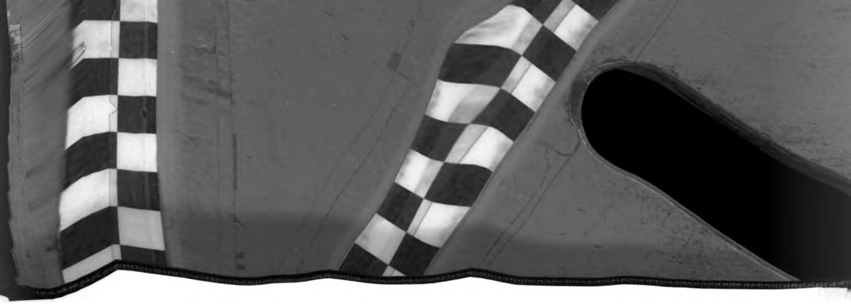
The rigid group membership caused by the students' choosing their own summer activities negated any random assignment to the technical or non-technical groups. Therefore, there was no reason to assume normality between the two groups because pre-test differences were possible before the summer. Chi-squares were calculated on the data obtained from all of the words on the pre-test and differences were found between the technical and non-technical groups on nine words. (See Table 4.21)

Table 4.21. Technical (T) and Non-Technical (NT) Groups: Summary of pre-test group differences on students' self-ratings of descriptive words or phrases.

traits	pre X^2	post X^2	high group rating[a]
skilled	8.986*	5.357	T
efficient	6.041*	9.560*	T
logical	12.355*	11.051*	T
curious	6.287*	3.411	T
successful	8.323*	8.732*	T
tense	7.982*	.06	T
above average	9.480*	3.788	T
an achiever	10.000*	5.477	T
inquisitive	7.936*	3.252	T

*Significant at .05

[a]represents the group (T) or (NT) which rated themselves highest on each of the words or phrases.



As measured by the pre-test the technical group rating exceeded the ratings of non-technical group on the following nine words: skilled, efficient, logical, curious, successful, tense, above average, an achiever, and inquisitive.[1]

The students reacted to the same words on the post-test and the technical group rated themselves as more logical, efficient, and successful on both the pre- and post-measures. (See Table 4.21) These three traits were characteristic of the technical group.

The reactions to the remaining words which produced differences between the groups on the pre-test, were not significantly different on the post-test. The traits: skilled, curious, tense, and above average received lower ratings from the technical group than the non-technical group after the summer. There were no appreciable changes among the students in the non-technical group in their responses to these words.

The traits of an achiever and inquisitive were rated about the same by the technical group on the pre- and post-measures. The lack of group differences after the summer was caused by higher ratings on the post-test by the non-technical group. The non-technical group reported that they were more inquisitive and more of an achiever after their summer experience than the technical group.

Chi-square tests were calculated for all words included in the post-test. As presented in Table 4.22, differences were observed between the groups on their responses to nine words or phrases not

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[1] The response frequencies are presented in Appendix C, Table C5.

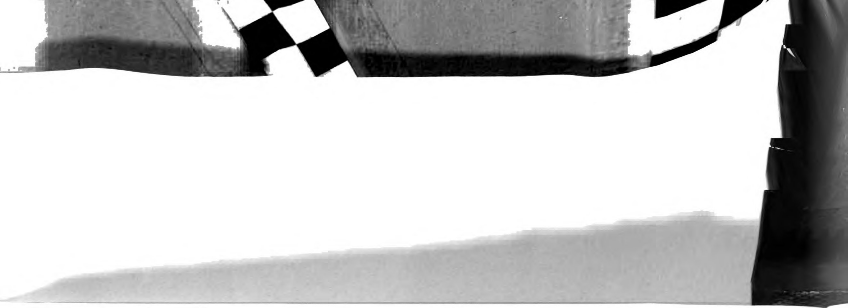


Table 4.22. Technical (T) and Non-Technical (NT) Groups: Summary of post-test group differences on students' self-ratings of descriptive words or phrases

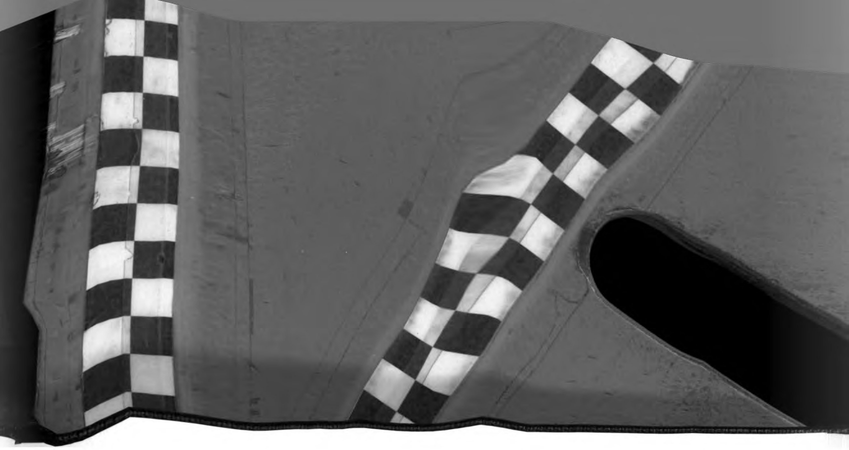
traits	pre X^2	post X^2	high group rating[a]
challenging	1.146	10.053*	T
thing oriented	1.439	6.711*	T[b]
a leader	.756	11.03 *	T
confident	3.293	8.678*	T
unsure	3.223	7.785*	T
practical	2.289	12.350*	T
careful	2.669	8.994*	T-NT[c]
persistent	5.953	15.184*	T
motivated	3.585	7.225*	T

*Significant at .05

[a] represents the group (T) or (NT) which rated themselves highest on the word or phrases.

[b] represents a pre to post regression effect on the ratings of the technical group.

[c] represents post-test rating shifts by both groups (See Appendix C, Table C6)



significant on the pre-test. In each of these cases the null hypothesis was rejected. The words and phrases were: challenging, thing oriented, a leader, confident, unsure, practical, careful, persistent, and motivated.[2]

The technical group rated themselves as more: challenging, confident, motivated, practical, persistent, and also as a leader than did the non-technical group. They also felt that they were less unsure after the summer experience than the non-technical group. The phrase, thing oriented, received a more realistic score from the technical group on the post-test. After the summer the scores of the technical group tended to cluster in the "sometimes" and "usually" thing oriented categories rather than the extreme scores noted on the pre-test. Little or no change occurred in the non-technical groups reactions to the eight traits.

The post-test reaction to the word careful produced differences between the two groups. However, the differences between the groups were caused by a pre- to post-test shift in rating by both groups. The technical group became less careful and the non-technical group rated themselves as more careful after the summer.

One final analysis was completed on student data which were not part of the questionnaires. The cumulative and Spring grades of both groups were analyzed with Analysis of Variance. Differences were found between the two groups for the two measures of achievement. The technical group had higher grades than the non-technical group.

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[2]The response frequencies are presented in Appendix C, Table C6.

Analysis of Covariance was used to determine whether the summer had affected the grades of the two groups. The cumulative and Spring term grades were used as covariate against the dependent variable, Fall achievement. The Fall (1968) grades for the technical group were significantly higher than the Fall grades of the non-technical group when Spring grades were used as covariate. No differences between the groups were observed with cumulative grades as covariate.

Discussion

Students in the technical and non-technical groups were convinced that a summer technical job was an important addition to an engineering program. In Tables 4.2, 4.3 and 4.7, both groups indicated personal benefits derived from a technical job. The strongest support for technical employment was received from the technical group, but both groups wholeheartedly endorsed the technical summer job as a worthwhile supplement to the academics.

Even though both groups endorsed summer technical work, the data reported in Table 4.17, shows why the technical group sought their job. The technical group stated that a technical job was essential. Differences between the groups were observed on the pre- and post-measures. The technical group was stronger than the non-technical group in their commitment to summer technical work as a valuable addition to their engineering program.

Two reasons given by engineering educators and industrial representatives for summer employment have been the possible financial gain and the recruitment aspect of bringing the employer and employee together for three months. The data presented in

Tables 4.3 and 4.7 does not support these as important student benefits. Technically employed students said that being employed by a certain company was important to them. They also rejected the concept that the summer job merely provided a financial gain.

Findings presented in Table 4.12 represent a change of attitude on the part of the technically employed. The summer employment increased their confidence toward solving engineering problems. This increased confidence probably was due to the practical engineering problems encountered during the course of the summer. The non-technical group did not change their rating on this variable.

Two questions were concerned with academic and personal assertiveness: toward a classmate, and toward a professor. Post-test analysis indicated that assertiveness toward a professor and classmate was increased for the technical group after the summer. The technical group was more assertive than their counterpart; the non-technical group. The technical group gained confidence in themselves and planned on exerting this confidence in the classroom.

Support for increased confidence among the technical group was also presented in Table 4.19. The students reacted to statements about their first full-time engineering job and the technical group felt more competent and anxious to get started in their career after the summer job than the non-technical group. Their personal confidence increased during the summer.

The literature review suggested that students are concerned about a lack of information with respect to what an engineer does at his job. The technical group (Table 4.20) left no doubt that they knew

what an engineer does after the summer. Their experience in an industrial corporation during the summer answered this question. It should be noted that before the summer the responses of the two groups were identical.

A corollary question, to the knowledge about an engineer's job was included in a group of statements about student expectations for the senior year. One of the statements asked if the students expected to obtain an idea of what an engineer does from the next school year. The findings in Table C2 (Appendix C) indicated that non-technicals were still seeking an acceptable answer to this question about the job of an engineer. Despite the fact that they had completed three years of engineering education they are not sure what an engineer does on the job.

Words that are used to describe a person were included in the study to provide a personal attitude survey without necessarily relating the attitudes to engineering.

Presented in Table 4.21 are pre-test responses to nine words which produced differences between the groups. The technical group exhibited more of each of the personal qualities than the non-technical group. As a group, they reported that they were more: skilled, logical, efficient, curious, successful, tense, above average, an achiever, and inquisitive than the non-technical group. All except tense were considered as positive traits for an engineering student. After the summer the technical group lowered their rating of the word tense which caused the lack of group differences after the summer. This lower rating by the technical group can be construed as a positive attribute of technical employment.

Three of the nine pre-differences were significant on the post-measure. The technical group retained their differences in response to logical, efficient and successful. However, the group differences were not observed for skilled, curious, above average, an achiever, and inquisitive on the post-measure. These post-changes occurred in two ways: (1) the technical group felt that they were less skilled, curious, and above average, and (2) the non-technical group increased their feelings about achievement and became more inquisitive after the summer.

The post-test attitude changes in the technical group can be interpreted as a more realistic outlook toward themselves. The students experience in industry deflated their view of their competencies, however, their Fall term grades were significantly higher than before the summer when compared to the grades of the non-technical group. Their achievement did not decrease, but instead their attitude related to their skills and achievement became more realistic.

After the summer the non-technical group increased in their attitude toward achievement and inquisitiveness. They entered Fall term with a positive gain in these two traits. The increased achievement felt by the non-technical group was not reflected in their actual achievement as measured by Fall term grades.

Presented in Table 4.22 are responses to nine words that produced group differences only on the post-test. The technical group rated themselves as: more challenging, a leader, more confident, less unsure, more practical, more persistent, motivated, and thing oriented than the non-technical group.

The post-rating of thing oriented was not comprised of a greater or lesser ranking, but instead the technical group became more centered in their ranking. The post-test center ranking can be interpreted as a realistic view from a group of students that just returned from a technical summer job. Their orientation to the industrial world during the summer gave them a broader perspective toward the field of engineering. The center rating could also be described as a result of regression toward the mean.

The positive traits listed above were important derivatives of summer technical employment. The technical group returned to the campus in the Fall with a different outlook toward themselves. The personal attitude changes as measured by the word rating list added credibility to the changes found in the student's attitude toward their engineering classes and academic competencies. The higher achievement level for the technical group during Fall term indicated that the positive feelings were translated into action.

The overall findings presented in Chapter IV identified a technical group that returned to the campus in the Fall with reported positive changes in their attitudes. They expressed no negative feelings toward the summer technical job.

Summary

The data obtained from the pre- and post-questionnaires were analyzed and the results follow.

The first section was comprised of specific questions about the summer and provided a basis for division of the sample. The technical group was comprised of 126 students, and 154 students were

included in the non-technical group. Both groups felt that a technical summer job was important because they wanted experience on an engineering job and desired some feedback on their ability as an engineer. Eighty-three percent of the technical group found their own summer job. The technical group wholeheartedly supported their technical summer job as a positive experience.

Two differences in engineering attitudes between the groups were identified before the summer. The technical group felt that technical summer employment was more essential than the non-technical group. The non-technical group relied more heavily on the advice of faculty and advisors on the choice of elective courses than the technical group. These differences between the groups were also evident on the post-test. Post-test differences between technical and non-technical groups were found on the following variables:

1. ability to solve engineering problems
2. academic assertiveness toward a classmate
3. academic assertiveness toward a professor in class
4. anticipation of their first full-time engineering job
5. knowledge of what an engineer does on the job
6. expectation for their senior year-receive knowledge of what an engineer does on the job

Differences on the first five variables were caused by increased ratings by the technical group, but the differences found for number six were related to high expectations from the non-technical group.

The students responded to a word rating list in the last section of the questionnaire. Chi-square contingency tables were used to present the findings. Pre-test differences between the groups were observed on the responses to the following words:

1. skilled
2. efficient
3. logical
4. curious
5. successful
6. tense
7. above average
8. an achiever
9. inquisitive

The technical group exceeded the non-technical group in each of these qualities. Post-test examination of the same traits identified only logical, efficient, and successful as characteristic of the technical group.

Post-test analysis of the responses to the remainder of the words produced nine differences between the groups. The traits were:

1. challenging
2. thing oriented
3. a leader
4. confident
5. unsure
6. practical
7. careful
8. persistent
9. motivated

The technical group felt that they were more challenging, confident, practical, persistent, motivated, less unsure, and more of a leader after the summer than the non-technical group. The technical group post-rating of the phrase, thing oriented, was less extreme and more realistic than their pre-test rating. The non-technical group rated themselves as more careful and the technical group less careful on the post-test.

The cumulative and Spring term grade point averages were significantly higher for the technical group than the non-technical group. Analysis of Covariance was used to determine whether differences in grade point average between the groups were observable at the end of Fall term. Both the cumulative and Spring term grades were used as the covariate. The technical group had significantly

higher grades than the non-technical group during Fall term, 1968, with Spring grades as covariate.

The discussion section centered around the attitude changes that were noted for the technical group after the summer. The pre- and post-differences between the groups were discussed in reference to their summer experience.

Chapter V which follows is comprised of a summary of the study, recommendations and implications for further research.

CHAPTER V

SUMMARY

Educators, representatives of industry and students have expressed a need for technical summer employment for engineering students. The changing emphasis in Engineering Education, from a detailed set of specific skills to a more generalized mathematics-science oriented program, has made it more difficult for educators to communicate or interpret to students what to expect in an engineering job.

Claims are made that engineering students who have had summer technical employment are positively affected by the experience. An extensive review of literature pertaining to summer employment revealed little research which quantified the associate effects of technical work on students. As a result, the study was conceived to determine the associate effects of technical summer employment on the attitudes of engineering undergraduate students.

The population was designated as the junior engineering class at Michigan State University during Spring term, 1968. Junior class membership was defined as students who were enrolled in the required junior engineering classes. The sample was divided into two groups. The technical group was comprised of those subjects (126) who were employed in a summer technical job. Students (154) who were not technically employed were designated as the non-technical group. The final sample (280) was eighty-two percent of the population.

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Two questionnaires (pre- and post-measures) were developed to evaluate and study the associative effects of the summer experience on the two groups. The null hypothesis which provided direction for the study:

> No disproportionality will be found in engineering or personal attitudes between the technical and non-technically employed groups as measured by the questionnaire.

The chi-square statistic was used where appropriate to determine whether the students' attitudes were affected by the summer experience. Analysis of co-variance was used to determine whether Fall term grades were affected by the summer experience. Frequency counts and percentile distributions were used to present the data when tests of significance were inappropriate.

Wholehearted support was indicated for technical summer employment by the technical group. They cited many personal and academic benefits derived from the technical job.

Two differences between the groups in engineering attitudes were identified before the summer. The technical group indicated technical summer employment was more essential than the non-technical group. The non-technical group relied more heavily on the advice of faculty and advisors on the choice of elective courses than the technical group. These group differences were also evident on the post-test. Post-test differences between technical and non-technical groups were found on the following self-reported variables:

1. reported ability to solve engineering problems
2. reported academic assertiveness toward a classmate
3. reported academic assertiveness toward a professor in class

4. reported anticipation of their first full-time engineering job
5. reported knowledge of what an engineer does on the job
6. reported expectation for their senior year-receive knowledge of what an engineer does on the job

Group differences on the first five variables were caused by increased ratings after the summer by the technical group, but group differences found for number six were related to high post-test expectations from the non-technical group.

The students responded to a word rating list in the last section of the questionnaire. Pre-test differences between the groups were observed on the responses to the following words: skilled, efficient, logical, curious, successful, tense, above average, an achiever, and inquisitive.

The technical group rating exceeded the rating of non-technical group in each of these qualities. Post-test examination of the same traits identified only logical, efficient, and successful as characteristic of the technical group.

Post-test analysis of the responses to the remainder of the words produced nine differences between the groups. The traits were: challenging, thing oriented, a leader, confident, unsure, practical, careful, persistent, and motivated. The technical group reported that they were more challenging, confident, efficient, practical, persistent, motivated, more of a leader, and less unsure after the summer than the non-technical group. The technical group post-rating of the phrase, thing oriented was less extreme and more realistic than their pre-test rating. The non-technical group rated themselves as more careful and the technical group less careful on the post-test.

The grades of the technical group were significantly higher than the grades of the non-technical group during Fall term, 1968.

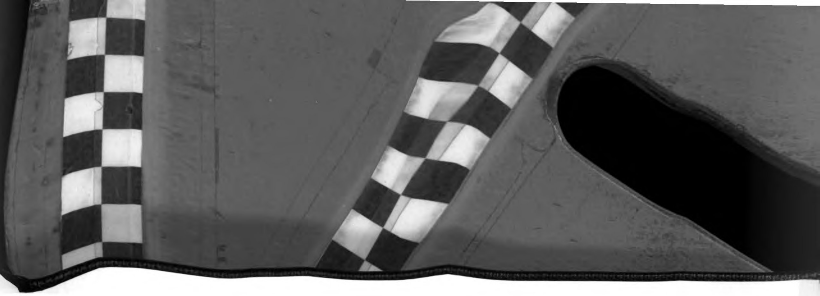
The overall findings identified a technical group that returned to the campus in the Fall with reported positive changes in their attitudes. As a group, they expressed no negative feelings toward the summer technical job.

Recommendations

In Chapter I engineering education at Michigan State University was portrayed as a theory oriented program. Students involved in this type of engineering program have concerns about the specific duties performed by an engineer and often are concerned about their skills in engineering application. It was speculated in the literature that a summer spent in industry might increase the confidence of students and consequently, their ability to solve engineering problems.

The technical group returned to the campus with a reported increase in confidence and indicated more competence at solving engineering problems than the non-technical group. Ratings of the students in the technical group exceeded the non-technical group rating on several (7) positive adjectives used to describe a person after the summer. The reported increased competence of the technical group was reflected in higher grades after the summer than the grades of the non-technical group.

The recommendations which follow have been developed from the findings of the study and are pertinent to engineering education, industry, and the students involved in technical education.



1. The College of Engineering at Michigan State University should initiate a summer job program for their students. This program would be aimed at involving engineering students in summer technical employment. Although the summer program would not be mandatory, professors should encourage students to avail themselves of the industrial experience.
2. The entire teaching faculty in the College of Engineering should make an effort to explain and demonstrate the nature of the work done by engineers. The students in the non-technical group entered their senior year without an understanding of engineering duties, which attests to the need for an accurate definition by the professors. The students should benefit academically from this knowledge of engineering early (freshmen or sophomore year) in the program.
3. The administration and faculty of the College of Engineering should contact industry and help them develop meaningful summer jobs for engineering students. The need for students to have this type of experience must be presented to industrial representatives. The logical sequence would be engineering educators carrying their concern for students' education directly to the corporations. Only in this way will engineering students be able to find sufficient industrial jobs during the summer.
4. Employing industries must be willing to expend considerable time, effort, and money to make summer jobs a worthwhile experience for the students. The jobs should be well defined, with realistic demands placed on the students. Summer pay should be high

enough to make it possible for students to live away from home and still save money for their next academic year. Supervisors should be assigned to the student engineers so that the summer experience is guided by an experienced person rather than allowing too much freedom for the fledgling engineer.

5. Engineering professors should be encouraged to work in industry during the summer. It was suggested in the literature that professors bring back their industrial experience and integrate this practical knowledge in the classroom. Students who were unable to be involved in summer technical employment would benefit from the professors experiences.

Implications for Further Research

The findings of the study suggest that further attention be given to the effects of summer employment on college students. The attempt in this study to quantify and describe student changes attributable to summer work is only a begining. The following research considerations are important to consider as derivatives of the exploratory study about summer employment.

The present study should be replicated with another junior engineering class at Michigan State University. Although the results of the study are encouraging it is appropriate to duplicate the study to determine if a different sample of engineering students behave in a similar fashion.

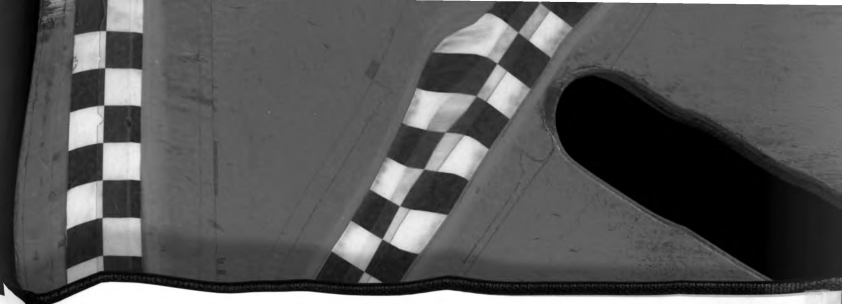
Two new questionnaires should be developed and administered to another junior engineering class at Michigan State University. The new study would attempt to define and examine the student changes

indicated by the present study. How do students perceive the rated positive effects of summer employment? Possibly personal interviews with a random sample of employed and non-employed students would clarify how the students view the stated effects of summer employment.

Whenever personal changes in attitude are examined it is appropriate to study the long-term effects as well as short-term. The design of this study allowed for immediate student response after the summer and analysis of student grades ten weeks after they returned to the campus. A logical extension of the present study would be to question the sample at the end of their senior year to determine whether the group differences were temporary or stable.

The engineering colleges nationwide lose about fifty percent of their students between the freshmen and senior year. What effect would a technical job early in the college program (after freshmen year) have on the attitudes of engineering students toward the field of engineering? Would more students tend to persist in engineering if they had an engineering related summer job? Answers to these questions could have important implications for engineering education.

An interesting extension to the use of engineering students and corresponding technical employment would be a study of students from other university majors. For instance, if business, education or law students were given the opportunity to be employed during the summer in jobs related to their chosen fields, would the results parallel the results indicated for engineering students? Positive results from the study would have implications for students in many disciplines.



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APPENDICES

APPENDIX A

THE (PRE-) QUESTIONNAIRE

This questionnaire is designed to obtain your opinions about yourself and your college education. The results will be used to find common concerns among the junior class which could provide guidelines for future Engineering Education.

Please answer each question as honestly as you can. The only purpose in asking for your name is to make the study as thorough as possible. In no way will your responses and name be reported to anyone. Your answers will be treated in strictest confidence! As soon as the completion of the data is insured your name will be torn off and the code number will be used.

Work as quickly as you can, reading each question carefully before deciding upon your best response. Do not skip any items. Answer all questions, even though you may not think about yourself in exactly the way the question is stated.

IMPORTANT: For the purposes of this questionnaire, Technical Work is defined as: any engineering or science oriented work appropriate to your educational level.

Please print your name and student number on the top of the next page and begin working.

NAME______________________
(print)

Student Number______________

CODE______________ (1-9)

SECTION I

1. Are you planning on being employed this summer? Yes __ No __ (10)

   (a) If Yes, check whether: Employed engineering/technical work (Technical work is any engineering or science oriented work appropriate to your educational level.) Yes __ No __ (11)

   IF YOU ANSWERED YES HERE SKIP #2 & #3 AND GO TO #4

   Employed in non-technical work Yes __ No __ (12)

   IF YOU ANSWERED YES HERE GO TO #2

   (b) If No, check whether you will be engaged in:
   Summer School __
   Active Military Duty (ROTC) __ (13)
   Vacation or Travel __
   Other (Specify)____________ __

   IF YOU ANSWERED HERE SKIP #2 AND GO TO #3

2. Please indicate your main reason for not seeking a technical summer job. (Check only one)
   (a) No job available __
   (b) Positions are too distant from my home __
   (c) More money in non-technical work __ (14)
   (d) Not important to me __
   (e) Other (Specify)______________________ __

3. Assuming you had a choice of what you would do this summer and were actively seeking a technical job, how would you rate each of the following reasons for seeking this job.

	Important	Not Important	
(a) Wanted experience on an engineering job (to see engineering)	__	__	(15)
(b) Wanted experience with a certain company	__	__	(16)
(c) Wanted to obtain some feedback on my ability as an engineer	__	__	(17)
(d) Wanted to determine whether engineering is to be my life's work	__	__	(18)

IF YOU ANSWERED HERE SKIP #4 &#5 & GO TO #6

4. Please rate each of the following reasons for seeking a technical job:

	Important	Not Important	
(a) Wanted experience on an engineering job (to see engineering)	___	___	(19)
(b) Wanted experience with a certain company	___	___	(20)
(c) Wanted to obtain some feedback on my ability as an engineer	___	___	(21)
(d) Wanted to determine whether engineering is to be my life's work	___	___	(22)

5. Which one of the following most closely fits the way that you obtained your summer technical job? (check only one)
   (a) Soley through my own efforts ___ (23)
   (b) Through the efforts and prompting of a professor ___ (24)
   (c) Through an acquaintance in the company ___ (25)
   (d) Through parental or family efforts ___ (26)

6. Have you ever been employed in technical work (as defined above) any previous summer?
   Yes ___ (27)
   No ___

SECTION II

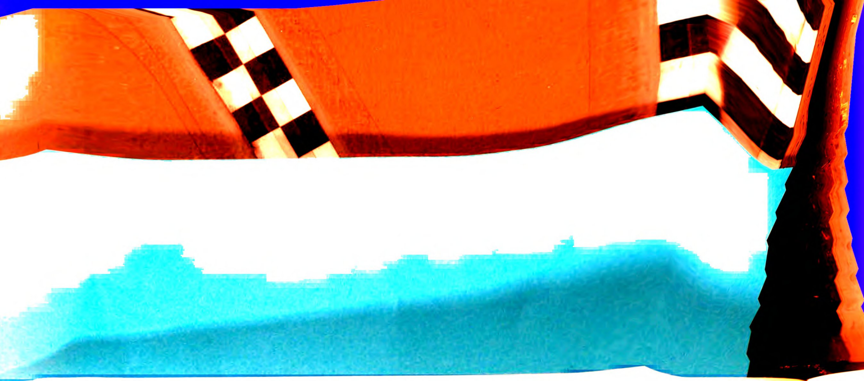
This section of the questionnaire will deal with your feelings about engineering classes and your education.

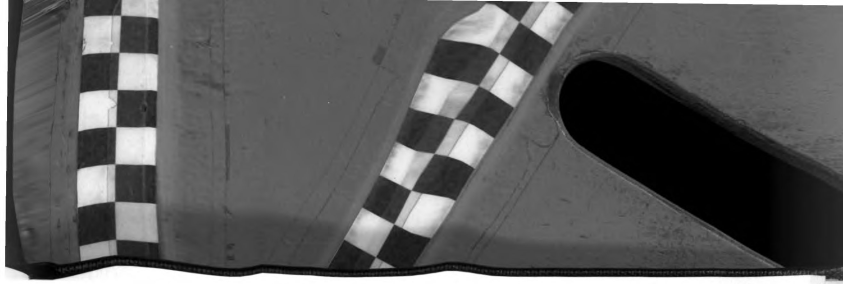
7. Place a check (✓) above the number closest to the place where you would rank your engineering program.

   Theoretical Engineering |—1—|—2—|—3—|—4—|—5—|—6—| Applied Engineering (28)

8. All engineering programs at Michigan State University require a lot of mathematics.
   Which one of the following best describes your feeling about mathematics?
   (a) Very important to an engineer ___
   (b) Modest importance to an engineer ___ (29)
   (c) Somewhat important to an engineer ___
   (d) Little importance to an engineer ___

9. Which one of the following best describes your feelings about your ability to apply mathematics to solve engineering problems?
   (a) Usually able to do so ___
   (b) Frequently able to do so ___ (30)
   (c) Sometimes able to do so ___
   (d) Seldom able to do so ___





10. During a discussion of an engineering problem with a classmate which one of the following describes your position?
    (a) Usually try to prove that my solution is correct ___
    (b) Sometimes try to prove that my solution is correct ___
    (c) Usually am open-minded----attempt to figure out which solution is best ___ (31)
    (d) Sometimes just accept the solutions that my classmates present ___
    (e) Usually accept the solutions that my classmates present ___

11. It is said that an engineer uses mathematics, a thorough knowledge of the physical sciences, and engineering methodology to solve engineering problems. Which one of the following best describes your ability at solving engineering problems.
    (a) Quite confident of my ability ___
    (b) Fairly confident of my ability ___ (32)
    (c) Hesitant of my ability ___

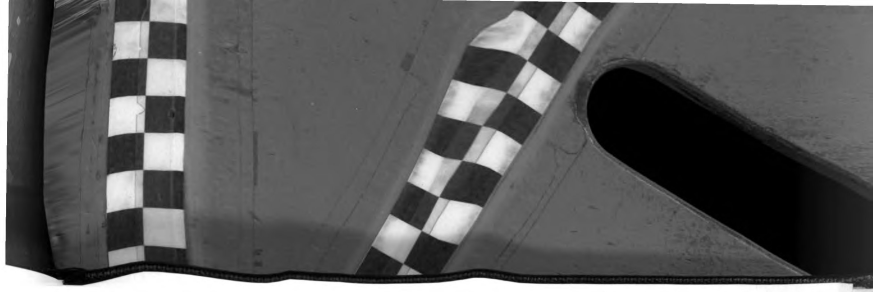
12. Define your attitude towards your engineering classes:
    (a) Usually enthusiastic ___
    (b) Sometimes enthusiastic ___ (33)
    (c) Consider them a necessary evil (unenthusiastic) ___
    (d) Sometimes dread them ___

13. Which of the following best describes your approach to class work:
    (a) Almost always complete my assignments ___
    (b) Usually complete my assignments ___ (34)
    (c) Often disregard assignments ___

14. While solving an engineering problem, I:
    (a) Usually rely on my own judgments ___
    (b) Sometimes rely on my own judgments ___ (35)
    (c) Usually rely on the judgments of my classmates ___

15. Which one of the following best describes your feelings about engineering as you approach your senior year?
    (a) Enthusiastic ___
    (b) Mildly enthusiastic ___
    (c) "Just another year" ___ (36)
    (d) Mildly reluctant ___
    (e) Reluctant ___

16. Please indicate your opinion of the value of at least one summer's engineering or technical work as a part of the engineering educational process. (check one)
    (a) Consider it essential ___
    (b) Useful but not essential ___
    (c) No more useful than any other type of work ___ (37)
    (d) Consider vacation or travel more important ___

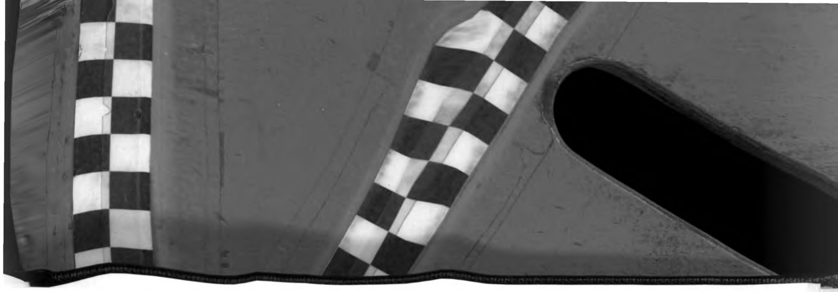


17. During a discussion of an engineering problem with a professor, in his class, which one of the following describes your position?
    - (a) Usually try to prove that my solution is correct __
    - (b) Sometimes try to prove that my solution is correct __
    - (c) Usually am open-minded----attempt to figure out which solution is best __ (38)
    - (d) Sometimes just accept the solutions that the professor presents __
    - (e) Usually accept the solutions that the professor presents __

18. You will be eligible to consider a full-time engineering position approximately one year from now. Indicate which one of the following best describes your feeling toward that first job.
    - (a) Quite competent - anxious to get started __
    - (b) Fairly competent - concerned about what to expect __
    - (c) Fairly competent - very concerned about what to expect __ (39)
    - (d) Unsure of my ability to solve "real" engineering problems __

19. Do you feel that you have an understanding of what an engineer does?
    - Yes __ (40)
    - No __
    - (a) If Yes, which of the following was most important to obtaining this understanding
      - As a part of my engineerinc classes __
      - From an engineer __ (41)
      - Past technical job __
      - My own reading __
      - Other (Specify)____________________ __
    - (b) If No, react to <u>each</u> of the following statements which are possible results of this lack of understanding of what an engineer does.

	Strongly Agree	Agree	Disagree	Strongly Disagree	
(a) The engineering problems seem meaningless	__	__	__	__	(42)
(b) It is difficult to decide why some engineering courses are taught	__	__	__	__	(43)
(c) The lack of understanding of what an engineer does has not a affected my education	__	__	__	__	(44)
(d) It makes an engineering major choice very difficult	__	__	__	__	(45)



20. Rate each of the following statements on what you hope to obtain from your senior engineering classes.

	Strongly Agree	Agree	Disagree	Strongly Disagree	
(a) First courses that deal with "real" engineering problems	___	___	___	___	(46)
(b) Obtain an idea of what an engineer does	___	___	___	___	(47)
(c) Develop skills in engineering application	___	___	___	___	(48)
(d) Add to my skill in engineering application	___	___	___	___	(49)
(e) No specific expectations	___	___	___	___	(50)

21. Rate each of the following statements about your reasons for choosing your electives.

(a) It should broaden my education (non-technical	___	___	___	___	(51)
(b) It must be a technical course	___	___	___	___	(52)
(c) I rely on the recomendations of advisors and faculty	___	___	___	___	(53)
(d) I rely on the recomendations of other students	___	___	___	___	(54)
(e) It is a haphazard choice	___	___	___	___	(55)
(f) Look for courses which will raise my grade point average	___	___	___	___	(56)

22. If you were considering an engineering job at graduation time (not graduate school or army) rate each of the following engineering areas for its attractiveness for you.

	No	Probably not	Maybe	Yes	
(a) Production	___	___	___	___	(57)
(b) Research	___	___	___	___	(58)
(c) Technical Sales	___	___	___	___	(59)
(d) Engineering Management	___	___	___	___	(60)
(e) Engineering Design	___	___	___	___	(61)

23. Please describe in the space provided how you feel about your engineering education.

Word Rating List

SECTION III

Following is a list of words used to describe a person. You are to rate yourself on each of the words.

Read each word carefully, then decide which of the following rating would describe you.

Rating Number	Meaning of Number
1	This word never describes me.
2	This word sometimes describes me.
3	This word usually describes me.
4	This word always describes me.

After you decide upon the response which describes you, circle the corresponding number.

Example:

1. Happy 1 2 3 4

This individual has chosen the rating number "2" for the word happy. This means that he feels that the word "happy" sometimes describes him.

If you have any questions, raise your hand. If not, turn to the next page and begin rating all of the words. DO NOT SKIP ANY WORDS. Work as rapidly as you can and do not spend too much time on any one word.

I AM:	Never	Sometimes	Usually	Always
1. organized	1	2	3	4
2. impatient	1	2	3	4
3. challenging	1	2	3	4
4. illogical	1	2	3	4
5. mature	1	2	3	4
		(62-66)		
I AM:				
6. a follower	1	2	3	4
7. dependable	1	2	3	4
8. an extrovert	1	2	3	4
9. floating	1	2	3	4
10. thing oriented	1	2	3	4
		(67-71)		
I AM:				
11. competent	1	2	3	4
12. unenthusiastic	1	2	3	4
13. routine	1	2	3	4
14. a leader	1	2	3	4
15. tolerent	1	2	3	4
		(72-76)		

I AM:	Never	Sometimes	Usually	Always
16. inconsistent	1	2	3	4
17. an engineer	1	2	3	4
18. irresponsible	1	2	3	4
19. dedicated	1	2	3	4
20. pushed	1	2	3	4
		(77-79) (10-11)		
I AM:				
21. undependable	1	2	3	4
22. introvert	1	2	3	4
23. a thinker	1	2	3	4
24. hesitant	1	2	3	4
25. people-oriented	1	2	3	4
		(12-16)		
I AM:				
26. confident	1	2	3	4
27. skilled	1	2	3	4
28. weak-willed	1	2	3	4
29. reliable	1	2	3	4
30. consistent	1	2	3	4
		(17-21)		

I AM:

	Never	Sometimes	Usually	Always
31. responsible	1	2	3	4
32. strong willed	1	2	3	4
33. immature	1	2	3	4
34. unorganized	1	2	3	4
35. striving	1	2	3	4
		(22-26)		

I AM:

	Never	Sometimes	Usually	Always
36. unskilled	1	2	3	4
37. self-confident	1	2	3	4
38. efficient	1	2	3	4
39. apathetic	1	2	3	4
40. logical	1	2	3	4
		(27-31)		

I AM:

	Never	Sometimes	Usually	Always
41. incompetent	1	2	3	4
42. talented	1	2	3	4
43. unsure	1	2	3	4
44. easily distracted	1	2	3	4
45. practical	1	2	3	4
		(32-36)		

I AM:

	Never	Sometimes	Usually	Always
46. curious	1	2	3	4
47. successful	1	2	3	4
48. careful	1	2	3	4
49. thorough	1	2	3	4
50. orderly	1	2	3	4
		(37-41)		

I AM:

	Never	Sometimes	Usually	Always
51. purposeful	1	2	3	4
52. studious	1	2	3	4
53. discontented	1	2	3	4
54. energetic	1	2	3	4
55. pessimistic	1	2	3	4
		(42-46)		

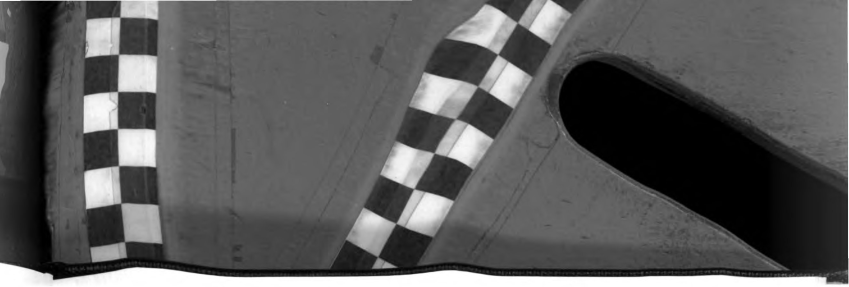
I AM:

	Never	Sometimes	Usually	Always
56. creative	1	2	3	4
57. intelligent	1	2	3	4
58. rebellious	1	2	3	4
59. systematic	1	2	3	4
60. below average	1	2	3	4
		(47-51)		

I AM:	Never	Sometimes	Usually	Always
61. reckless	1	2	3	4
62. dependable	1	2	3	4
63. exacting	1	2	3	4
64. lazy	1	2	3	4
65. stubborn	1	2	3	4
		(52-56)		
I AM:				
66. accepting	1	2	3	4
67. persistent	1	2	3	4
68. submissive	1	2	3	4
69. competitive	1	2	3	4
70. impulsive	1	2	3	4
		(57-61)		
I AM:				
71. unreasonable	1	2	3	4
72. dependent	1	2	3	4
73. sociable	1	2	3	4
74. retiring	1	2	3	4
75. driven	1	2	3	4
		(62-66)		

I AM:	Never	Sometimes	Usually	Always
76. tense	1	2	3	4
77. critical	1	2	3	4
78. casual	1	2	3	4
79. above average	1	2	3	4
80. productive	1	2	3	4
		(67-71)		
I AM:				
81. relaxed	1	2	3	4
82. optimistic	1	2	3	4
83. persuadable	1	2	3	4
84. motivated	1	2	3	4
85. conforming	1	2	3	4
		(72-76)'		
I AM:				
86. ambitious	1	2	3	4
87. independent	1	2	3	4
88. determined	1	2	3	4
89. contented	1	2	3	4
90. aggressive	1	2	3	4
		(77-79)		
		(10-11)		

	Never	Sometimes	Usually	Always
I AM:				
91. a person who delays	1	2	3	4
92. indecisive	1	2	3	4
93. non-critical	1	2	3	4
94. concerned	1	2	3	4
95. an achiever	1	2	3	4
		(12-16)		
I AM:				
96. a planner	1	2	3	4
97. indifferent	1	2	3	4
98. inconsistent	1	2	3	4
99. reasonable	1	2	3	4
100. inquisitive	1	2	3	4
		(17-21)		
I AM:				
101. impatient	1	2	3	4
102. reserved	1	2	3	4
103. dominant	1	2	3	4
104. inaccurate	1	2	3	4
105. passive	1	2	3	4
		(22-26)		



APPENDIX B

THE (POST-) QUESTIONNAIRE

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This questionnaire is designed to obtain your opinions about yourself and your college education. The results will be used to find common concerns among the junior class which could provide guidelines for future Engineering Education.

Please answer each question as honestly as you can. The only purpose in asking for your name is to make the study as thorough as possible. In no way will your responses and name be reported to anyone. Your answers will be treated in strictest confidence! As soon as the completion of the data is insured your name will be torn off and the code number will be used.

Work as quickly as you can, reading each question carefully before deciding upon your best response. Do not skip any items. Answer all questions, even though you may not think about yourself in exactly the way the question is stated.

IMPORTANT: For the purposes of this questionnaire, Technical Work is defined as: any engineering or science oriented work appropriate to your educational level.

Please print your name and student number on the top of the next page and begin working.

NAME ____________________
(print)
Student Number ______________

CODE ______________ (1-9)

SECTION I

		Yes	No	
1.	Were you employed this summer?	___	___	(10)
	(a) If YES, check whether: Employed engineering/technical work (Technical work is any engineering or science oriented work appropriate to your educational level).	___	___	(11)
	IF YOU ANSWERED YES HERE GO TO QUESTION #4			
	Employed in non-technical work	___	___	(12)
	IF YOU ANSWERED YES HERE GO TO QUESTION #2 and 3			
	(b) If NO, check whether you were engaged in:			
	Summer School		___	
	Active Military Duty (ROTC)		___	(13)
	Vacation or Travel		___	
	Other (Specify)		___	
	IF YOU ANSWERED HERE GO TO QUESTION #2 & 3			

2. You did not have a technical summer job. Do you feel that your summer experience had an effect on your senior year? Rate each of the following possible affects of your summer.

	Yes	No	
(a) helped in choosing electives	___	___	(14)
(b) increased my engineering skills	___	___	(15)
(c) increased my self-confidence	___	___	(16)
(d) confirmed my engineering committment	___	___	(17)

		Yes	No	
3.	Do you think that a technical summer job has a positive affect on the students' engineering education?	___	___	(18)

IF YOU ANSWERED QUESTION #3 GO TO SECTION II

Technically Employed Only

4. Please write a brief description of your summer technical job. Structure your comments to include area worked, duties, type of supervision, responsibility, oral and written reports given.

5.

6.

7.

8

1

5. Rate each of the following possible effects of your techni al experience.

		Yes	No	
(a)	Supplemented my college program	___	___	(19)
(b)	I gained maturity in engineering practice	___	___	(20)
(c)	Gained confidence towards the senior year	___	___	(21)
(d)	A financial gain only	___	___	(22)
(e)	Strengthened my committment to engineering	___	___	(23)
(f)	Influenced my engineering specialization	___	___	(24)
(g)	It was a poor experience	___	___	(25)
(h)	Disliked the engineering atmosphere - duties	___	___	(26)
6.	Did the company make you an offer for a full-time position?	___	___	(27)
7.	Would you consider working for your summer company on a full-time basis?	___	___	(28)
8.	Do you feel that the company derived worthwhile benifits from your employment?	___	___	(29)
9.	Did you consider your summer duties appropriate to the level of your education?	___	___	(30)
10.	Did you feel that your summer employer treated you as a professional?	___	___	(31)
11.	Was the work directly pertinent to any engineering course that you have taken?	___	___	(32)
12.	Would you recommend that a faculty member in your department coordinate summer technical employment for student?	___	___	(33)

13. The College would like to create a list of industries who hire engineering students during the summer. Would you please give the Name, location of plant, department you worked in this summer, and approximately your monthly salary. THIS IS AN OPTIONAL QUESTION - FEEL FREE TO SKIP THE QUESTION IF YOU OBJECT TO DISCLOSING THE INFORMATION.

Firm______________________________

Location____________________________

Dept.______________________________

Salary/mo.__________________________

SECTION II

This section of the questionnaire will deal with <u>your feelings</u> about engineering classes and your education.

14. Place a check (x) above the number closest to the place where you would rank your engineering program.

Theoretical Engineering | 1 | 2 | 3 | 4 | 5 | 6 | Applied Engineering (34)

15. All engineering programs at Michigan State University require a lot of mathematics.
Which one of the following best describes your feeling about mathematics?
(a) Very important to an engineer ___
(b) Modest importance to an engineer ___
(c) Somewhat important to an engineer ___ (35)
(d) Little importance to an engineer ___

16. Which one of the following best describes your feelings about your ability to apply mathematics to solve engineering problems?
(a) Usually able to do so ___
(b) Frequently able to do so ___ (36)
(c) Sometimes able to do so ___
(d) Seldom able to do so ___

10. During a discussion of an engineering problem with a classmate which one of the following describes your position?
    (a) Usually try to prove that my solution is correct
    (b) Sometimes try to prove that my solution is correct
    (c) Usually am open-minded----attempt to figure out which solution is best (31)
    (d) Sometimes just accept the solutions that my classmates present
    (e) Usually accept the solutions that my classmates present

11. It is said that an engineer uses mathematics, a thorough knowledge of the physical sciences, and engineering methodology to solve engineering problems. Which one of the following best describes your ability at solving engineering problems.
    (a) Quite confident of my ability
    (b) Fairly confident of my ability (32)
    (c) Hesitant of my ability

12. Define your attitude towards your engineering classes:
    (a) Usually enthusiastic
    (b) Sometimes enthusiastic (33)
    (c) Consider them a necessary evil (unenthusiastic)
    (d) Sometimes dread them

13. Which of the following best describes your approach to class work:
    (a) Almost always complete my assignments
    (b) Usually complete my assignments (34)
    (c) Often disregard assignments

14. While solving an engineering problem, I:
    (a) Usually rely on my own judgments
    (b) Sometimes rely on my own judgments (35)
    (c) Usually rely on the judgments of my classmates

15. Which one of the following best describes your feelings about engineering as you approach your senior year?
    (a) Enthusiastic
    (b) Mildly enthusiastic
    (c) "Just another year" (36)
    (d) Mildly reluctant
    (e) Reluctant

16. Please indicate your opinion of the value of at least one summer's engineering or technical work as a part of the engineering educational process. (check one)
    (a) Consider it essential
    (b) Useful but not essential
    (c) No more useful than any other type of work (37)
    (d) Consider vacation or travel more important

17. During a discussion of an engineering problem with a professor, in his class, which one of the following describes your position?
    (a) Usually try to prove that my solution is correct ___
    (b) Sometimes try to prove that my solution is correct ___
    (c) Usually am open-minded----attempt to figure out which solution is best ___ (38)
    (d) Sometimes just accept the solutions that the professor presents ___
    (e) Usually accept the solutions that the professor presents ___

18. You will be eligible to consider a full-time engineering position approximately one year from now. Indicate which one of the following best describes your feeling toward that first job.
    (a) Quite competent - anxious to get started ___
    (b) Fairly competent - concerned about what to expect ___
    (c) Fairly competent - very concerned about what to expect ___ (39)
    (d) Unsure of my ability to solve "real" engineering problems ___

19. Do you feel that you have an understanding of what an engineer does?
    Yes ___ (40)
    No ___
    (a) If Yes, which of the following was most important to obtaining this understanding
        As a part of my engineerinc classes ___
        From an engineer ___ (41)
        Past technical job ___
        My own reading ___
        Other (Specify)____________________ ___

    (b) If No, react to each of the following statements which are possible results of this lack of understanding of what an engineer does.

	Strongly Agree	Agree	Disagree	Strongly Disagree	
(a) The engineering problems seem meaningless	___	___	___	___	(42)
(b) It is difficult to decide why some engineering courses are taught	___	___	___	___	(43)
(c) The lack of understanding of what an engineer does has not a affected my education	___	___	___	___	(44)
(d) It makes an engineering major choice very difficult	___	___	___	___	(45)

20. Rate each of the following statements on what you hope to obtain from your senior engineering classes.

	Strongly Agree	Agree	Disagree	Strongly Disagree	
(a) First courses that deal with "real" engineering problems	__	__	__	__	(46)
(b) Obtain an idea of what an engineer does	__	__	__	__	(47)
(c) Develop skills in engineering application	__	__	__	__	(48)
(d) Add to my skill in engineering application	__	__	__	__	(49)
(e) No specific expectations	__	__	__	__	(50)

21. Rate each of the following statements about your reasons for choosing your electives.

(a) It should broaden my education (non-technical	__	__	__	__	(51)
(b) It must be a technical course	__	__	__	__	(52)
(c) I rely on the recomendations of advisors and faculty	__	__	__	__	(53)
(d) I rely on the recomendations of other students	__	__	__	__	(54)
(e) It is a haphazard choice	__	__	__	__	(55)
(f) Look for courses which will raise my grade point average	__	__	__	__	(56)

22. If you were considering an engineering job at graduation time (not graduate school or army) rate each of the following engineering areas for its attractiveness for you.

	No	Probably not	Maybe	Yes	
(a) Production	__	__	__	__	(57)
(b) Research	__	__	__	__	(58)
(c) Technical Sales	__	__	__	__	(59)
(d) Engineering Management	__	__	__	__	(60)
(e) Engineering Design	__	__	__	__	(61)

23. Please describe in the space provided how you feel about your engineering education.

Word Rating List

SECTION III

Following is a list of words used to describe a person. You are to rate yourself on each of the words.

Read each word carefully, then decide which of the following rating would describe you.

Rating Number	Meaning of Number
1	This word never describes me.
2	This word sometimes describes me.
3	This word usually describes me.
4	This word always describes me.

After you decide upon the response which describes you, circle the corresponding number.

Example:

1. Happy 1 2 3 4

This individual has chosen the rating number "2" for the word happy. This means that he feels that the word "happy" sometimes describes him.

If you have any questions, raise your hand. If not, turn to the next page and begin rating all of the words. DO NOT SKIP ANY WORDS. Work as rapidly as you can and do not spend too much time on any one word.

I AM:	Never	Sometimes	Usually	Always
1. organized	1	2	3	4
2. impatient	1	2	3	4
3. challenging	1	2	3	4
4. illogical	1	2	3	4
5. mature	1	2	3	4
		(62-66)		
I AM:				
6. a follower	1	2	3	4
7. dependable	1	2	3	4
8. an extrovert	1	2	3	4
9. floating	1	2	3	4
10. thing oriented	1	2	3	4
		(67-71)		
I AM:				
11. competent	1	2	3	4
12. unenthusiastic	1	2	3	4
13. routine	1	2	3	4
14. a leader	1	2	3	4
15. tolerent	1	2	3	4
		(72-76)		

I AM:	Never	Sometimes	Usually	Always
16. inconsistent	1	2	3	4
17. an engineer	1	2	3	4
18. irresponsible	1	2	3	4
19. dedicated	1	2	3	4
20. pushed	1	2	3	4
		(77-79) (10-11)		
I AM:				
21. undependable	1	2	3	4
22. introvert	1	2	3	4
23. a thinker	1	2	3	4
24. hesitant	1	2	3	4
25. people-oriented	1	2	3	4
		(12-16)		
I AM:				
26. confident	1	2	3	4
27. skilled	1	2	3	4
28. weak-willed	1	2	3	4
29. reliable	1	2	3	4
30. consistent	1	2	3	4
		(17-21)		

I AM:	Never	Sometimes	Usually	Always
31. responsible	1	2	3	4
32. strong willed	1	2	3	4
33. immature	1	2	3	4
34. unorganized	1	2	3	4
35. striving	1	2	3	4
		(22-26)		

I AM:	Never	Sometimes	Usually	Always
36. unskilled	1	2	3	4
37. self-confident	1	2	3	4
38. efficient	1	2	3	4
39. apathetic	1	2	3	4
40. logical	1	2	3	4
		(27-31)		

I AM:	Never	Sometimes	Usually	Always
41. incompetent	1	2	3	4
42. talented	1	2	3	4
43. unsure	1	2	3	4
44. easily distracted	1	2	3	4
45. practical	1	2	3	4
		(32-36)		

I AM:	Never	Sometimes	Usually	Always
46. curious	1	2	3	4
47. successful	1	2	3	4
48. careful	1	2	3	4
49. thorough	1	2	3	4
50. orderly	1	2	3	4
		(37-41)		

I AM:	Never	Sometimes	Usually	Always
51. purposeful	1	2	3	4
52. studious	1	2	3	4
53. discontented	1	2	3	4
54. energetic	1	2	3	4
55. pessimistic	1	2	3	4
		(42-46)		

I AM:	Never	Sometimes	Usually	Always
56. creative	1	2	3	4
57. intelligent	1	2	3	4
58. rebellious	1	2	3	4
59. systematic	1	2	3	4
60. below average	1	2	3	4
		(47-51)		

I AM:	Never	Sometimes	Usually	Always
61. reckless	1	2	3	4
62. dependable	1	2	3	4
63. exacting	1	2	3	4
64. lazy	1	2	3	4
65. stubborn	1	2	3	4
		(52-56)		

I AM:	Never	Sometimes	Usually	Always
66. accepting	1	2	3	4
67. persistent	1	2	3	4
68. submissive	1	2	3	4
69. competitive	1	2	3	4
70. impulsive	1	2	3	4
		(57-61)		

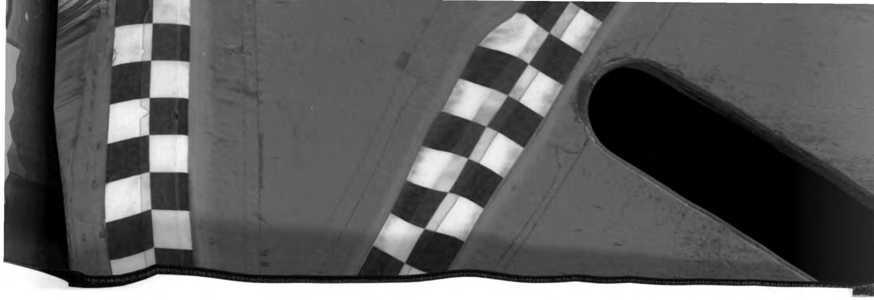
I AM:	Never	Sometimes	Usually	Always
71. unreasonable	1	2	3	4
72. dependent	1	2	3	4
73. sociable	1	2	3	4
74. retiring	1	2	3	4
75. driven	1	2	3	4
		(62-66)		

I AM:	Never	Sometimes	Usually	Always
76. tense	1	2	3	4
77. critical	1	2	3	4
78. casual	1	2	3	4
79. above average	1	2	3	4
80. productive	1	2	3	4
		(67-71)		

I AM:	Never	Sometimes	Usually	Always
81. relaxed	1	2	3	4
82. optimistic	1	2	3	4
83. persuadable	1	2	3	4
84. motivated	1	2	3	4
85. conforming	1	2	3	4
		(72-76)'		

I AM:	Never	Sometimes	Usually	Always
86. ambitious	1	2	3	4
87. independent	1	2	3	4
88. determined	1	2	3	4
89. contented	1	2	3	4
90. aggressive	1	2	3	4
		(77-79) (10-11)		

	Never	Sometimes	Usually	Always
I AM:				
91. a person who delays	1	2	3	4
92. indecisive	1	2	3	4
93. non-critical	1	2	3	4
94. concerned	1	2	3	4
95. an achiever	1	2	3	4
		(12-16)		
I AM:				
96. a planner	1	2	3	4
97. indifferent	1	2	3	4
98. inconsistent	1	2	3	4
99. reasonable	1	2	3	4
100. inquisitive	1	2	3	4
		(17-21)		
I AM:				
101. impatient	1	2	3	4
102. reserved	1	2	3	4
103. dominant	1	2	3	4
104. inaccurate	1	2	3	4
105. passive	1	2	3	4
		(22-26)		



APPENDIX C

MISCELLANEOUS TABLES

Table C1. Technical Group: Students' rated reactions to technical summer jobs

Responses	Yes		No	
	f	%	f	%
Company offer a full-time position?	77	61	49	39
Would you consider the offer?	89	71	37	29
Did company derive worthwhile benefits from your employment?	120	95	6	5
Were your duties appropriate to your educational level?	84	67	42	33
Were your treated as a professional?	98	78	28	22
Was work directly pertinent to any engineering course you have taken?	64	51	62	49
Would you recommend that a faculty member coordinate summer employment?	95	75	31	25

Table C2. Technical (T) and Non-Technical (NT) Groups: Students' rated expectations for their senior year

RESPONSES	PRE								POST							
	T				NT				T				NT			
	SA	A	D	SD	SA	A	D	SD	SA	A	D	SD	SA	A	D	SD
First courses that deal with "real" engineering problems	34	56	36	←A	46	79	27	←A	27	64	33	←A	40	78	34	←A
	df = 2				X^2 = 4.615				df = 2				X^2 = 1.085			
Obtain an idea of what an engineer does	14	76	29	7	28	96	24	4	9	64	35	12	27	93	25	6
	df = 3				X^2 = 5.902				df = 3				X^2 = 14.669*			
Develop skills in engineering application	65	52	9	←A	72	73	6		54	59	8		56	89	6	
	df = 2				X^2 = 2.248				df = 2				X^2 = 3.132			
Add to my skills in engineering application	58	59	8	←A	67	80	6	←A	48	70	3	←A	63	83	5	
	df = 2				X^2 = 1.302				df = 2				X^2 = .325			
No specific expectations		9	58	54		14	75	55		9	57	50		14	76	59
	df = 2				X^2 = 1.280				df = 2				X^2 = .443			

* Significant at .01

Legend: SA = strongly agree, A = agree, D = disagree, SD = strongly disagree

A represents a collapsing of the cell frequency to the adjacent cell.

Table C3. Technical (T) and Non-Technical (NT) Groups: Students' reported reasons for choosing electives

RESPONSES	PRE								POST							
	T				NT				T				NT			
	SA	A	D	SD	SA	A	D	SD	SA	A	D	SD	SA	A	D	SD
It should broaden my education (non-technical)	34	51	18	←A	66	65	22	←A	45	60	18	←A	63	73	14	←A
	df = 2				X^2 = .088				df = 2				X^2 = 2.117			
It must be a technical course	A→	18	74	33	A→	25	85	41	A→	19	70	32	A→	14	96	40
	df = 2				X^2 = .313				df = 2				X^2 = 3.722			
I rely on the recommendations of advisors and faculty	A→	57	56	11	A→	88	46	16	A→	53	56	12	A→	91	48	12
	df = 2				X^2 = 6.119*				df = 2				X^2 = 7.425*			
I rely on the recommendations of other students	A→	58	51	15	A→	56	74	20	A→	57	46	17	A→	66	70	16
	df = 2				X^2 = 2.535				df = 2				X^2 = 1.914			
It is a haphazard choice	A→	6	38	80	A→	12	60	77	A→	6	40	73		11	66	72
	df = 2				X^2 = 4.746				df = 2				X^2 = 4.556			
Look for courses which will raise my grade point average	A→	27	61	36	A→	40	72	39	A→	19	60	41	A→	34	74	43
	df = 2				X^2 = .907				df = 2				X^2 = 2.235			

* Significant at .05

Legend: SA = strongly agree, A = agree, D = disagree, SD = strongly disagree

A represents a collapsing of the cell frequency to the adjacent cell.

Table C4. Technical (T) and Non-Technical (NT) Groups: Students' rating of engineering areas attractiveness

RESPONSES	PRE								POST							
	T				NT				T				NT			
	No	PN	M	Yes	No	PN	M	Yes	No	PN	M	Yes	No	PN	M	Yes
production	11	28	59	26	9	31	82	28	16	27	53	25	23	33	66	28
	df = 3				X^2 = 1. 727				df = 3				X^2 = 0. 347			
research	16	27	40	41	19	33	50	47	14	21	42	44	15	35	52	49
	df = 3				X^2 = 0. 089				df = 3				X^2 = 1. 577			
technical sales	32	61	25	6	49	55	32	14	37	43	30	11	50	39	43	19
	df = 3				X^2 = 5. 520				df = 3				X^2 = 3. 318			
engineering management	10	27	40	47	12	27	57	56	9	22	41	49	11	28	50	61
	df = 3				X^2 = 1. 119				df = 3				X^2 = 0. 016			
engineering design	A→	18	50	56	A→	13	71	66	A→	15	46	60	A→	20	58	72
	df = 2				X^2 = 2. 826				df = 2				X^2 = . 084			

No significant at . 05

Legend: PN = probably not, M = maybe

A represents a collapsing of the cell frequency to the adjacent cell.

Table C5. Technical (T) and Non-Technical (NT) Groups: Pre-test group differences on students' self-rating of descriptive words or phrases

I AM:	PRE								POST							
	T				NT				T				NT			
	N	S	U	A	N	S	U	A	N	S	U	A	N	S	U	A
skilled		24	89	13	A→	53	92	9		18	98	10		39	106	9
	df = 2				X^2 = 8.986*				df = 2				X^2 = 5.357			
efficient		20	84	22	A→	35	105	12	A→	11	108	7	A→	29	108	17
	df = 2				X^2 = 6.041*				df = 2				X^2 = 9.560*			
logical		4	108	14	A→	19	106	29		5	111	10		13	110	30
	df = 2				X^2 = 12.355*				df = 2				X^2 = 11.051*			
curious		6	76	44		21	83	50		10	86	30		17	88	48
	df = 2				X^2 = 6.287*				df = 2				X^2 = 3.411			
successful		19	101	6		45	105	4	A→	17	105	4		37	107	9
	df = 2				X^2 = 8.323*				df = 2				X^2 = 8.732*			
tense	3	91	32	←A	16	106	29	←A	9	94	23	←A	11	115	26	←A
	df = 2				X^2 = 7.982*				df = 2				X^2 = .06			
above average	A→	30	68	28	A→	61	72	20		29	75	22		51	83	20
	df = 2				X^2 = 9.480*				df = 2				X^2 = 3.788			
an achiever		20	92	14	A→	49	91	12	A→	18	94	14		39	99	14
	df = 2				X^2 = 10.000*				df = 2				X^2 = 5.477			
inquisitive		13	93	20	A→	34	91	25		13	90	23		27	97	27
	df = 2				X^2 = 7.936*				df = 2				X^2 = 3.252			

* Significant at .05

Legend: N = never, S = sometimes, U = usually, A = always

A represents a collapsing of the cell frequency to the adjacent cell.

Table C6. Technical (T) and Non-Technical (NT) Groups: Post-test group differences on students' self-rating of descriptive words or phrases

I AM:	PRE								POST							
	T				NT				T				NT			
	N	S	U	A	N	S	U	A	N	S	U	A	N	S	U	A
challenging	A→	56	62	8		75	73	6		43	81	1		62	79	12
	df = 2				X^2 = 1.146				df = 2				X^2 = 10.053*			
thing oriented	16	76	31	←A	24	83	45	←A	7	74	43	←A	23	85	43	←A
	df = 2				X^2 = 1.439				df = 2				X^2 = 6.711*			
a leader	A→	74	51	←A	A→	99	55	←A	A→	56	70	←A	A→	99	55	←A
	df = 1				X^2 = .756				df = 1				X^2 = 11.03*			
confident		24	85	17	A→	43	92	19		16	89	21	A→	39	98	16
	df = 2				X^2 = 3.293				df = 2				X^2 = 8.678*			
unsure	8	110	8		15	122	17		8	113	5		15	120	19	
	df = 2				X^2 = 3.223				df = 2				X^2 = 7.785*			
practical		9	90	27	A→	6	108	40		1	106	19		13	106	35
	df = 2				X^2 = 2.289				df = 2				X^2 = 12.350*			
careful	A→	19	92	15	A→	19	106	29		20	99	7	A→	13	117	23
	df = 2				X^2 = 2.669				df = 2				X^2 = 8.994*			
persistent		20	95	11		41	94	16		17	104	5	A→	41	94	17
	df = 2				X^2 = 5.953				df = 2				X^2 = 15.184*			
motivated		24	89	13	A→	43	98	11	A→	19	90	17	A→	43	96	14
	df = 2				X^2 = 3.585				df = 2				X^2 = 7.225*			

* Significant at .05

Legend: N = never, S = sometimes, U = usually, A = always

A represents a collapsing of the cell frequency to the adjacent cell.

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