DOCUMENT RESUME

ED 022 413 24 HE 000 001

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THE EFFECTS OF A PRE-FRESHMAN ORIENTATION PROGRAM ON ACADEMIC PROGRESS. FINAL REPORT.
Massachusetts Univ., Amherst. Dept. of Basic Engineering.
Spons Agency-Office of Education (DHEW), Washington, D.C. Bureau of Research.
Bureau No-BR-5-8186
Pub Date 18 Aug 67
Contract-OEC-5-10-155
Note-94p.
EDRS Price MF-$0.50 HC-$3.84
Descriptors-*ACADEMIC ACHIEVEMENT, *COLLEGE BOUND STUDENTS, COLLEGE PREPARATION, DROPOUT PREVENTION, *ENGINEERING EDUCATION, *ORIENTATION, *STUDENT ATTITUDES
Identifiers-*School of Engineering, University of Massachusetts

A two-week orientation program designed to acquaint pre-freshman engineering students with material relevant to their subsequent curriculum was successful in boosting the students' chances for survival in both engineering and other academic programs. Verified by carefully drawn samples from three separate entering classes, it was found that the program increases by over 50 percent a student's chances of remaining enrolled in engineering at the beginning of his sophomore year, doubles his chances of receiving an engineering degree in ten semesters, and increases by almost 50 percent his chances of obtaining some degree. Judging from indirect evidence, the program is effective because it causes the student to re-evaluate his role and responsibility in future academic life. Further experimental work to measure such attitudinal changes is needed. The number of students participating in the program does not seem to affect its outcome. It is felt that to meet its own objectives, the program can be no shorter than two weeks. (Author/JS).

BR-5-8186
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FINAL REPORT

THE EFFECTS OF A PRE-FRESHMAN ORIENTATION PROGRAM ON ACADEMIC PROGRESS

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August 18, 1967

Submitted in partial fulfillment of U.S. Office of Education, Bureau of Research S-8186, Contract No. 5-10-155, Effects of Pre-Freshman Orientation on Academic Progress

SUMMARY

THE EFFECTS OF A PRE-FRESHMAN
ORIENTATION PROGRAM ON ACADEMIC PROGRESS

The effect of the two-week pre-freshman engineering orientation program, whicn has been designed around substantive material of high face validity to the subsequent engineering curriculum is to increase the student's chances of survival, not only as an engineering student, but in other programs if he chooses to transfer to them.

The evidence indicates that the pre-engineering orientation program will increase a student's chances of remaining enrolled in engineering at the beginning of the sophomore year by more than 50 percent. It will more than cut in half his chances of being a dropout by the beginning of the sophomore year. It will reduce his chances of becoming a dropout after ten semesters by approximately 20 percent. It will almost double his chances of receiving an engineering degree by the end of ten semesters. It will increase his chances of obtaining some degree by almost 50 percent.

These facts are verified by carefully drawn samples from three separate entering classes, in which all samples are balanced for their desire to participate in the program, and with one pair of Experimental and Control groups balanced for mathematical ability, and another pair of Experimental and Control groups balanced for their study skills as measured by the Brown-Holtzman Test of Study Skills.

On the basis of indirect evidence, it is thought that the reason for this effect is that the program changes the attitudes of the student. It is felt that the student better understands his own role and responsibilities in his higher education experience. These inferences need to be verified by

further experimental work that is designed particularly for this purpose.

Within the range investigated, the number of students participating in the program does not seem to have an appreciable effect on the outcome of the program.

On an intuitive basis it is felt that the two-week length is as short as it can be and still meet the objectives of the program.

THE EFFECTS OF A PRE-FRESHMAN ORIENTATION PROGRAM

1.0 Introduction

Orientation has generally been conceded as a useful device to smooth the transition for individuals engaging in a new activity. So widely recognized is this technique that it is difficult to find any organization of any size that does not practice it. It is difficult to get a job, join an organization, buy an automobile, or even rent an apartment without getting "oriented" to the new situation. Educational organizations have long practiced this technique. Indeed, in many schools they not only orient the students who come into the system, they orient the new teachers, and in many cases even orient parents to the experiences their children are going to receive.

The fact that orientation is of value to the individuals embarking on new experiences does not need to be questioned. But the objectives, the extent, and the effects of the orientation do need to be questioned if we are ever to improve the situation. Of course, objective, extent, and effect are interrelated.

If the orientation is to take place for the administrative convenience of the organization involved, a brief exposure to orientation procedures is probably best. This might well take the form of instruction in how to complete certain forms, cursory descriptions of obligations and benefits, and perhaps a short welcome to the new situation. On the other hand, in many cases orientation is viewed as a technique to achieve "readiness" for some future challenge or experience. In these situations the orientation should probably be more extensive. In many cases of this sort it may be viewed as an opportunity to convey a considerable amount of substantive material, and here one often wonders where the orientation ends, and the subsequent experience begins. Many are familiar with the "orientation" given to persons entering the basic training phase of military service, but to what extent is the basic training itself an "orientation" to the larger facts of military life?

In the academic setting we have a similar kind of problem of definition. There are many in higher education who feel that the freshman year is primarily "orientation" to substantive academic work and scholarly or professional training to be received in the rest of the undergraduate years. Many view the freshman year as a "leveling" process designed to bring students with marginal high school preparation up to a level where they can profit by their subsequent work in higher education, and as a device to fill in the gaps in the background of the students. In this way the freshman year is considered an "orientation" to prepare the students to profit by the pearls of wisdom they receive in the later years. Many would disagree with this approach because they feel that the freshman year itself is a substantive academic task, and in view of the difficulties with which it is fraught feel that the concept of orientation is better applied to pre-freshman experiences that will help students master the first year. The differences in the points of view are mostly a matter of objective. Certainly the experiences in the freshman year help the student profit by subsequent work, but we are also aware of the problems many freshmen have completing the first year. And certainly, a student who does not complete the first year is in no position to profit by subsequent work, whatever its quality or nature.

It is this latter thought--a student cannot profit from subsequent work if he does not satisfactorily complete his freshman year--that has focused our attention on pre-freshman orientation experiences that are designed to help students complete the freshman year.

A program was developed, tested, and reported that demonstrated success in helping incoming engineering students survive the first year.[1] When two entering freshman groups were matched, both in mathematical ability and desire to participate in an orientation program, the group who did participate in the orientation (Experimental group) retained 80.5 percent of the students in engineering at the beginning of the Sophomore year while the group who were not permitted to participate in the orientation had only 50.0 percent in engineering at the beginning of the Sophomore year.[1]

The task of this report is to further document this difference, and find out what effects, if any, continue to be evident due to this program in later undergraduate years.

It is widely recognized that when remedial programs, or special preparation programs of various sorts are compared, there is generally differences between experimental and control groups immediately following such programs. However, these differences tend to disappear over time. The longer one waits after such programs the smaller are the differences one can find.

Contrary to the decreasing trend that is usually observed, differences between the Experimental and Control group became larger over time in the work cited above.[1] This trend is also of primary interest.

1.1 The Nature of Orientation Programs

Most colleges and universities offer some sort of orientation program for incoming freshmen. This varies from programs that last from several hours to several days or weeks. Ordinarily these programs deal primarily with administrative matters. Sometimes they are extended to include aptitude and achievement testing, the history and tradition of the institution, selection of courses of study, and the like. Such activities are traditionally administered by the Office of the Dean of Students, and are commonly implemented by professionally trained guidance and counseling staff, and perhaps student service organizations. There is usually a minimum of faculty participation. Such activities frequently take place in the fall immediately preceding the students' first registration at the institution. Lately, an increasing number of institutions are resorting to the device of bringing students onto the campus sometime during the summer preceding the fall registration. The students often stay on the campus for two or three days during which many of these activities take place. By handling orientation primarily in this fashion, a more personalized job can be done for the students, and it can be accomplished with a smaller staff at a time when the campus is not preparing for the annual fall invasion.

These activities appear to be extremely helpful to the student, but their primary purpose is administrative convenience. Without such activities complete chaos would result at registration and during the first few days of classes, particularly in larger institutions.

Relatively little experimental work or thought has gone into the possibility of orientation programs for students that are primarily substantive in an academic sense. Although considerable work and effort has gone into testing students for aptitude and achievement in various subject matter areas, and this is commonly followed up by recommendations or requirements that students participate in remedial or honors work, this has not been generally extended to the presentation of substantive academic work as the keystone of a carefully designed program of orientation to help the students make the most of their subsequent higher educational experience.

It has long been recognized that a freshman student entering into the academic community for the first time has a large transition to make. It is also well-known that many students do not successfully accomplish this transition. As a matter of fact, "dropouts" have been studied for more than 40 years[2]. It is also well-known that most "dropouts" from college occur during the freshman year[2], and that about as many students drop out during the freshman year as during the remaining three years combined. Therefore, before beginning the examination of the effect of an orientation program designed around substantive and challenging academic tasks it will be productive to become familiar with the dropout phenomenon in some detail, as well as the nature of the freshman engineering student. A review of material relevant to these subjects is presented in Appendix A and Appendix B for those interested.

2.0 Objective

This study is specifically designed to determine if long run significant differences in subsequent academic performance can be obtained and maintained by a pre-freshman orientation experience that is primarily designed to cover substantive academic material. The orientation program is two weeks long, which allows adequate treatment of the material chosen.

The material chosen for this orientation program has a high relevance and face validity when viewed against the undergraduate engineering program. The material used, however, is not prerequisite for any of the courses the students take in subsequent engineering curricula. The main topics, review of mathematical concepts and the use of the slide rule, are material that have generally been squeezed out of most undergraduate programs because of the pressure from the inclusion of additional science and new technology. The details of the course content, administration, and development are presented in Appendix C.

The measures of success chosen for the pre-freshman orientation program are academic performance variables. Operationally, the definition of success of the pre-freshman orientation experience is a bachelor's degree in some field of engineering. Naturally, all students will not succeed to this criterion, but all students entering the School of Engineering will move to some point along the road toward this goal. The farther they go, the higher will be their success as it has been defined.

Some students who start in the School of Engineering transfer to other fields within the University. Many of these students will earn degrees in fields such as business administration, history, economics, English, etc. These students who transfer from engineering, and reach a non-engineering degree in a field of their choice will no doubt be succeeding in a way satisfying for them. Indeed, obtaining these degrees may represent the best possible success for these individuals. However, in view of the fact that objectives of the pre-freshman orientation experience is an engineering degree, the success of these individuals cannot be judged as meeting the criterion. For this reason, the students who transfer out of engineering will be analyzed in terms of how many of them reach some degree at the University of Massachusetts, but this analysis will be performed separately and will provide an interesting aspect of the results.

The performance variables of most interest in a study of this sort are first of all, survival and eventual graduation in engineering. Other variables that provide useful comparisons that help to understand the long-term effects of pre-orientation experience are things such as the grade-point averages of students as they progress through school, the number of failures, and the comparisons of grades in particular courses that are common to all engineering students.

In order to more fully understand some administrative implications of using an orientation such as will be described, the number of students participating in the program is also considered as a variable. It was felt the nature of the orientation program might be such that the number of students participating would be critical to its success. For this reason groups of different sizes are analyzed and compared (see Item 3.0, Samples).

It is hoped the collection and analysis of this information will reveal clues concerning the mechanism of how the program obtains some of its results.

3.0 Population and Samples

The population of greatest general interest is all high school students entering schools and colleges of engineering. More particularly, we are interested in those students who enter without any deficiencies or advanced standing, and who register for regular freshman programs that lead to degrees in engineering. However, strict statistical inference will not permit statements concerning this population from the sample that is available for study. Rather, we are limited to statements about students entering the School of Engineering at the University of Massachusetts, who have registered, or will register in engineering, who will begin their freshman year without deficiency or advanced standing in mathematics, and who could be induced to volunteer for an orientation program such as is described.

It would appear that the actual population to which inferences can be made from this study is of little general scientific interest, however, the measurable parameters of this population are typical of a much wider group (see Table 3.0-1). It may be said that the population is typical of schools of engineering at state universities who draw their students from the upper third of high school classes with SAT scores averaging close to 525 verbal and 625 math. These values are representative of a wide range of schools of engineering, and it is felt that the results obtained could be duplicated at many institutions.

3.1 Samples

The samples for this work were drawn from freshman students who entered engineering at the University of Massachusetts in 1962, 1964, and 1965 (graduating classes of 1966, 1968, and 1969). In the classes of 1966 and 1969 two groups were drawn, and were designated the "Experimental" group and the "Control" group.

Table 3.0-1 -- Description of Entering Freshmen in Engineering

	Year 1965	1966
Number of Students (Basis of Subsequent Figures)	251	278
CEEB Verbal (Mean)	534	520
CEEB Math (Mean)	630	620
Standing in High School Class (Mean % from top)	19.8	20.8

The sample from the class of 1966 was divided in the following way:

1. All entrants were given a brochure describing the program and at a group meeting during a 3-day summer testing and counseling period, the program was explained to both the students and their parents, questions were answered, and students were urged to attend. No tuition was charged; the only charge was for room, board, school supplies, etc.
2. Those students who did volunteer were arranged in descending order according to their score on the University of Massachusetts Mathematic Achievement Test. They were then "counted off" alternately from the top of the list into two groups.
3. A coin was tossed to determine which of these two groups was to be designated the "Experimental" and which was designated the "Control" group.
4. The "Experimental" group was advised they were accepted into the program. The "Control" group was advised that they were unable to be taken into the program. Because of late cancellations and "no-shown," the "Control" group had 56 members, and the "Experimental" group had 41 members.

The sample from the class of 1969 was divided into an "Experimental" and a "Control" group in the following way:

1. All entrants were mailed a copy of a brochure describing the program well in advance. At a group meeting during a 3-day summer testing and counseling period the program was explained to both the students and their parents, questions were answered and students were urged to attend. A tuition of $20.00 per student was charged, along with usual University rates for room and board. Students had to provide their own school supplies.

2. Those students who did volunteer were analyzed for unusual circumstances surrounding their backgrounds, and students with unusual credentials, for example, females, veterans, foreign students, etc., were removed from the sample. Those students remaining in the sample were arranged in descending order according to their score on the Brown-Holtzman Study Skills Test. They were then "counted off" alternately from the top of the list into two groups.
3. A coin was tossed to determine which of these two groups was to be designated the "Experimental" and which was to be designated the "Control" group.
4. The "Experimental" group was advised they were accepted into the program. The "Control" group was advised they were unable to be taken into the program. When a student in the "Experimental" group either cancelled or became a "no-show," the corresponding member of the "Control" group was removed from that sample. At the completion of the program there were 23 members in both the experimental and control groups for whom complete data was available.

It may be seen that the sample from the class of 1969 was divided in much the same way as the class of 1966. The primary difference was that the criteria for separating the students was the Brown-Holtzman Study Skills Test instead of a measure of mathematical aptitude. Also, before the counting off operation was performed the entire sample was analyzed for members with unusual backgrounds. These students were removed from the sample because it was felt that they would tend to inflate variances. For example, females, veterans, and foreign students were removed because these characteristics ordinarily do not occur in large numbers in entering engineering classes. This operation gave us relatively more homogeneous and typical samples, and corresponding individuals in the two samples were more nearly "matched." Then, if data were incomplete for an individual from either group, or a student dropped out before the fall registration for any reason, it would be possible to remove the corresponding member of the other group and retain evenly balanced samples. Further, since the samples drawn from the class of 1966 were not handled in this way, it gave us the opportunity to cross-compare results from the two sampling methods. (Subsequent tables indicate that it makes little or no difference which of these procedures are used as far as the initial measures on the samples are concerned.)

The sample of students drawn from the class of 1968 was made up of all the entering engineering students who volunteered for the pre-freshman orientation program that year. And although there was no control for this sample it was possible to investigate an orientation program operated at approximately twice the size of the Experimental groups in either the class of 1966 or the class of 1969. This permitted an investigation of whether the size of the group participating in the orientation program was in some way critical to its success. If, as was suspected, the clientele ordinarily served by the University of Massachusetts changed little from year to year it would be possible to use the control groups from the class of 1966 and/or the class of 1969 as a base line from which we could judge the progress of the sample from the class of 1968.

Actually, it was found that the initial measures of all the groups, the class of 1966, 1968, and 1969 were reasonably similar. Our assumption that the clientele served by the University of Massachusetts in the School of Engineering varied but little over the short run was borne out. Table 3.1-1 compares the CEEB Mathematic scores for the five different samples and Table 3.1-2 compares the CEEB Verbal scores for these five samples. When analysis

Table 3.1-1 -- Comparison of CEEB Mathematics Scores for All Samples

	Class of 1966 Experimental	Class of 1966 Control	Class of 1968 Experimental	Class of 1969 Control	Class of 1969 Experimental
Sample Size	41	54	84	23	23
Mean	60.146	60.796	61.952	63.435	62.739
Standard Deviation	5.374	5.472	4.967	6.920	2.988

Analysis of Variance

	Sum of Squares	DF	Mean Square	F Ratio
Between Groups	239.1112	4	59.7778	2.1774
Within Groups	6039.7777	220	27.4535	
Total	6278.8889	224		

$F_{05 \text{ at } 1/200 \text{ d.f.}} = 2.42$

Table 3.1-2 -- Comparison of CEEB Verbal Scores for All Samples

	Class of 1966 Experimental	Class of 1966 Control	Class of 1968 Experimental	Class of 1969 Control	Class of 1969 Experimental
Sample Size	41	54	84	23	23
Mean	50.220	51.907	52.679	52.174	54.217
Standard Deviation	6.118	7.459	6.487	7.808	5.616

Analysis of Variance

	Sum of Squares	DF	Mean Square	F Ratio
Between Groups	277.7620	4	69.4405	1.5318
Within Groups	9973.1002	220	45.3323	
Total	10250.8622	224		

F_{05} at 1/200 d.f. = 2.42

Table 3.1-3 -- Comparison of High School Rank (inverted, percentile)*

	Class of 1966 Experimental	Class of 1966 Control	Class of 1968 Experimental	Class of 1969 Control	Class of 1969 Experimental
Sample Size	41	54	84	23	23
Mean	7.3585*	9.0519	10.9774	11.1043	8.9826
Standard Deviation	6.7583	10.3171	11.0647	19.7766	8.8441

Analysis of Variance

	Sum of Squares	DF	Mean Square	R Ratio
Between Groups	441.4487	4	110.3622	.8685
Within Groups	27955.3440	220	127.0697	
Total	28396.7926	224		

F_{05} at 1/200 d.f. = 2.42

*7.3585 means the average class standing of this group is 7.3585 percentile from the top of the high school graduating class.

of variance is performed no significant difference is obtained at the five percent level. Table 3.1-3 describes the high school rank (inverted, percentile) for these five groups and again, analysis of variance demonstrates no significant difference at the five percent level.

A locally developed test in mathematics, focusing primarily on trigonometry and algebra, which has been found to be an important indicator of performance during the freshman year, was administered to all groups. The data from the trigonometry test is displayed in Table 3.1-4, along with the results of an analysis of variance on the five groups. Again no significant difference at the five percent level was obtained. When the algebra test scores were compared in the same manner, a significant difference was found to exist at both the five and one percent level.

A careful analysis of Table 3.1-5, where the algebra scores and analysis of variance are displayed, reveals the reason for the significant difference reported above. The difference in means between the samples drawn from the class of 1966, and the samples drawn from the classes of 1968 and 1969, indicates that there is an apparent shift in the quality of the algebra preparation of the entering students some time between the class of 1966 and the classes of 1968 and 1969. The algebra scores were re-analyzed comparing only the group from the class of 1968 with both the "Experimental" and the "Control" groups from the class of 1969. Table 3.1-6 displays these figures together with an analysis of variance table that indicates there is no difference in the algebra scores between these groups at the five percent level.

These sample statistics are summarized in Table 3.1-7.

Table 3.1-4 -- Comparison of Trigonometry Scores for All Samples

	Class of 1966 Experimental	Class of 1966 Control	Class of 1968 Experimental	Class of 1969 Control	Class of 1969 Experimental
Sample Size	41	54	84	23	23
Mean	16.415	16.500	16.881	17.261	16.652
Standard Deviation	4.062	3.612	3.950	2.927	3.626

Analysis of Variance

	Sum of Squares	DF	Mean Square	F Ratio
Between Groups	15.4471	4	3.8618	.2720
Within Groups	3123.9129	220	14.1996	
Total	3139.360	224		

F_{05} at 1/200 d.f. = 2.42

Table 3.1-5 -- Comparison of Algebra Scores for All Samples

	Class of 1966 Experimental	Class of 1966 Control	Class of 1968 Experimental	Class of 1969 Control	Class of 1969 Experimental
Sample Size	41	54	84	23	23
Mean	19.902	19.481	16.774	16.565	15.913
Standard Deviation	4.538	4.343	4.238	3.847	4.188

Analysis of Variance

	Sum of Squares	DF	Mean Square	F Ratio
Between Groups	537.7237	4	134.4309	6.3473
Within Groups	4025.2719	220	18.2967	
Total	4562.9956	224		

F_{05} at 1/200 d.f. = 2.42

Table 3.1-6 -- Comparison of Algebra Scores for the Samples From the Class of 1968, and the Experimental and Control Groups from the Class of 1969

	Class of 1968 Experimental	Class of 1969 Control	Class of 1969 Experimental
Sample Size	84	23	23
Mean	16.774	16.565	15.913
Standard Deviation	4.238	3.847	4.188

Analysis of Variance

	Sum of Squares	DF	Mean Square	F Ratio
Between Groups	13.3886	2	6.6943	.3861
Within Groups	2202.1806	127	17.3400	
Total	2215.5692	129		

F_{05} at 2/125 d.f. = 3.07

Table 3.1-7

SAMPLE STATISTICS

Sample Characteristics	Class '66 Experimental Estimate	Class '66 Experimental N Used	Class '66 Control Estimate	Class '66 Control N Used	Class '68 Experimental Estimate	Class '68 Experimental N Used	Class '69 Control Estimate	Class '69 Control N Used	Class '69 Experimental Estimate	Class '69 Experimental N Used	Significant Differences
	Treatment & Control Groups										
Original Sample Size (N)	41		54		84		23		23		
CEEB Verbal (2 digits)											
Mean (x)	50.220	41	51.907	54	52.679	84	52.174	23	54.217	23	No at 5%
Standard Deviation (σ)	6.118		7.459		6.487		7.808		5.616		
CEEB Math (2 digits)											
Mean (x)	60.146	41	60.796	54	61.952	84	63.435	23	62.739	23	No at 5%
Standard Deviation (σ)	5.374		5.472		4.967		6.920		2.988		
Trigonometry Score[1]											
Mean (x)	16.415	41	16.500	54	16.881	84	17.261	23	16.652	23	No at 5%
Standard Deviation (σ)	4.062		3.612		3.950		2.927		3.626		
Algebra Score[1]											
Mean (x)	19.902	41	19.481	54	16.774	84	16.565	23	15.913	23	Yes[3] at 5%
Standard Deviation (σ)	4.538		4.343		4.238		3.847		4.188		
High School Rank[2]											
Mean (x)	7.3585	41	9.2226	53	10.9774	84	12.7700	20	9.3909	22	No at 5%
Standard Deviation (σ)	6.7583		10.3385		11.0617		20.7480		8.8275		

[1] Locally prepared tests.

[2] Inverted percentage (highest percentile would be entered as 1.0000).

[3] Difference also exists at 1% (see Table 5.1-5), but when only class of 1968 is tested with class of 1969, Experimental and Control, no difference exists at 5% (see Table 5.1-6).

4.0 Procedure

During the life of the project the grades of the students falling in the various samples were examined and compared so that the progress of the samples could be monitored throughout the life of the project. From time to time various comparisons were made with this preliminary data so that possible leads might be uncovered. At the conclusion of the study the official records from the Registrar's Office at the University of Massachusetts were photocopied and it is on this data the analysis has been performed.

The main subject of this research was the freshman class entering the University in 1962, designated as the class of 1966. This group was followed through to their graduation, or completion of ten semesters (the close of the marking period in June of 1967). Of the total of 97 students, who were included in the Experimental and Control group, there remain but eight students who have not either graduated or dropped out. This means complete data is presented for 89 students of the original 97 students; the eight students who still remain enrolled in school after ten semesters are all from the Control group.

Research was also done with the students entering the University of Massachusetts in 1964 and 1965, designated the graduating classes of 1968 and 1969. These two groups were followed up to and including their registration at the beginning of the sophomore year. This permits complete and accurate comparisons for two semesters of work, and makes it possible to include the usual "leakage" that comes during the summer period.

5.0 Results

The criterion of success of the pre-freshman orientation program has been previously defined as graduation with an engineering degree. It was pointed out that many of the students in the samples would not reach this criterion but since all started along this path, the distance they traveled toward the goal provides a useful measure of the success of the program.

The extent to which students in the samples were able to "survive" in the School of Engineering is the most interesting and useful statistic that has been developed. Non-surviving students followed either of two routes, and although these routes may have been more satisfactory for the individual students, nevertheless they lead away from the goal which is our criterion measure. Students either remained in engineering, or followed the alternate routes of transferring to some other degree program in the University, or left the University completely. On occasion students who left the University would return, and in one case, a student who transferred to a non-engineering degree program returned to the School of Engineering to continue on toward his original goal. For this reason, survival statistics in the early semesters ordinarily contain three categories; (1) students enrolled in engineering, (2) students enrolled in the University in a non-engineering program, (3) students who have left the University. After eight semesters a fourth and fifth category begins to appear, graduation in engineering which is our criterion, and graduation in a non-engineering field.

Comparisons of grade-point average between the Experimental and Control samples have not been particularly useful. The reason these comparisons are not sensitive measures is that those students who obtain low grade-point averages are dismissed from the University. Academic dismissal tends to truncate the grade-point distribution after the end of the second semester when attrition becomes substantial. The grade-point comparisons from semester to semester then can only be made between survivors, and surviving students in both the Experimental and Control group exhibit very similar grade-point distributions.

Another comparison that reveals interesting information is the comparison between the performance of the Experimental and Control groups in the individual courses required of all students in the School of Engineering irrespective of their "major."

Of particular interest is an analysis of the numbers of students who transfer from the School of Engineering to other areas within the University. Data on these transfers are presented both in terms of the number of students who do transfer, and the time at which these transfers take place.

It is helpful to analyze the foregoing data in sections. To aid in this analysis the data is considered in four parts, first the freshman year for all samples and populations, second the remaining undergraduate years for the samples from the class of 1966, third the fact of graduation for the sample from the class of 1966, and last the analysis of the performance of students who transfer to non-engineering degree programs.

5.1 The Freshman Year

It was originally supposed that all Experimental groups, from the classes of 1966, 1968, and 1969, would respond similarly throughout the freshman year. It was also thought that all the Control groups would respond similarly throughout the freshman year. Yet, it was thought that all the Experimental groups would respond differently from all the Control groups. This would mean that differences shown to exist between the Experimental and Control group for the class of 1966 would also hold true for the comparisons between the

Experimental and Control group of the class of 1969. If these hypotheses are borne out for the freshman year it was felt that the data that was obtained on the class of 1966 throughout the remaining semesters could be extended to the other Experimental groups. The results do not fit this pattern exactly, but come very close.

The effect of the pre-freshman orientation program on the class of 1966 during the freshman year has been partially reported[1]. This data reveals that:

1. At the end of the first semester a greater proportion of students in the Experimental group satisfactorily completed thier first semester mathematics course than did the Control group. However, this difference was not significant at the 5 percent level.
2. At the end of the second semester a greater proportion of students in the Experimental group satisfactorily completed their second semester mathematics course than did the Control group. This difference was significant at the 5 percent level.
3. There is no significant difference in the final grade received by the Experimental and the Control group in both their first semester mathematics grades and the second semester mathematics grades. (Apparently the significant difference obtained against the criterion of "satisfactory completion" described in Item 2 is attributable to the fact a number of students in the Control group withdrew, dropped out, or transferred. This would be evident in a Chi Square analysis of attribute data but would not necessarily be reflected in an analysis of variance of the grades of the survivors.)
4. There was a significant difference between the performance of the Experimental and Control groups on the first hour examination given in first semester mathematics course and on the final examination

but these differences were not revealed in the final grade (see Item 3 above).

5. There was no significant difference in the grade-point averages of the survivors in Experimental and Control group at the end of the first semester of their freshman year, but a significant difference did exist at the end of the second semester of the freshman year.

The survival status of the samples from the class of 1966 is reported in Table 5.1-1 for the data at the end of the first semester and Table 5.1-2 for the end of the second semester. Chi Square analysis reveals that the survival status of the Experimental group at the end of the second semester can be considered independent of the Control group at the 5 percent level. In view of the fact that the Experimental group shows a lower number of drop-outs and higher retention in engineering it may be said that the pre-orientation program significantly improves survival. Although each of these tables show a lower value in one of their cells than is desirable for Chi Square analysis, the data in Tables 5.1-3 and 5.1-4 show the three survival categories of; Students Enrolled in Engineering, Students Enrolled in Non-Engineering, and Dropouts, colapsed into the two categories of; Students Enrolled in Engineering and Students Not Enrolled in Engineering. These tables, which do have adequate values in all cells, show the same result.

This same analysis was performed on the samples from the class of 1969, and are reported in Tables 5.1-5 through 5.1-8. In the case of the class of 1969 the results are slightly different, but the most tenable conclusion is the same. There is, however, an added value to the comparisons from the class of 1969 beyond verification of the class of 1966 results. The samples from the class of 1966 were drawn on the basis of attempting to balance mathematical ability, and the samples from the class of 1969 were drawn on the basis of

Table 5.1-1 -- Comparison of Survival Status of the Experimental and Control Groups of the Class of 1966 at the end of the First Semester (3 by 2 table)

	Students Enrolled in Engineering	Students Enrolled in Non-Engineering	Dropouts
Experimental	36	4	1
Control	37	10	9

Computed Chi Square = 6.83; Chi $\text{Square}_{05 \text{ at } 2 \text{ d.f.}}$ = 5.99

Table 5.1-2 -- Comparison of Survival Status of the Experimental and Control Groups of the Class of 1966 at the end of the Second Semester (3 by 2 table)

	Students Enrolled in Engineering	Students Enrolled in Non-Engineering	Dropouts
Experimental	33	3	5
Control	28	9	19

Computed Chi Square = 9.48; Chi $\text{Square}_{05 \text{ at } 2 \text{ d.f.}}$ = 5.99

Table 5.1-3 -- Comparison of Survival Status of the Experimental and Control Groups of the Class of 1966 at the end of the First Semester (2 by 2 table)

	Students Enrolled in Engineering	Students NOT Enrolled in Engineering
Experimental	36	5
Control	37	19

Computed Chi Square = 5.52; Chi $\text{Square}_{05 \text{ at } 1 \text{ d.f.}}$ = 3.84

Table 5.1-4 -- Comparison of Survival Status of the Experimental and Control Groups of the Class of 1966 at the end of the Second Semester (2 by 2 table)

	Students Enrolled in Engineering	Students NOT Enrolled in Engineering
Experimental	33	8
Control	28	28

Computed Chi Square = 3.95; Chi $\text{Square}_{05 \text{ at } 1 \text{ d.f.}}$ = 3.84

Table 5.1-5 -- Comparison of Survival Status of the Experimental and Control Groups of the Class of 1969 at the end of the First Semester (3 by 2 table)

	Students Enrolled in Engineering	Students Enrolled in Non-Engineering	Dropouts
Experimental	19	4	0
Control	12	9	2

Computed Chi Square = 5.50; Chi $\text{Square}_{05 \text{ at } 2 \text{ d.f.}}$ = 5.99

Table 5.1-6 -- Comparison of Survival Status of the Experimental and Control Groups of the Class of 1969 at the end of the Second Semester (3 by 2 table)

	Students Enrolled in Engineering	Students Enrolled in Non-Engineering	Dropouts
Experimental	13	6	4
Control	6	10	7

Computed Chi Square = 4.397; Chi $\text{Square}_{05 \text{ at } 2 \text{ d.f.}}$ = 5.99

Table 5.1-7 -- Comparison of Survival Status of the Experimental and Control Groups of the Class of 1969 at the end of the First Semester (2 by 2 table)

	Students Enrolled in Engineering	Students NOT Enrolled in Engineering
Experimental	19	4
Control	12	11

Computed Chi Square = 4.85; Chi $\text{Square}_{05 \text{ at } 1 \text{ d.f.}} = 3.84$

Table 5.1-8 -- Comparison of Survival Status of the Experimental and Control Groups of the Class of 1969 at the end of the Second Semester (2 by 2 table)

	Students Enrolled in Engineering	Students NOT Enrolled in Engineering
Experimental	13	10
Control	6	17

Computed Chi Square = 5.16; Chi $\text{Square}_{05 \text{ at } 1 \text{ d.f.}} = 3.84$

the Brown-Holtzman Study Skills Test. This matter will be explored later in this report (see Item 6.0, Discussion).

The results from the class of 1969 are displayed in the "three by two" Chi Square tables in 5.1-5 and 5.1-6. The values of Chi Square fall just short of producing significant differences, but the "two by two" tables do show significant differences. This apparent disparity may be because of the small sample sizes that are available, but it is more likely that the very low frequencies in several cells of the three by two tables invalidate the test. Therefore, the "two by two" tables were developed, where the cell frequencies are adequate. These results verify the conclusion reached with the class of 1966, i.e., that the pre-orientation program significantly improves survival. This is further borne out by the comparisons of all Experimental groups and all Control groups that follow.

An analysis of the comparisons of all Experimental and all Control groups on the basis of their survival at the end of the first and second semesters of the freshman year is shown by Figure 5.1-9 and Tables 5.1-10 through 5.1-13. Tables 5.1-10 and 5.1-11 show that at the end of the first and second semesters of the freshman year the fact of survival in the School of Engineering, transfer to other University programs, and dropouts are not independent of the year the sample was drawn for Experimental groups at the 5 percent level. It may then be said that while survival tends to be more difficult with the passage of time, all Experimental groups exhibit the same characteristics; and drawing from the previous argument it is clear that these characteristics are higher retention in engineering and lower dropout.

The same analysis for the Control groups, shown in Tables 5.1-12 and 5.1-13, show the same result at the end of the first semester but not at the end of the second semester. A significant difference is revealed between the

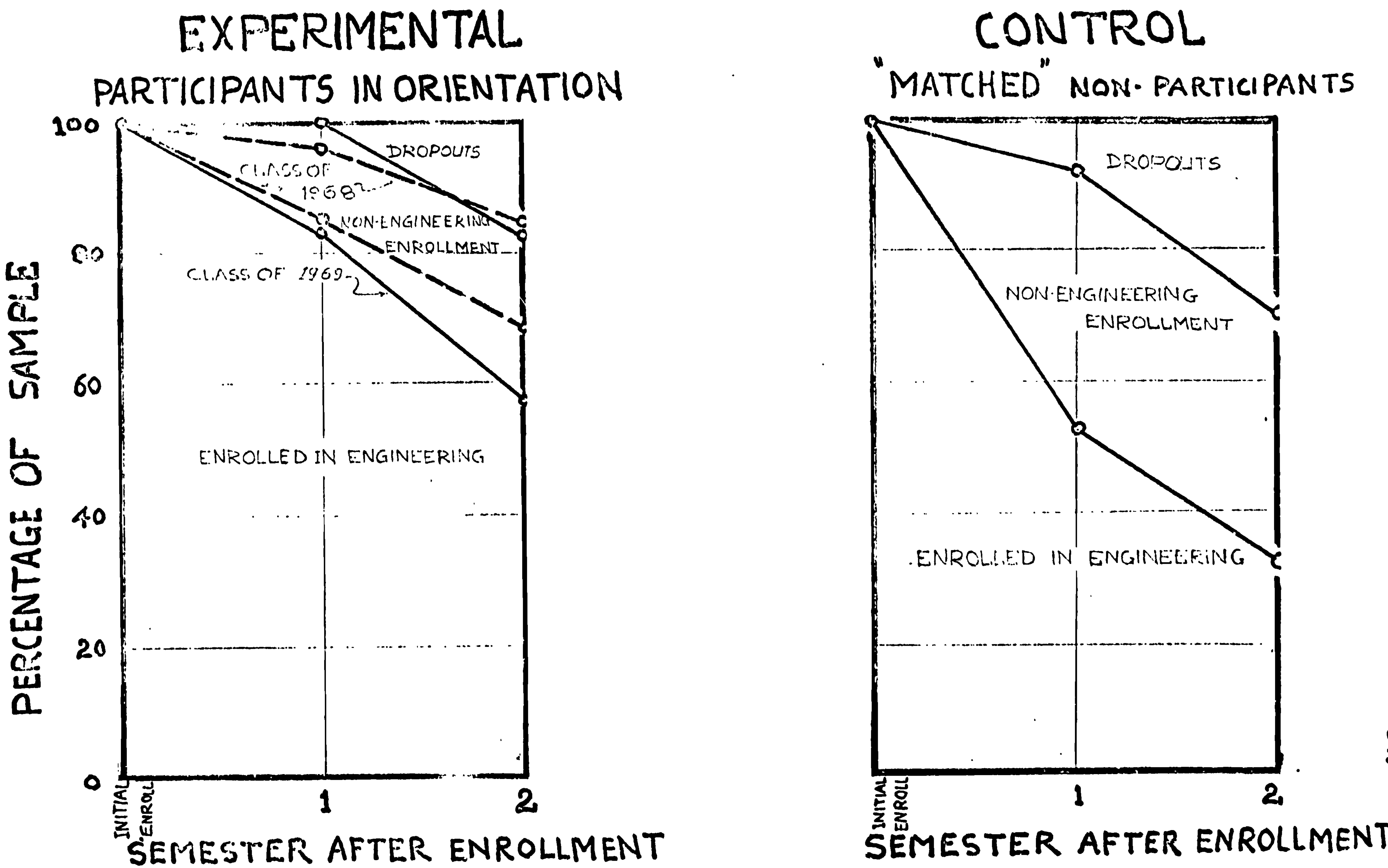

FIG. 5.1-9 STATIS OF SAMPLES AT THE END OF SEMESTER

Table 5.1-10-- Comparison of Survival Statis of Experimental Groups at the End of the First Semester

	Students Enrolled in Engineering	Students Enrolled in Non-Engineering	Dropouts
Class of 1966	36	4	1
Class of 1968	18	9	4
Class of 1969	19	4	0

Computed Chi Square = 2.27; Chi $Square_{05 \text{ at } 4 \text{ d.f.}}$ = 9.49

Table 5.1-11-- Comparison of Survival Statis of Experimental Groups at the End of the Second Semester

	Students Enrolled in Engineering	Students Enrolled in Non-Engineering	Dropouts
Class of 1966	33	3	5
Class of 1968	62	15	14
Class of 1969	13	6	4

Computed Chi Square = 7.32; Chi $Square_{05 \text{ at } 4 \text{ d.f.}}$ = 9.49

Table 5.1-12-- Comparison of Survival Statis of Control Groups at the End of the First Semester

	Students Enrolled in Engineering	Students Enrolled in Non-Engineering	Dropouts
Class of 1966	37	10	9
Class of 1969	12	9	2

Computed Chi Square = 4.21; Chi $Square_{05}$ at 2 d.f. = 5.99

Table 5.1-13 -- Comparison of Survival Statis of Control Groups at the End of the Second Semester

	Students Enrolled in Engineering	Students Enrolled in Non-Engineering	Dropouts
Class of 1966	28	9	19
Class of 1969	6	10	7

Computed Chi Square = 7.32; Chi $Square_{05}$ at 2 d.f. = 5.99

survival figures for the Control group from the class of 1966 and the Control group of the class of 1969 (see Table 5.1-13).

Comparison of the results from the Experimental groups of the classes of 1966, 1968, and 1969 show that the percent surviving in the School of Engineering at the beginning of the sophomore years falls from 80.5 percent for the class of 1966, to 68.11 percent for the class of 1968, to 56.6 percent for the class of 1969. While the drop in survival rate for the Experimental groups from 80.5 percent in 1966 to 56.6 percent in 1969 is considerable, it is more than matched by the drop in the survival rate of the matched Control groups for the same classes. In 1966, 50.0 percent of the Control group survived in engineering to the beginning of the sophomore year, while in the class of 1969 only 26.1 percent of the Control group was able to survive to the beginning of the sophomore year.

It is obvious that with the passage of time survival in the engineering program becomes much more difficult in an absolute sense, but that this survival is enhanced by approximately the same proportion by the orientation program. This increasing difficulty may be due to increasing difficulty of the curriculum, a more impersonal attitude toward the students as the University expands, administrative changes, or any number of variables or combinations. Because of the design of the study which drew Control and Experimental groups from the same entering classes, the trend of increasing difficulty can be treated as a variable exteraneous to the study, although it remains a serious matter from an administrative point of view.

From the foregoing, it would then appear that the figures describing the effect of the pre-freshman orientation program on the class of 1966 could not be duplicated for the other classes in an absolute sense. However, it remains reasonably clear that the differences that are obtained between the Experimental and the Control group for the class of 1966 could be extended to other classes on a relative basis.

In the curriculum of the School of Engineering at the University of Massachusetts there are 23 different courses that are required for graduation from all engineering students irrespective of their curriculum. The frequency with which the Control and Experimental group from the class of 1966 obtained letter grades of A, B, C, D, and F in their first attempt at these courses is tabulated in Table 5.1-14. These frequencies were analyzed by the Chi Square technique and significant differences are revealed in only two of the 23 courses. These differences are obtained in the first semester chemistry course, the course listed No. 12 in Table 5.1-14, and in the course in economics that is usually taken by engineering freshmen in their first semester, listed as No. 23 in Table 5.1-14. It is clear that when making 20 or more analyses by Chi Square at a criterion of 5 percent, at least one significant difference should be obtained by chance. It is indeed possible that both of these differences were obtained by chance, but it is interesting to note that both of these courses are ones ordinarily taken in the first semester of the freshman year.

If these differences are not due to chance, the evidence would indicate that the pre-freshman orientation program contributed to this difference, and further, it is notable that neither of these courses are particularly dependent on a background in mathematics, the basic subject matter of the orientation program. And, although the likelihood of obtaining one difference of this sort by chance is high, and the chances of obtaining two differences of this sort by chance are not unreasonable, these differences fit into a general pattern of argument that will be developed in the discussion portion of this report (see Section 6.0).

Table 5.1-14 -- Frequency of Grades in Selected Courses

No.			A	B	C	D	F	Significant Difference at 5%
1.	Math 5 (or 105)	Control	3	8	17	9	16	No
		Experimental	2	9	15	7	6	
2.	Math 5 (or 105)	Control	4	8	9	6	12	No
		Experimental	4	8	10	9	5	
3.	Math 31 (or 185)	Control	5	8	5	7	3	No
		Experimental	6	5	11	10	0	
4.	Math 32 (or 186)	Control	6	8	9	3	2	No
		Experimental	10	4	13	2	1	
5.	ME 1 (or Engin 103)	Control	7	16	21	2	5	No
		Experimental	6	11	18	3	1	
6.	ME 2 (or Engin 104)	Control	6	12	14	3	5	No
		Experimental	5	12	13	2	3	
7.	ME 63 (or ME 263)	Control	2	6	5	3	3	No
		Experimental	3	5	8	6	2	
8.	CE 34 (or 35 or 140)	Control	6	10	5	3	4	No
		Experimental	6	8	11	4	0	
9.	CE 52 (or 36 or 141)	Control	5	7	6	6	2	No
		Experimental	4	6	9	6	2	
10.	CE 53 (or 88 or 242)	Control	2	4	5	5	4	No
		Experimental	5	4	6	9	1	
11.	CE 75 (or 257)	Control	0	2	8	2	0	No
		Experimental	0	7	11	5	0	
12.	Chem 1 or 3	Control	4	16	14	9	11	Yes
	(or 111 or 113)	Experimental	3	15	18	1	0	
13.	Chem 2 or 4	Control	3	7	13	12	2	No
	(or 112 or 114)	Experimental	1	15	15	5	2	
14.	Physics 5 (or 105)	Control	3	15	13	7	6	No
		Experimental	6	17	7	5	1	
15.	Physics 6 (or 106)	Control	10	12	8	0	2	No
		Experimental	7	15	10	1	0	
16.	Physics 7 (or 107)	Control	5	3	14	2	2	No
		Experimental	4	3	15	4	3	
17.	English 1 (or 111)	Control	1	9	24	16	3	No
		Experimental	1	2	24	8	3	
18.	English 2 (or 112)	Control	0	8	15	15	5	No
		Experimental	1	8	19	8	1	
19.	English 25 (or 125)	Control	2	9	20	7	2	No
		Experimental	0	7	16	10	3	

Table 5.1-14 -- Frequency of Grades in Selected Courses (Cont.)

No.		A	B	C	D	F	Significant Difference at 5%
20. English 26 (or 126)	Control	0	9	18	8	0	No
	Experimental	1	8	15	6	1	
21. English 50 (or 331)	Control	3	12	7	0	0	No
	Experimental	3	18	4	1	0	
22. Speech 3 (or 101)	Control	3	8	21	7	0	No
	Experimental	0	7	18	2	0	
23. Econ. 25 (or 125)	Control	8	6	12	10	2	Yes
	Experimental	0	13	9	10	1	

Analysis of the data on the Experimental group from the class of 1968 is instructive. This group contained 91 students, and is more than twice the size of the Experimental sample from the class of 1966, and more than three times the size of the Experimental group in the class of 1969. Ninety-one students were admitted to the program and followed through the freshman year in an attempt to analyze whether or not the size of the group of students participating in the orientation program had an appreciable effect on the results obtained. Because all qualified students who applied were accepted in an attempt to secure a group as large as possible, it was impossible to obtain a control group for this sample. It was hoped that the initial measures of one of the Control groups from either the class of 1966 or 1969 would be similar enough to the group in the class of 1968 so that they could be used as a basis of comparison.

Tables 3.1-1 through Tables 3.1-6 show the analysis of variance comparisons between the initial measures on all the samples, and Table 3.1-7 summarizes the mean values. It is clear from these tables that the Control group from the class of 1969 is the best possible group against which the Experimental sample drawn from the class of 1968 can be compared. A Chi Square analysis of survival data comparing the Experimental group from the class of 1968 to the Control group of 1969 indicates significant differences are obtained at the end of both the first semester and the second semester (see Tables 5.1-15 and 5.1-16). The fact that the Experimental sample drawn from the class of 1968 responds in the same fashion as the other Experimental groups is also shown in the results of a Chi Square analysis in Table 5.1-10 and Table 5.1-11. This latter evidence tends to be the more convincing because the trends of the survival data described earlier indicate that some variable extraneous to the study is apparently causing survival to be lower

Table 5.1-15-- Comparison of Survival Status of the Class of 1968 Experimental Group and the Class of 1969 Control Group at the end of the First Semester

	Students Enrolled in Engineering	Students Enrolled in Non-Engineering	Dropouts
Class of 1968 Experimental	78	9	4
Class of 1969 Control	12	9	2

Computed Chi Square = 13.20; Chi Square$_{05 \text{ at } 2 \text{ d.f.}}$ = 5.99

Table 5.1-16-- Comparison of Survival Status of the Class of 1968 Experimental Group and the Class of 1969 Control Group at the end of the Second Semester

	Students Enrolled in Engineering	Students Enrolled in Non-Engineering	Dropouts
Class of 1968 Experimental	62	15	14
Class of 1969 Control	6	10	7

Computed Chi Square = 13.79; Chi Square$_{05 \text{ at } 2 \text{ d.f.}}$ = 5.99

in both Experimental and Control groups in later classes. If this is the case, comparing an Experimental group from an earlier year to a Control group of a later year tends to bias the results in favor of obtaining significant differences.

Although the argument is not entirely clear cut, the weight of evidence seems clearly to indicate that the size of the group going through the orientation program does not seem to effect its results within the ranges of figures investigated. However the comparisons are made, the three Experimental groups responded significantly better than the Control groups across the size range going from 23 participants, to 41 participants, to 91 participants.

5.2 The Remaining Years

The class of 1966 was followed through either ten semesters beyond their initial enrollment or graduation. During the first eight semesters this group was categorized as either being enrolled in engineering, enrolled within the University but in some non-engineering program, or as a dropout. Beginning with the eighth semester two additional categories are added; engineering graduates, and graduates from the University in non-engineering programs. The semester by semester status of the students in the Experimental and Control group is shown in Figure 5.2-1, and analysis of these categorizations is performed by Chi Square; the results are displayed in Tables 5.1-1, 5.1-2, and 5.2-2 through 5.2-10.

The most outstanding fact that is evident from an examination of Figure 5.2-1 is the proportion of students who remain enrolled in engineering. It appears to be much higher in the Experimental group than in the Control group. The figure also reveals a lower proportion of students both transferring to non-engineering programs, and dropping out of the Experimental group. These

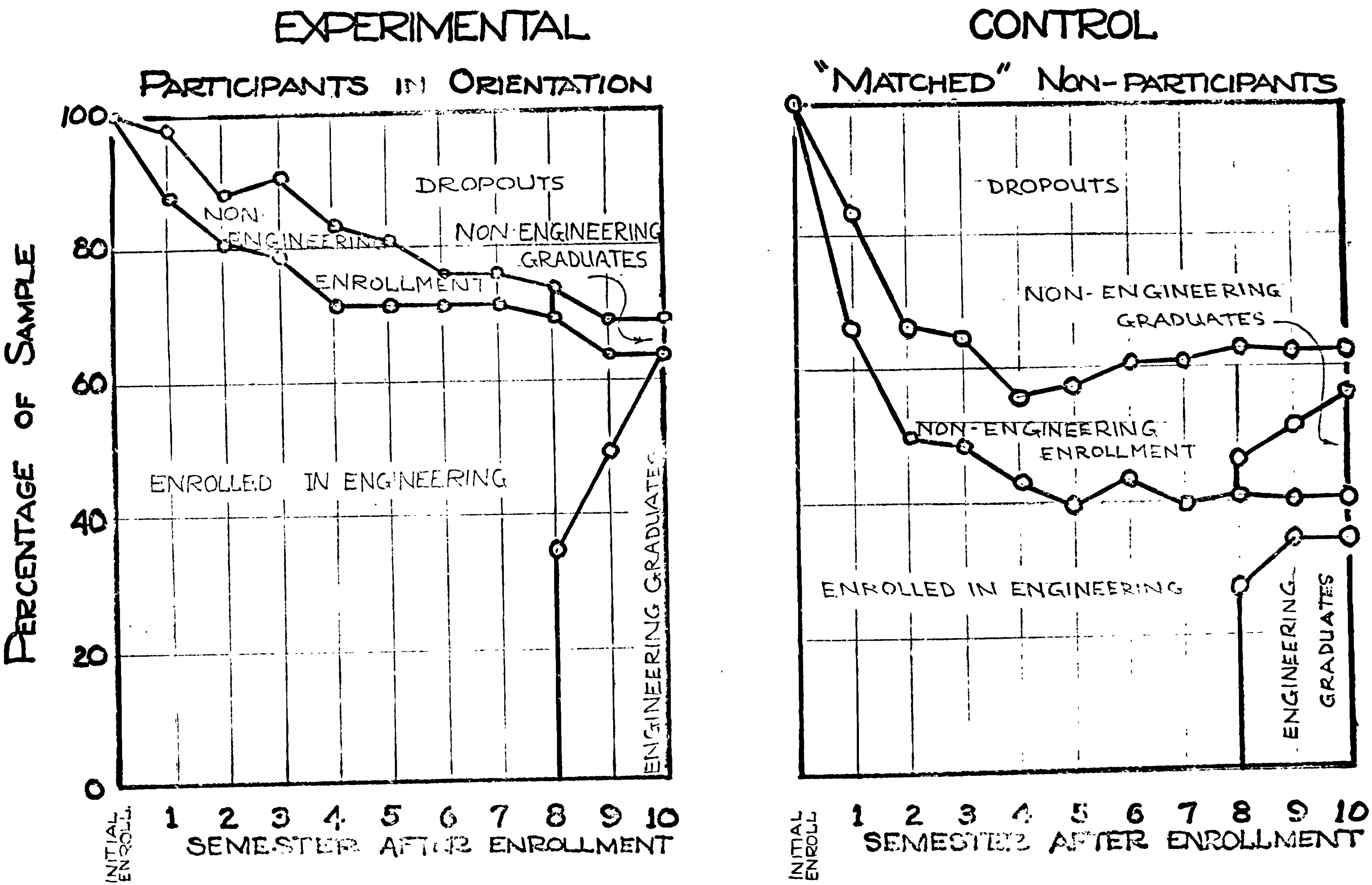

Fig. 5·2·1 STATIS OF CLASS OF 1966 SAMPLES AT END OF SEMESTER

Table 5.2-2 -- Comparison of Survival Status Between the Experimental and Control Groups of the Class of 1966 at the end of the Third Semester (3 by 2 table)

	Students Enrolled in Engineering	Students Enrolled in Non-Engineering	Dropouts
Experimental	32	4	5
Control	27	9	20

Computed Chi Square = 9.25; Chi Square$_{05 \text{ at } 2 \text{ d.f.}}$ = 5.99

Table 5.2-3 -- Comparison of Survival Status Between the Experimental and Control Groups of the Class of 1966 at the end of the Fourth Semester (3 by 2 table)

	Students Enrolled in Engineering	Students Enrolled in Non-Engineering	Dropouts
Experimental	29	6	6
Control	24	7	25

Computed Chi Square = 10.12; Chi Square$_{05 \text{ at } 2 \text{ d.f.}}$ = 5.99

Table 5.2-4 -- Comparison of Survival Status Between the Experimental and Control Groups of the Class of 1966 at the end of the Fifth Semester (3 by 2 table)

	Students Enrolled in Engineering	Students Enrolled in Non-Engineering	Dropouts
Experimental	29	5	7
Control	22	10	24

Computed Chi Square = 9.87; Chi $\text{Square}_{05 \text{ at } 2 \text{ d.f.}}$ = 5.99

Table 5.2-5 -- Comparison of Survival Status Between the Experimental and Control Groups of the Class of 1966 at the end of the Sixth Semester (3 by 2 table)

	Students Enrolled in Engineering	Students Enrolled in Non-Engineering	Dropouts
Experimental	29	3	9
Control	24	10	22

Computed Chi Square = 7.55; Chi $\text{Square}_{05 \text{ at } 2 \text{ d.f.}}$ = 5.99

Table 5.2-6 -- Comparison of Survival Status Between the Experimental and Control Groups of the Class of 1966 at the end of the Seventh Semester (3 by 2 table)

	Students Enrolled in Engineering	Students Enrolled in Non-Engineering	Dropouts
Experimental	29	3	9
Control	22	12	22

Computed Chi Square = 9.73; Chi $Square_{05}$ at 2 d.f. = 5.99

Table 5.2-7 -- Comparison of Survival Status Between the Experimental and Control Groups of the Class of 1966 at the end of the Third Semester (2 by 2 table)

	Students Enrolled in Engineering	Students NOT Enrolled in Engineering
Experimental	32	9
Control	27	29

Computed Chi Square = 8.84; Chi $Square_{05}$ at 1 d.f. = 3.84

Table 5.2-8 -- Comparison of Survival Status Between the Experimental and Control Groups of the Class of 1966 at the end of the Fourth Semester (2 by 2 table)

	Students Enrolled in Engineering	Students NOT Enrolled in Engineering
Experimental	29	12
Control	24	32

Computed Chi Square = 7.42; Chi $\text{Square}_{05 \text{ at } 1 \text{ d.f.}}$ = 3.84

Table 5.2-9 -- Comparison of Survival Status Between the Experimental and Control Groups of the Class of 1966 at the end of the Fifth Semester (2 by 2 table)

	Students Enrolled in Engineering	Students NOT Enrolled in Engineering
Experimental	29	12
Control	22	34

Computed Chi Square = 9.39; Chi $\text{Square}_{05 \text{ at } 1 \text{ d.f.}}$ = 3.84

Table 5.2-10 -- Comparison of Survival Status Between the Experimental and Control Groups of the Class of 1966 at the end of the Sixth Semester (2 by 2 table)

	Students Enrolled in Engineering	Students NOT Enrolled in Engineering
Experimental	29	12
Control	24	32

Computed Chi Square = 7.42; Chi Square$_{05 \text{ at } 1 \text{ d.f.}}$ = 3.84

Table 5.2-11 -- Comparison of Survival Status Between the Experimental and Control Groups of the Class of 1966 at the end of the Seventh Semester (2 by 2 table)

	Students Enrolled in Engineering	Students NOT Enrolled in Engineering
Experimental	29	12
Control	22	34

Computed Chi Square = 9.39; Chi Square$_{05 \text{ at } 1 \text{ d.f.}}$ = 3.84

inferences are supported by significant differences obtained in the Chi Square analyses presented in Tables 5.1-1, 5.1-2, and 5.2.2 through 5.2.11.

Beyond these initial observations there are other trends that deserve attention. It is clear that in both the Experimental and Control group there is an initial high rate of attrition from the engineering program If the transfer and dropout effects are considered together, it is clear that the initial attrition in the Experimental group seems to level off after four semesters. In the Control group this trend continues for five semesters.

When the number of dropouts are analyzed, it is noticed that the dropouts from the Experimental group continue at a more or less regular rate from the first up to the ninth semester. In the Control group, on the contrary, the dropouts seem to reach a maximum at the end of the fourth semester, after which some of these students return to the University and continue their work. Although the proportion of dropouts is higher in the Control group, the maximum is reached sooner.

The non-engineering enrollment presents an interesting contrast. The number of students transferring from the School of Engineering to some non-engineering program from the Experimental group reaches a maximum after approximately three to four semesters. In the Control group the number of students transferring from engineering to non-engineering programs does not reach its peak until somewhere between the fifth and seventh semesters. From this point onward the number of dropouts levels off, and apparently some students who have dropped out return to continue their programs toward degrees in non-engineering fields. While the return of dropouts to their higher education program is certainly desirable, and there is evidence that this is occuring in the Control group and not in the Experimental group, it should be pointed out that this phenomena is taking place at a much higher proportion of dropouts than ever occured in the Experimental group

An analysis of the status of the Experimental and Control groups by Chi Square is presented in Tables 5.1-1, 5.1-2, and 5.2-2 through 5.2-11. Tables 5.1-1, 5.1-2, and 5.2-2 through Table 5.2-6 show a Chi Square analysis in which the Experimental group is compared to the Control group for each of the first seven semesters, before graduation becomes a factor. The Experimental groups are categorized as being either enrolled in the School of Engineering, enrolled in the University in a non-engineering program, or as a dropout. These tables show that the categories into which the subjects from the Experimental group appear are independent of the categories in which subjects from the Control group appear, at the 5 percent level. Since the proportion of students retained in engineering is higher in the Experimental group at the end of each semester, we may conclude that the Experimental group retained a significantly higher proportion of students in the engineering program.

Unfortunately the cell frequencies in some of these tables are lower than is desirable for Chi Square analysis. One of these tables has two cells with values under five, four of these tables have one cell with a value under five. For this reason an additional analysis was made in which the subjects in the Experimental and Control groups were categorized into only two categories. The categories used are, Students Enrolled in Engineering, and Students Not Enrolled in Engineering. In this latter analysis significant differences are obtained in all cases verifying the previous results.

An analysis of variance was performed on the grade-point averages that students in the Experimental and Control groups received at the end of each semester. These figures are analyzed two different ways, first the grade-point averages for students in the Experimental and Control groups who were still enrolled in engineering are compared (Tables 5.2-12 through 5.2-21). Second, a comparison of the semester grade-point averages is made for the Experimental and Control group for all students who are in the University at the end of the semester, whatever their curriculum--engineering or otherwise (Tables 5.2-22 through 5.2-31).

As was mentioned earlier, grade-point average comparisons are not a sensitive measure of the performance of these groups. Individuals whose performance falls below certain levels are dismissed from the institution, which truncates the grade-point distributions. When truncated distributions are compared the results of the analysis of variance are not particularly useful.

The first comparison of the grade-point averages between the Experimental and Control group, for only students enrolled in engineering, shows that the Experimental group obtained higher averages than the Control group at the end of five of the ten semesters, and that the Control group obtained higher averages than the Experimental group at the end of five semesters. In only one case was the difference significant, and this occured at the end of the second semester when the difference favored the Experimental group.

The comparison of grade-point averages for all students who remained in the University, irrespective of their curriculum, shows that at the end of seven of the ten semesters the Experimental group had higher grade-point averages than did the Control group. At the end of three semesters the Control group exhibited higher grade-point averages than the Experimental group. In only two cases were these differences significant, the end of the second semester and at the end of the tenth semester; both of these differences favored the Experimental group.

Table 5.2-12 -- Comparison of Semester Grade Point Averages Between the Portion of the Experimental and Control Groups of the Class of 1966 Still Enrolled in Engineering at the End of the First Semester

	Experimental	Control
Sample Size	36	47
Mean Grade Point Average	2.2278	1.9532
Standard Deviation	.5665	.8627

Analysis of Variance

	Sum of Squares	DF	Mean Square	F Ratio
Between Groups	1.5370	1	1.5370	2.7381
Within Groups	45.4692	81	0.5613	
Total	47.0063	82		

F_{05} at 1/80 d.f. = 3.11

Table 5.2-13 -- Comparison of Semester Grade Point Averages Between the Portion of the Experimental and Control Groups of the Class of 1966 Still Enrolled in Engineering at the End of the Second Semester

	Experimental	Control
Sample Size	34	39
Mean Grade Point Average	2.3588	1.9821
Standard Deviation	.6425	.8451

Analysis of Variance

	Sum of Squares	DF	Mean Square	F Ratio
Between Groups	2.5786	1	2.5786	4.4916
Within Groups	40.7898	71	.5741	
Total	43.3384	72		

$F_{05 \text{ at } 1/70 \text{ d.f.}} = 3.98$

Table 5.2-14 -- Comparison of Semester Grade Point Averages Between the Portion of the Experimental and Control Groups of the Class of 1966 Still Enrolled in Engineering at the End of the Third Semester

	Experimental	Control
Sample Size	31	30
Mean Grade Point Average	2.1097	2.2067
Standard Deviation	.6963	.8030

Analysis of Variance

	Sum of Squares	DF	Mean Square	F Ratio
Between Groups	.1434	1	.1434	.2545
Within Groups	33.2458	59	.5635	
Total	33.3892	60		

F_{05} at 1/60 d.f. = 4.00

Table 5.2-15 -- Comparison of Semester Grade Point Averages Between the Portion of the Experimental and Control Groups of the Class of 1966 Still Enrolled in Engineering at the End of the Fourth Semester

	Experimental	Control
Sample Size	29	30
Mean Grade Point Average	2.4069	2.0800
Standard Deviation	.6508	.9622

Analysis of Variance

	Sum of Squares	DF	Mean Square	F Ratio
Between Groups	1.5758	1	1.5758	2.3205
Within Groups	38.7066	57	.6791	
Total	40.2824	58		

$F_{05 \text{ at } 1/55 \text{ d.f.}} = 4.02$

Table 5.2-16 -- Comparison of Semester Grade Point Averages Between the Portion of the Experimental and Control Groups of the Class of 1966 Still Enrolled in Engineering at the End of the Fifth Semester

	Experimental	Control
Sample Size	28	26
Mean Grade Point Average	2.3357	2.3000
Standard Deviation	.6816	.8579

Analysis of Variance

	Sum of Squares	DF	Mean Square	F Ratio
Between Groups	.0172	1	.0172	.0289
Within Groups	30.9443	52	.5951	
Total	30.9615	53		

F_{05} at 1/50 d.f. = 4.03

Table 5.2-17 -- Comparison of Semester Grade Point Averages Between the Portion of the Experimental and Control Groups of the Class of 1966 Still Enrolled in Engineering at the End of the Sixth Semester

	Experimental	Control
Sample Size	27	25
Mean Grade Point Average	2.4259	2.4960
Standard Deviation	.7769	.7950

Analysis of Variance

	Sum of Squares	DF	Mean Square	F Ratio
Between Groups	.0637	1	.0637	.1033
Within Groups	30.8615	50	.6172	
Total	30.9252	51		

$F_{05 \text{ at } 1/50 \text{ d.f.}} = 4.03$

Table 5.2-18 -- Comparison of Semester Grade Point Averages Between the Portion of the Experimental and Control Groups of the Class of 1966 Still Enrolled in Engineering at the End of the Seventh Semester

	Experimental	Control
Sample Size	28	25
Mean Grade Point Average	2.4143	2.4240
Standard Deviation	.6731	.9080

Analysis of Variance

	Sum of Squares	DF	Mean Square	F Ratio
Between Groups	.0012	1	.0012	.0020
Within Groups	32.0199	51	.6278	
Total	32.0211	52		

F_{05} at 1/50 d.f. = 4.03

Table 5.2-19 -- Comparison of Semester Grade Point Averages Between the Portion of the Experimental and Control Groups of the Class of 1966 Still Enrolled in Engineering at the End of the Eighth Semester

	Experimental	Control
Sample Size	27	24
Mean Grade Point Average	2.5889	2.6625
Standard Deviation	.7541	.5190

Analysis of Variance

	Sum of Squares	DF	Mean Square	F Ratio
Between Groups	.0688	1	.0688	.1608
Within Groups	20.9829	49	.4282	
Total	21.0518	50		

F_{05} at 1/48 d.f. = 4.04

Table 5.2-20 -- Comparison of Semester Grade Point Averages Between the Portion of the Experimental and Control Groups of the Class of 1966 Still Enrolled in Engineering at the End of the Ninth Semester

	Experimental	Control
Sample Size	17	11
Mean Grade Point Average	2.1882	2.8091
Standard Deviation	.9643	.6655

Analysis of Variance

	Sum of Squares	DF	Mean Square	F Ratio
Between Groups	2.5743	1	2.5743	3.4668
Within Groups	19.3067	26	.7426	
Total	21.8811	27		

F_{05} at 1/26 d.f. = 4.23

Table 5.2-21 -- Comparison of Semester Grade Point Averages Between the Portion of the Experimental and Control Groups of the Class of 1966 Still Enrolled in Engineering at the End of the Tenth Semester

	Experimental	Control
Sample Size	6	7
Mean Grade Point Average	2.8167	2.1571
Standard Deviation	.4215	.8384

Analysis of Variance

	Sum of Squares	DF	Mean Square	F Ratio
Between Groups	1.4053	1	1.4053	3.0278
Within Groups	5.1055	11	.4641	
Total	6.5108	12		

F_{05} at 1/11 d.f. = 4.84

Table 5.2-22 -- Comparison of Semester Grade Point Averages Between the Experimental and Control Groups of the Class of 1966, Whatever Their Curriculum, at the End of the First Semester

	Experimental	Control
Sample Size	39	53
Mean Grade Point Average	2.1513	1.8509
Standard Deviation	.6303	.8805

Analysis of Variance

	Sum of Squares	DF	Mean Square	F Ratio
Between Groups	2.0266	1	2.0266	3.2918
Within Groups	55.4099	90	.6157	
Total	57.4365	91		

F_{05} at 1/90 d.f. = 3.95

Table 5.2-23 -- Comparison of Semester Grade Point Averages Between the Experimental and Control Groups of the Class of 1966, Whatever Their Curriculum, at the End of the Second Semester

	Experimental	Control
Sample Size	40	46
Mean Grade Point Average	2.2775	1.9196
Standard Deviation	.6639	.8458

Analysis of Variance

	Sum of Squares	DF	Mean Square	F Ratio
Between Groups	2.7411	1	2.7411	4.6627
Within Groups	49.3821	84	.5879	
Total	52.1233	85		

F_{05} at 1/80 d.f. = 3.96

Table 5.2-24 -- Comparison of Semester Grade Point Averages Between the Experimental and Control Groups of the Class of 1966, Whatever Their Curriculum, at the End of the Third Semester

	Experimental	Control
Sample Size	35	36
Mean Grade Point Average	2.0771	2.1250
Standard Deviation	.7125	.8244

Analysis of Variance

	Sum of Squares	DF	Mean Square	F Ratio
Between Groups	.0406	1	.0406	.0683
Within Groups	41.0492	69	.5949	
Total	41.0899	70		

F_{05} at 1/70 d.f. = 3.98

Table 5.2-25 -- Comparison of Semester Grade Point Averages Between the Experimental and Control Groups of the Class of 1966, Whatever Their Curriculum, at the End of the Fourth Semester

	Experimental	Control
Sample Size	34	37
Mean Grade Point Average	2.3794	2.0703
Standard Deviation	.6480	.8866

Analysis of Variance

	Sum of Squares	DF	Mean Square	F Ratio
Between Groups	1.6933	1	1.6933	2.7718
Within Groups	42.1529	69	.6109	
Total	43.8462	70		

$F_{05\ 1/70\ d.f.} = 3.98$

Table 5.2-26 -- Comparison of Semester Grade Point Averages Between the Experimental and Control Groups of the Class of 1966, Whatever Their Curriculum, at the End of the Fifth Semester

	Experimental	Control
Sample Size	33	32
Mean Grade Point Average	2.2606	2.2156
Standard Deviation	.7754	.8053

Analysis of Variance

	Sum of Squares	DF	Mean Square	F Ratio
Between Groups	.0329	1	.0329	.0526
Within Groups	39.3410	63	.6245	
Total	39.3738	64		

F_{05} at 1/60 d.f. = 4.00

Table 5.2-27 -- Comparison of Semester Grade Point Averages Between the Experimental and Control Groups of the Class of 1966, Whatever Their Curriculum, at the End of the Sixth Semester

	Experimental	Control
Sample Size	31	34
Mean Grade Point Average	2.3742	2.4735
Standard Deviation	.8017	.7436

Analysis of Variance

	Sum of Squares	DF	Mean Square	F Ratio
Between Groups	.1600	1	.1600	.2686
Within Groups	37.5255	63	.5956	
Total	37.6855	64		

F_{05} at 1/60 d.f. = 4.00

Table 5.2-28 -- Comparison of Semester Grade Point Averages Between the Experimental and Control Groups of the Class of 1966, Whatever Their Curriculum, at the End of the Seventh Semester

	Experimental	Control
Sample Size	31	34
Mean Grade Point Average	2.4161	2.3971
Standard Deviation	.7202	.8426

Analysis of Variance

	Sum of Squares	DF	Mean Square	F Ratio
Between Groups	.0059	1	.0050	.0095
Within Groups	38.9916	63	.6189	
Total	38.9975	64		

F_{05} at 1/60 d.f. = 4.00

Table 5.2-29 -- Comparison of Semester Grade Point Averages Between the Experimental and Control Groups of the Class of 1966, Whatever Their Curriculum, at the End of the Eighth Semester

	Experimental	Control
Sample Size	30	36
Mean Grade Point Average	2.6200	2.5583
Standard Deviation	.7265	.5206

Analysis of Variance

	Sum of Squares	DF	Mean Square	F Ratio
Between Groups	.0622	1	.0622	.1606
Within Groups	24.7955	64	.3874	
Total	24.8577	65		

F_{05} at 1/65 d.f. = 3.99

Table 5.2-30 -- Comparison of Semester Grade Point Averages Between the Experimental and Control Groups of the Class of 1966, Whatever Their Curriculum, at the End of the Ninth Semester

	Experimental	Control
Sample Size	18	20
Mean Grade Point Average	2.1944	2.5850
Standard Deviation	.9359	.6409

Analysis of Variance

	Sum of Squares	DF	Mean Square	F Ratio
Between Groups	1.4451	1	1.4451	2.2922
Within Groups	22.6949	36	.6304	
Total	24.1400	37		

F_{05} at 1/36 d.f. = 4.11

Table 5.2-31 -- Comparison of Semester Grade Point Averages Between the Experimental and Control Groups of the Class of 1966, Whatever Their Curriculum, at the End of the Tenth Semester

	Experimental	Control
Sample Size	7	13
Mean Grade Point Average	2.8000	2.1108
Standard Deviation	.3873	.6238

Analysis of Variance

	Sum of Squares	DF	Mean Square	F Ratio
Between Groups	2.1614	1	2.1614	6.9847
Within Groups	5.5701	18	.3094	
Total	7.7315	19		

F_{05} at 1/18 d.f. = 4.41

It would appear from the above comparisons of grade-point averages that the Experimental group who participated in the pre-orientation program performed at least as well as those who did not, and although no consistent significant differences were obtained (probably due to truncated distributions) all differences that were significant favored the Experimental group. Interestingly enough, a larger proportion of differences favoring the Experimental group were obtained when the samples were compared irrespective of their curriculum than were obtained when only students in the School of Engineering were compared. Again it should be remembered that the subject matter of the pre-orientation program was primarily mathematical, yet differences are being revealed in performance in non-mathematical areas. This clue will be developed further (see Item 6.0, Discussion).

5.3 Graduation

Graduation is the primary criterion of success of the pre-orientation program. The most important single fact developed from this study is that at the end of ten semesters, 63.5 percent of the Experimental sample received degrees in engineering compared to only 33.9 percent of the Control group. The pre-orientation program increased the proportion of graduates from the School of Engineering at the end of ten semesters by 87.5 percent.

At the end of ten semesters there are no students from the Experimental group who still remain in school; all have either received degrees or become dropouts. In the Control group at the end of ten semesters 14.2 percent still remain in school, 7.1 percent are still enrolled in engineering and 7.1 percent are enrolled in some non-engineering program. A careful analysis of the academic record of these individuals indicate that approximately one half of those still enrolled in Engineering will probably receive their degrees with little difficulty, and the other half are marginal. The same proportions hold true for students still enrolled in non-engineering programs.

The Control group shows a larger proportion receiving degrees in non-engineering fields, 14.2 percent compared to 4.8 percent. However, all students in the Experimental group who were enrolled in non-engineering programs at the end of the seventh semester have received their degree by the end of the eighth semester, while approximately one third of the students in the Control group enrolled in non-engineering programs at the end of the seventh semester received their degrees at the end of the eighth semester, another one third of these students received their degrees by the end of the tenth semester, and the remaining third are still enrolled at the end of ten semesters.

A comparison of the total proportion of graduates from the Experimental and Control groups shows that 68.3 percent of the Experimental group received some degree by the end of ten semesters, compared to only 48.1 percent of the Control group. Students who participated in the engineering orientation program receive approximately 50 percent more degrees than the students who did not participate when degrees of all sorts are considered.

The differences between the Experimental and Control group in the number of degrees awarded, and the number of engineering degrees awarded, are shown in Tables 5.3-1 and 5.3-2.

5.4 Transfer Students from Engineering

All of the original samples drawn were students enrolled at the beginning of their freshman year in the School of Engineering. Students who, for any reason, left the School of Engineering followed one of two alternate routes.

Table 5.3-1 -- Comparison of the Graduates, Irrespective of Curriculum, Between Experimental and Control Groups of the Class of 1966 After Ten Semesters

	Graduates	Non Graduates
Experimental	28	13
Control	27	29

Computed Chi Square = 3.89; Chi $\text{Square}_{05 \text{ at } 1 \text{ d.f.}} = 3.84$

Table 5.3-2 -- Comparison of Engineering Graduates Only Between The Experimental and Control Groups of the Class of 1966 After Ten Semesters

	Engineering Graduates	Students Not Receiving Engineering Degrees
Experimental	26	15
Control	19	37

Computed Chi Square = 8.27; Chi $\text{Square}_{05 \text{ at } 1 \text{ d.f.}} = 3.84$

They either transferred to some other degree department within the University, or they left the University and became a "dropout."

Figure 5.4-1 describes the students who transferred from the School of Engineering to other degree departments in the University. It shows not only the numbers of students who transferred from the Experimental and the Control group separately, but the time at which these transfers took place measured in semesters after their first enrollment.

It is evident from Figure 5.4-1 that the Control group has a higher proportion of transfers at every point after their initial enrollment. Some of the students who transferred from engineering to other degree granting departments eventually became dropouts, or in one case transferred back into the School of Engineering. All transfers out of the School of Engineering, from both the Experimental and Control groups, occured before the end of the sophomore year (fourth semester).

Those students who remained in non-engineering programs and continued toward graduation exhibit some interesting contrasts. Examination of Figure 5.2-1 shows that the non-engineering enrollment in the Experimental group decreases across the junior year (the fourth through the sixth semester) while the dropouts increase the same amount. This means that some of the students transferring from engineering in the Experimental group often did not remain very long in their non-engineering program, but left school as dropouts. In contrast to this, the Control group shows an increase in non-engineering enrollment during the fourth through sixth semesters. This increase is not caused by additional transfers from engineering, rather it is caused by students who have previously dropped out of the University and were readmitted. These readmitted students apparently did reasonably well because after the sixth semester the non-engineering enrollment in the Control

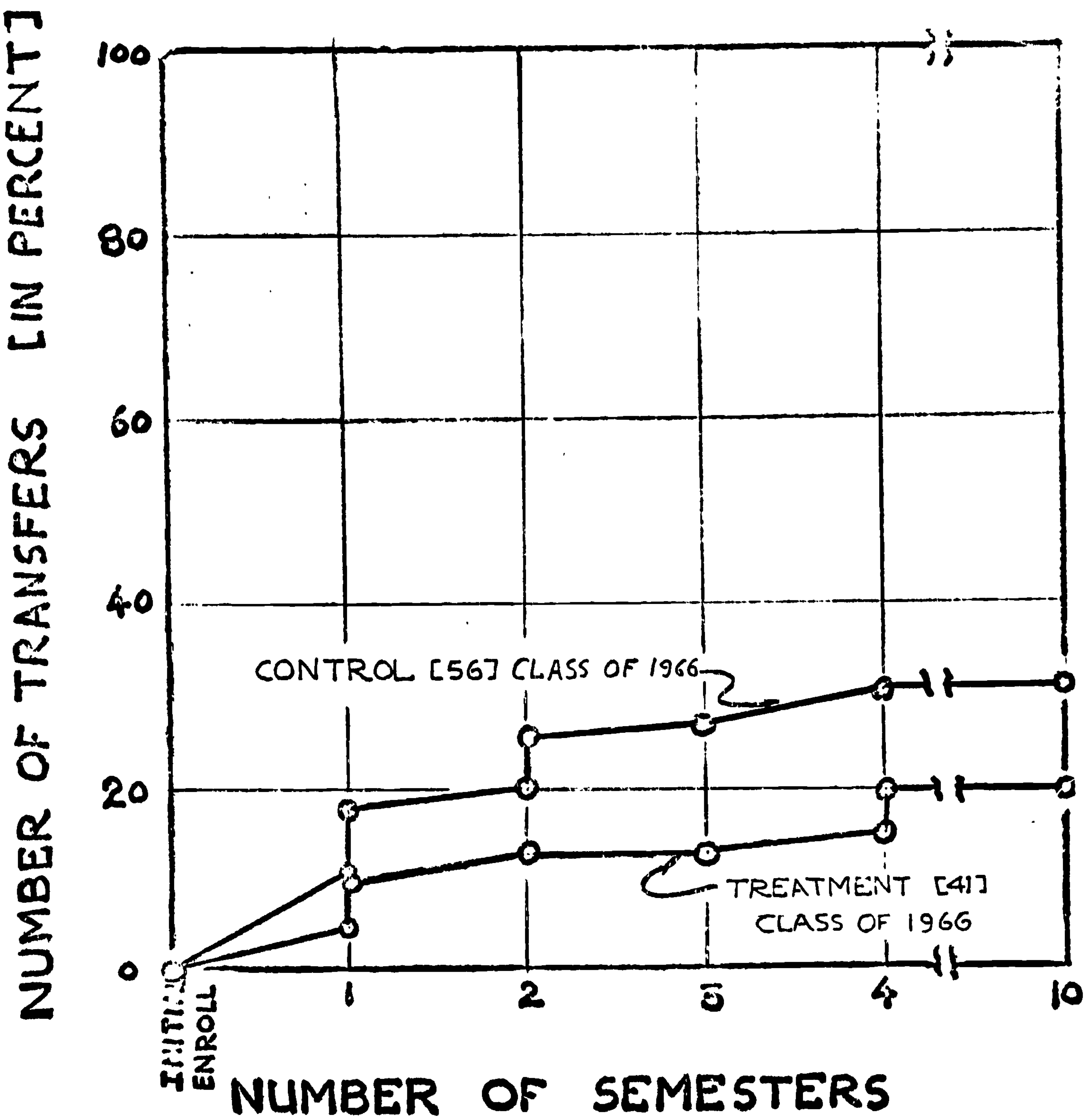

FIG. 5·4-1 PERCENT OF SAMPLES FROM CLASS OF 1966 TRANSFERING FROM ENGINEERING BY SEMESTER group remained relatively stable through the tenth semester. Beyond the sixth semester the enrollment in non-engineering programs of the Experimental sample also remains stable.

An examination of the graduation of these students enrolled in non-engineering programs is also instructive. All those students in the Experimental group who transferred to non-engineering programs, and who did not drop out, received degrees at the end of eight semesters. In contrast to this, the students who transferred to non-engineering programs from the Control group performed quite differently. Approximately one third of the non-engineering enrollment in the Control group received degrees after eight semesters, another one third of these students received degrees by the end of the tenth semester and the remaining third were still enrolled at this time. A careful analysis of the academic record of these students who are still enrolled in non-engineering programs at the end of ten semesters reveals approximately half of them have extremely good chances of eventual graduation, and the other half are marginal students for whom the issue is still very much in doubt.

In summary, it appears that the pre-freshman orientation program tends to reduce the number of transfer students from the School of Engineering in a substantial way, the students who did not participate in the orientation program tended to have a better survival rate once they had transferred, and finally, the students who participated in the orientation program and who transferred to non-engineering programs tended to receive degrees sooner and in a higher proportion than did the transfer students who did not have the benefit of the program.

6.0 Discussion

The two-week pre-engineering orientation program was instituted primarily to help ease the transition between high school and the first year of the engineering curriculum. It is clear that the program does this, and much more for some individuals.

The evidence indicates that the pre-engineering orientation program will increase a student's chances of remaining enrolled in engineering at the beginning of the sophomore year by more than 50 percent. It will more than cut in half his chances of being a dropout by the beginning of the sophomore year. It will reduce his chances of becoming a dropout after ten semesters by approximately 20 percent. It will almost double his chances of receiving an engineering degree by the end of ten semesters. It will increase his chances of obtaining some degree by almost 50 percent.

These facts are verified by carefully drawn samples from three separate entering classes, in which all samples are balanced for their desire to participate in the program, and with one pair of Experimental and Control groups balanced for mathematical ability, and another pair of Experimental and Control groups balanced for their study skills as measured by the Brown-Holtzman Test of Study Skills.

These results of the several experiments come through so clearly there is little room left for doubt concerning the fact that the pre-freshman orientation program increases a student's chances for survival and graduation. The interesting question at this point is--why does this occur?

There are several tenable hypothesis concerning the cause of the differences obtained by the program. The first, and perhaps the most obvious hypothesis, is that the extra preparation the students receive gives them additional knowledge with which to meet their task of survival through the undergraduate program to graduation. If this hypothesis were true the extra mathematics preparation the students receive during the two-week program apparently so strengthens their background that these students are more capable of coping with problems of the freshman engineering curriculum. It is certainly true that a freshman engineering program is both directly and indirectly dependent on mathematics. The freshman engineer takes as many credit hours of mathematics as do mathematics majors, and in addition is required to take a course in computer programming using elementary numerical methods, and a course in physics that requires calculus to solve problems.

When the results of the experimental work are examined for evidence in connection with this hypothesis several facts are revealed:

1. No significant differences were found between the Experimental and Control groups in grades they received in any mathematics course.
2. No significant differences were found between the Experimental and Control groups in their grades in the freshman course in computer programming and numerical methods.
3. No significant differences were found between the Experimental and Control groups in their grades in the freshman physics course which relies heavily on mathematics.

Further, the history of remedial and cram courses throughout the literature indicates that significant differences are ordinarily obtained immediately following such courses, and as time goes on these differences tend to disappear. In the present case, survival in engineering which is the most reliable measure of the success of the program tends to show larger differences as time goes on, thus indicating the most reliable measures of success do not respond in a way that is typical of remedial or cram courses. From an intuitive point of view one other bit of evidence is available. It seems unlikely that a two-week session in mathematics would remedy all the deficiencies the participants had developed through twelve years of primary and secondary schooling, and then cause them to go on and perform at such a much higher level than would be the case had they not had this two-week exposure.

It would appear then, that the success obtained by the program is not because the students had two extra weeks of substantive mathematical training.

Why then, does the two-week orientation program achieve the success that it does? If the success does not depend upon the nature of the substantive material that is studied during this time, we are driven to ask questions concerning the possibility that the success is due to changes that may occur in the attitudes of the students who participate in the program.

An examination of the evidence surrounding the hypothesis that the success of the program is due to the changes in the way the participants regard themselves in their role as a student, and their attitudes toward their academic work, reveals the following.

1. The only significant differences obtained between the Experimental and Control group in performance in individual courses was in the first semester chemistry course, and in an economics course ordinarily taken by freshmen. Both of these differences favor the Experimental group. These courses are not highly dependent on mathematics, but rather on generalized student skills such as the diligent application of intellectual effort.
2. Significant differences in survival were found between the Experimental and Control groups constituted from the class of 1969, which were balanced on the basis of the Brown-Holtzman Study Skills Test rather than on mathematics, as were the Experimental and Control groups from the class of 1966. Balancing samples by this criterion produced essentially the same results as did balancing samples on the basis of mathematics background.

3. When semester grade-point averages are compared more differences favoring the Experimental group are found than those favoring the Control group. The only significant differences obtained favored the Experimental group. A higher proportion of differences favoring the Experimental group was found when the comparison was made irrespective of the curriculum than was obtained when only students enrolled in engineering were compared. If mathematics ability, rather than general student study skills, were the primary difference between the Experimental and Control groups the reverse of these findings would be expected.

4. Even though the pre-orientation program was focused on mathematical training, the students who transfer from engineering to some non-engineering program tend to have a better survival rate once they have transferred, and tend to receive their degrees sooner and in higher proportion than did the students who transferred from engineering who were in the Control group.

5. Fundamental changes in attitude toward academic life do explain the fact that differences in survival between the Experimental and Control group tend to get larger as these groups progress through their academic career.

6. There does not seem to be any evidence either in the results of the measures taken, or in the opinion of the faculty members who have dealt with these students to refute this hypothesis.

While the foregoing arguments cannot be said to present either proof or rejection of this hypothesis, in a statistical sense, it is nevertheless convincing to this investigator. Certainly, additional studies need to be made before this hypothesis can be considered "proved," and these studies should be implemented forthwith.

No examination was made of the length of the course as a variable. It is entirely possible that the same objectives could be achieved with a shorter program, or the possibility exists that much more beneficial results could be obtained from a program only slightly longer. While it is felt that this variable deserves investigation, those who have participated in this program over the past five years have intuitively felt that the two-week length is about right. The consensus of those working with the program is that the morale of the students tends to be very high the first two or three days, after which it seems to fall off toward the end of the first week, apparently because of the mounting pressure of the work assigned. The students' morale usually continues low through the beginning of the second week and then tends to climb to an enthusiastic level by the end of the program. Perhaps this same pattern would be evident on a somewhat shorter or longer schedule, but this seems unlikely to those with experience with the program. While this evidence certainly cannot be considered as definitive, it is presented for whatever value it may have to the reader.

7.0 Conclusions and Future Work

The effect of the two-week pre-freshman engineering orientation program, which has been designed around substantive material of high face validity to the subsequent engineering curriculum is to increase the students' chances of survival, not only as an engineering student, but in other programs if he chooses to transfer to them. It nearly doubles his chances of graduation in engineering, and increases his chances of getting some degree by almost 50 percent.

On the basis of indirect evidence, it is thought that the reason for this effect is that the program changes the attitudes of the student. It is felt that the student better understands his own role and responsibilities in his higher education experience. These inferences need to be verified by further experimental work that is designed particularly for this purpose.

Within the range investigated, the number of students participating in the program does not seem to have an appreciable effect on the outcome of the program.

On an intuitive basis it is felt that the two-week length is as short as it can be and still meet the objectives of the program.

APPENDIX A

Dropouts

> Why do approximately half the students in American colleges and universities leave before advancing their education to the point of an undergraduate degree? The extensive literature addressed to this question yields neither adequate nor conclusive answers. The dropout problem has been of continuing concern to educators and has been subject to perennial rediscovery in the research literature. Research on college student dropouts, college student attrition, has a history of at least 40 years.

The above was written by Summerskill[2], presumably about 1962. In this chapter of The American College, Summerskill reviews the research and makes inferences and recommendations. In the article he cites 181 references and organizes and presents this material in an extremely lucid way. Since this was written, articles have appeared in the technical literature at the rate of some 15 to 20 a year, and there seems to be no shortage of ideas concerning variables to be investigated in order to help predict dropouts. A recent report[3] of Princeton University Conference held in 1964 has also made its contribution. Most of the researchers managed to obtain significant differences.

In summary, it appears that age in college or at matriculation, sex, or hometown origin (when balanced for cultural opportunities and curriculum of secondary schools) make no clear difference to survival in a college program. Measurable variables that have been analyzed that do show significant differences are socio-economic origins, secondary school performance, and academic aptitude measures.

The reasons for students dropping out of college have been classified a number of different ways, most researchers agreeing that lack of motivation, poor academic performance, financial problems, and illness and injury are the most important causes. There are many studies to indicate that these reasons are neither independent, nor do they operate singly with individuals. It is particularly interesting to note that Summerskill[1] reports that the literature describes anywhere from 3 to 78 percent of the dropouts being due to academic failure, with a median value of 33 percent. He expresses concern that this may be effect rather than cause; and points out the basic cause of the poor academic performance that triggered academic dismissals was identified by most writers as lack of motivation.

Summerskill[2] ends his analysis of the college dropout with recommendations for further research. His primary recommendation is to investigate the changes in motivation of the individuals as they go through their college career.

Motivation is a variable that has defied precise numerical measurement at the present state of the art. In thinking about students who drop out, and students who survive in a program, a useful way to operationally define motivation might be to analyze the academic objectives of the students. By attempting to scale in some way the degree to which the student will cling to these objectives in spite of obstacles it can be said a scale of student "motivation" would be created. This would create a scale of the students' identification with some tangible academic goal described in the catalogue of the college to which he goes. While in actual practice this procedure might be exceedingly difficult, or even impossible, at a conceptual level we can start with this as a base and then make some reasonable hypotheses about how the students' survival would relate to this "motivation" scale. Most writers would probably agree with the following:

1. The lower the "motivation," as described above, the less chance a student has of going through to graduation, and conversly the higher the "motivation" the better the chance of going through to graduation.

2. A student should start with a reasonably well defined academic goal and his "motivation" toward this goal should tend to increase and be higher at the time of graduation than at the time of entrance.
3. To the extent that "motivation," as measured above, tended to fall lower and lower as a student progressed, the probability of his transfer to another program, or dropping out of college completely becomes progressively more likely.

If the above conceptual experiment is reasonable, and the expected results were obtained, the procedure for reducing potential dropouts seems quite clear. In oversimplified terms it is merely this; accept only well motivated students, or students who can be made well motivated by some procedure early in the academic program. In any event, all would recognize that the higher the initial motivation, and the more reinforcement it receives during the academic program, the better the chances are that the student would graduate.

This, of course, would argue for not only the selection of highly motivated students, but also argues for initial efforts to increase their motivation to still higher levels, together with recurrent efforts throughout the academic program to reinforce this motivation. This is easy to hypothesize, but completely unworkable when applied to the problems of the Office of Admissions of most colleges, and especially public institutions. However, it is clear that one of the lessons we can draw from the literature is that it is extremely helpful for a freshman student to have some definite academic goal, and understand clearly what this goal is, and what is required to attain it. And if this can be done it would likely reduce attrition.

APPENDIX B

Freshman Engineering Students

A view, in depth, of the freshman engineering student at M.I.T. disclosed[4] a hardworking student struggling with problems of adjustment to his college environment, and problems of intellectual mastery of course material. These students feel their studies are demanding, and complain about shortage of time for study and recreation. Typically the engineering freshman is willing, and indeed eager, to make the sacrifices necessary to get his degree because of his perception of rewards of success. "Tech is hell, but when you get a degree you got it made."

The engineering student appears to come from a more modest socio-economic background and he appears more vocationally oriented than the average for college students generally.[4,5] The family of the engineering student frequently views engineering education as a means of upward social mobility.

Year by year analyses of scores of college board exams and high school performance of entering freshmen made by the School of Engineering at the University of Massachusetts show entering engineering students appear to have better academic backgrounds than the students of the other colleges of the University, particularly in mathematics and science. When questioned they claim to be highly motivated toward engineering, but their reasons are often superficial and show little thought about the field or understanding of it. Further, Sussman[4] indicates that those who make the decisions for engineering earliest, on the basis of what appears to be more remote contact and poorer information, seem to be more positive about engineering being the only suitable field, and least willing to accept substitute goals.

The grades a freshman engineer receives appear to be highly indicative of his academic work throughout his undergraduate program; Willingham[6] reports correlation between freshman grade-point average and graduating average reaching R = .82.

However, when high school performance is used as a predictor of freshman work in engineering Willingham[6] reports that the correlation drops to R = .48. (Some work which partially verifies these results was done at the University of Massachusetts.)[7] While the value of R = .48 for correlation between high school work and freshman college work is quite high for this type of prediciton model it is clearly not of the same order as the R = .82 for predicting college graduating averages from freshman performance. And, although these correlations are not directly comparable it appears that there is something about the high school-college interface that causes the lower correlation between high school grades and college performance than between freshman performance and graduating average.

In summary then, even though the engineering student is a well motivated, hard working, able student, there is a very high drop out rate, and those who do drop out are not always the persons who have been the most able students in high school. The high school-college interface seems to be a barrier to many able students who are unable to adjust to college life and the severe demands of a freshman engineering program. Internal studies of the School of Engineering at the University of Massachusetts verify this fact. Approximately as many students drop out of engineering during the freshman year as during the remaining three years combined.

APPENDIX C

Description of the Pre-Freshman Orientation Program

A grant by the Charles F. Kettering Foundation and the University of Massachusetts made it possible to offer a pre-freshman program of two weeks in length immediately before the fall registration of September 1962. No tuition was charged; the only cost to the students were room, board, and school supplies. It was held during the summer preceding the freshman year, because it would leave the freshman year itself unmolested, it would use buildings and equipment otherwise idle during this time, and it would not add chores to the faculty during the semester "peak load" period. A program given before the freshman year begins also has attraction from the point of view of the student. It does not add to his load during the freshman year, a time period already overcrowded, it permits a student who, after an exposure to engineering, feels he wants to transfer to some other area, to do so before the semester begins, and it apparently helps the students to get back into a proper mental set, or get up their "academic momentum" before the term begins. It was also felt if anything was to be done to help students learn to budget their time, to develop acceptable study habits, and learn work effectively in a dormitory setting, the program could best be given at a time when they could be more or less insulated from outside distractions. The latter weeks of the summer, immediately preceding fall registration, are ideal for this purpose.

The basic objective of this program is to help the student survive the freshman year. An analysis of engineering dropouts and interviews with students and faculty reveal that lack of success in mathematics seems to be the greatest single cause, direct and indirect, of freshman mortality. Further, there is evidence that excellence in freshman mathematics is one of the best indications of high performance in the junior and senior years.[1] For these reasons, it was felt the content material of the program should focus on mathematics.

The following specific objectives for the program were formulated:

1. Level the diverse backgrounds of the students in mathematics.
2. Provide a cursory review of those areas in mathematics where, in the past, many students have demonstrated weaknesses exist.
3. Provide a period for the student to adjust to the problems of dormitory and campus living.
4. Orient the neophyte engineer to the history and tradition of his profession.

To implement these objectives, the two-week program was organized around four "courses" and a recreation period.

1. Mathematics - A review of high school algebra and trigonometry taught at the college level by a member of the Mathematics Department using the notation and language of freshman mathematics. This course was given during one hour of lecture per day, which generated, on the average, 2 hours of homework which was collected, corrected, and returned each day.
2. Applied Mathematics - A course in computation techniques organized around the use of logarithms and the slide rule on engineering type calculations. These computations were designed to utilize applied trigonometry and algebra involving exponential realtionships. This was presented in a 2 1/2 hour computation laboratory format which generated a minimum of outside work. The material was presented primarily by film during the first half hour of the period, and the laboratories were led by selected upperclassmen (about 8 to 1 student-

teacher ratio) under the general supervision of senior staff members. (1)

3. History and Tradition of Engineering - One-half hour lecture every other day; intended to describe the distinctions between engineering and science, the liberal arts, and the fine arts. The History of Engineering in ancient Egypt, Rome, etc. up through present day was presented leading up to the idea of "passing along the torch" to the next generation of freshmen.

4. Orientation to College Life - Primarily discussions led by upperclassmen covering topics of interest to the freshmen. Care was taken not to duplicate the regular University orientation program concerning student health, guidance, etc.

These courses were arranged in the following typical daily schedule:

7:00 - 8:00	Breakfast
8:00 - 9:00	Mathematics
9:00 - 11:30	Applied Mathematics
11:30 - 12:00	History and Tradition of Engineering, and Orientation to College Life (alternate days)
12:00 - 1:00	Lunch
1:00 - 3:30	Applied Mathematics
3:30 - 5:00	Recreation Program
5:00 - 6:00	Supper
6:00 - 8:00	Free Time
8:00 - 10:00	Study Period
10:00 - 10:30	Free Time
10:30	Lights Out

The recreation program is mandatory for students that do not have medical excuses because it is felt that the students would work and learn better if, after 6 1/2 hours of intense classroom work on mathematics, they had some exercise. The study period is enforced; upperclassmen walk the dormitory corridors to assure quiet and attendance at a desk in front of an open book or notebook. Supervision of the study period is gradually withdrawn during the second week.

It may be seen that the content material of Mathematics and Applied Mathematics were designed to cover the first two of the program objectives; leveling background in mathematics, and reviewing areas where, in the past, many students have demonstrated weaknesses. The objectives of helping students adjust to problems of dormitory and campus living, and orienting the students to the history and tradition of their profession are handled by the courses in Orientation and the History and Tradition of Engineering as well as the carefully organized daily schedule which was designed to demonstrate the level of effort required in engineering curricula, and how a student should, and can, budget his time.

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