INVENTORIED INTERESTS AS RELATED TO PERSISTENCE AND ACADEMIC ACHIEVEMENT IN AN ENGINEERING PROGRAM

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ABSTRACT

Curtis, John Taylor. Ph.D., Purdue University, January 1970. INVENTORIED INTERESTS AS RELATED TO PERSISTENCE AND ACADEMIC ACHIEVEMENT IN AN ENGINEERING PROGRAM. Major Professor: Lee E. Isaacson.

This study was conducted to determine if two engineering interest scales could be developed which would differentiate the interests among certain groups of engineering students at Purdue University using item analysis as the statistical technique.

The 1194 item alternatives of the Strong Vocational Interest Blank for Men (SVIB) were used in developing these two scales. The purposes of this study were: 1) to determine if an interest scale could be developed and cross-validated which would differentiate the interests of 231 freshman engineering students who continued in an engineering program for four semesters with a 4.00 or above graduation index from the interests of 90 freshman engineering students who either withdrew or transferred from engineering during this same period with a 4.00 or above graduation index; (2) to determine if an interest scale could be developed and cross-validated which would differentiate the interests of 235 freshman engineering students who were academically successful with a second

semester graduation index of 4.40 or higher from the interests of 251 freshman engineering students who were less academically successful with a second semester graduation index below 4.40; 3) to compare the two scales developed in this study with the SVIB Engineering Scale, McCampbell's Revised General Engineering Scale, and the SVIB Academic Achievement Scale; 4) to compare the profiles of the criterion groups on the SVIB 22 Basic Scales to determine the content of the author's two scales; and 5) to report a measure of reliability for the two scales thus developed. Cross-validation procedures were employed to determine the relationship between the two scales and criterion measures.

The first scale developed, the Engineering Persistence Scale (EPS), consisted of 177 significant items with 131 positive and 152 negative alternative weights. When this scale was combined with 12 other academic ability, achievement, and interest measures in a discriminant function analysis program, the "stay," "leave" engineering criterion groups were significantly discriminated. The EPS Scale did not contribute significantly to this discrimination.

The SVIB Engineering Scale was shorter than the author's scale and contributed significantly more to the discrimination of the two criterion groups than the EPS Scale. The SVIB Engineering Scale correlated .67 with the author's scale.

McCampbell's Revised General Engineering Scale was longer than the EPS Scale and did not contribute significantly to the discrimination of the two criterion groups. This scale correlated .64 with the EPS Scale.

The second scale developed, the Achievement Interest Scale (AAIS), consisted of 118 significant items with 91 positive and 82 negative alternative weights and correlated .27 with the cross-validation criterion, second semester graduation index. A combination of high school rank, the AAIS Scale, and SAT-Mathematics Section correlated .53 in a multiple correlation with the criterion. High School Rank contributed approximately 19 per cent and the AAIS Scale contributed 7 per cent to the prediction of the criterion variance which was significant. The author's scale had a reported reliability estimate of .90.

Compared with the AAIS Scale, the SVIB Academic Achievement Scale was shorter, correlated .19 with the criterion, and did not contribute significantly to the measure. These two scales correlated moderately and had a 79 per cent directional overlap.

Those students who continued in engineering appeared more interested in the sciences and the application of technical knowledge, while those who left favored the liberal arts and personal contact occupations, such as sales and management. In contrast, the more

academically successful students preferred academic pursuits. Implications of the findings for counseling and suggestions for future research were presented.

CHAPTER 1

INTRODUCTION

The increased enrollments of our colleges and universities, the growing need for talent and achievement in the sciences, and the cost to the student in time and money spent in preparation are factors which emphasize the importance of students selecting curricula consonant with the student's abilities and interests. This is of particular importance in engineering curricula where many students enter with unrealistic conceptions of their abilities, interests, and the demands of these programs. Despite the various measures of achievement and ability used as predictors to improve selection procedures, the number of unseccessful engineering students remains high (Elton and Rose, 1967; Grande and Simons, 1967; and Apostal, 1968). A result of inappropriate curriculum selection is that engineering programs tend to lose more students by transfer than they gain (Martin, 1956; Mayfield, 1961). Several authors have indicated that the attrition rate in the engineering curricula varies from 40 to 60 per cent (Martin, 1956; Freeman, 1960; Davis, 1965). Purdue University is similar to other institutions in the United States with 45 per cent of the 1966 freshman engineering class transferring from or withdrawing from the engineering program after their fourth semester (Lebold, 1968). While efforts have been made to improve these selection procedures by the addition of interest measures, such efforts have failed to yield significant results (Long, 1953). Various factors such as lack of motivation, poor high school preparation, and unrealistic conceptions of the demands of the engineering profession have been given as reasons why students fail to persist in these engineering curricula (Freeman, 1960; Holland and Nichols, 1964). Although a number of engineering students transfer to other curricula and eventually graduate, nevertheless, the high attrition rate in engineering is a serious problem when it is considered that engineering students obtain higher scores on certain ability and academic achievement measures used as admission standards when compared with other curricular groups (Freeman, 1960). Such a condition has existed at Purdue University where the students admitted to the Schools of Science and Engineering in 1966 had the highest high school rank and combined SAT verbal and Mathematics scores as entering freshmen (Admissions Report, 1967).

These problems in the engineering programs raise a basic question for counselors working with engineering students concerning the identification of the interests of students admitted to a specialized and demanding curriculum. While engineering students generally have higher levels of ability than do students enrolled in other curricula, it has not been possible to identify or predict those aspects of an engineering student's behavior which determine persistence in the engineering program.

In addition to certain ability measures presently used, the academic counselors in a large number of engineering programs have utilized the Strong Vocational Interest Blank, Male Form (SVIB), to provide the engineering student with information in making choices of school curricula which will prepare him for work related to his abilities and interests. Recent SVIB studies concerning students who have entered engineering curricula have focused upon the following:

(1) The prediction of graduation in engineering (Sadler, 1960; Mayfield, 1961; Lewis, Wolins, and Hogan, 1965; and Benjamin, 1967).

(2) Biographical factors as they relate to inventoried interests of engineering students and their continuance, transferral or withdrawal from an engineering curriculum (Chaney, 1962; and Watley, 1965).

(3) The prediction of academic success in an engineering program based on interest and academic factors (Sadler, 1950; Berdie, 1955; Lewis, Wolins, and Hogan, 1965).

(4) The revision of the engineering key to differentiate engineering graduates, using item analysis and development of subkeys for particular engineering programs, e.g., mechanical engineering scale (Dunnette, 1957; Mayfield, 1960; McCampbell, 1966; and Haddock, 1968).

While several studies have been concerned with the prediction of graduation from an engineering program and description of the interests of engineering graduates, Lebold (1968) and Apostal (1968) have observed that a critical period in the engineering program is the first four semesters. It is during that time that the student completes the basic requirements of the freshman engineering program and confirms his interest in engineering, enabling him to choose a particular engineering specialty. It also has been observed that the highest rate in attrition occurs during this period (Lebold, 1968).

In commenting on Super's (1969) career model to explain occupational development, O'Hara (1969) stressed the importance of studying occupational interests over short periods of time when he stated:

> There is need to encourage counselors to embark on research using the occupational prediction model and involving subjects in their own school systems. A successful career is composed of many parts. No one counselor deals with a person throughout the course of his career development. Counselors deal with clients ordinarily through three grade levels at the most. We cannot wait for the ultimate criterion of a successful career at age 65 to

> evaluate successful guidance work . . . . A counselor will more efficiently assist the move from grade 9 to 10 if he has gathered data relevant to the problem. Few counselors carry out such research; they need encouragement to do so (p. 29).

The present study was devoted to an analysis of occupational interests of engineering students over a four semester period. O'Hara's remarks were supportive of the present type of short-term research.

Statement of the Problem

It was the purpose of the present study, using item analysis of SVIB data from two freshman engineering classes at Purdue University, to develop two scales that could be used for the prediction of engineering student behavior. The two scales were designed to measure the following: (1) persistence in an engineering curriculum and (2) successful academic achievement in an engineering program. The purpose of the Engineering Persistence Scale was to identify the item responses that distinguish those continuing engineering students with a graduation index above 4.00 average after their first and fourth semesters from those students who either transferred or withdrew from an engineering program during that period and were similarly academically successful at the time of transfer or withdrawal. The graduation index is the grade point average of an individual at the time of graduation based on a six point scale. The SVIB Engineer Scale and McCampbell's revised Engineering Scale were compared with the Engineering Persistence Scale developed in this study. The purpose of this comparison was to determine whether or not the three scales discriminated continuing engineering students from transfer or withdrawal students and which of the three scales best discriminated among those three groups of engineering students.

The Academic Achievement Scale developed in this study was compared with the SVIB Academic Achievement Scale and other achievement and ability measures to determine whether or not these measures could identify the interest item responses that differentiated second-semester engineering students who had a graduation index of 4.40 or above from those engineering students whose graduation index was below 4.40. Those measures also were compared to determine if the academic achievement scale contributed to the prediction of academic success as determined by the other academic ability and achievement measures.

The Research Questions

The present study was designed to answer the following basic question: Did significant differences exist among selected groups of engineering students in their inventoried interests as measured by the SVIB? In addition, the study considered the following related questions:

1a. Is it possible to develop an Engineering Persistence Scale based upon responses to SVIB items obtained from a selected homogeneous sample of freshman engineering students enrolled in 1966 and cross-validated with a homogeneous sample of freshman engineering students enrolled in 1967.

1b. Does a significant difference exist between discriminating combinations of interest items as derived from item analysis of the author's criterion group data as compared with the SVIB Engineering Scale, the SVIB Basic Scales, and McCampbell's revised Engineering Scale in differentiating engineering students of 1967?

2a. Is it possible to develop an Engineering Academic Achievement Scale based upon responses to SVIB items obtained from a selected homogeneous sample of freshman engineering students enrolled in 1966 and cross-validated with a sample of freshman engineering students enrolled in 1967?

2b. Does a significant difference exist between discriminating combinations of interest items as derived from item analysis of the author's criterion group data, and other ability, achievement and interest measures used to predict academic achievement?

3. Does the author's Academic Achievement Scale singly or in combination with other prediction variables contribute significantly to the prediction of engineering academic achievement?

Significance of the Study

It was thought that findings in this study would make a positive contribution to research using the SVIB to differentiate the interests of engineering students who successfully pursue an engineering program for four semesters from those students who either transfer or withdraw from engineering during this period. Information obtained further would confirm item analysis as a useful technique in specifying and defining occupational interests. Finally, it was felt that this study would provide academic counselors and engineering students with additional information concerning engineering interests to facilitate a student's decision in selecting a curriculum consonant with his particular interests and abilities.

Limitations of the Study

The present study was restricted by the following limitations:

1. The generalizability of the results of the study was restricted to the sample of engineering students at Purdue University who entered the engineering program in 1966 or 1967.

2. The interests of engineering students sampled in the study were not necessarily representative of mature interest patterns.

CHAPTER 2

REVIEW OF RELATED RESEARCH

Interests as Related to Academic Achievement

Because the SVIB is used frequently in counseling with engineering students, one would expect much research concerning the predictive power of this inventory's scale with respect to the success of students in engineering colleges. However, Harris (1940), Moore (1949), and Mayfield (1960) noted that such does not appear to be the case.

In the area of academic achievement several authors (Chaney, 1962; Lavin, 1965; Berdie, 1960; and Johnson, 1965) have indicated that, in general, the relationship between interest inventory scores and measures of academic or vocational success has been low, although there have been a few notable exceptions.

Berdie (1960) has summarized the literature on the topic as follows:

> The consistently low but sometimes significant relationship found between SVIB scores and academic training grades lead inevitably to the conclusion that there is a slight relationship between interest scores and grades, but that the size of this relationship is such

> that it serves little use in making predictions and accounts for little of the variance in academic success (p. 43).

In a discussion of the relationships between achievement, ability, and interest measures, Mayhew (1965, p. 43) noted that high school rank in combination with scholastic aptitude measures when compared with freshman grade point average produced correlations which ranged from .37 to .83, with a median correlation of .62. Fishman and Pasanella (1960) reported that when more than those two intellective indices were utilized, the gains in correlation with freshman grades were so slight as to be virtually useless.

In spite of such negative results found between interest measures and academic achievement, Cronbach (1949) stated that although they have low correlations with grades, substantive interest measures improved the predictions obtained by using ability measures alone. Travers (1949) found that interest tests were of some value for predicting grades in courses within the area of interest. Collins (1955) noted that questions on the SVIB which dealt with school subjects correlated .19 with grade-point average. Hewer's (1957) study which used the physician key of the Strong for predicting grades of premedical students, found that when ability was controlled, there was little relationship between the physician key and grades of male freshmen, but there was some evidence that differences between grades in certain courses were related to the predictor.

From the present discussion it may be concluded that the relationship between interests as measured by the SVIB and academic performance is slight and a confused one. The following reasons have been suggested in explaining the confounding relationship between inventoried interests, academic achievement and continuance in a curriculum.

1. Restriction of interest score range because of course and curriculum selections (Berdie, 1955; Burgess, 1956; Chaney, 1962; Lavin, 1965).
2. Motivational factors which have not been controlled, such as clarity of vocational choice (Lavin, 1965) and the satisfaction of certain needs (Nettleton, 1966; Augustin, 1966; Rust and Ryan, 1954; Cronbach, 1949; Fredericson and Melville, 1954).
3. Failure to hold level of ability constant (Terman, 1954; Chaney, 1962; Lavin, 1965; Hewer, 1955).
4. The failure to control for sex differences (Lavin, 1965).

5. The inadequate definition of interests and criterion measures used in determining the relationship between interests and academic achievement (Segel, 1934; Strong, 1943; Pierson, 1947; Sadler, 1950; Berdie, 1955; Johnson, 1965).

The following research is discussed in relation to foregoing factors. From certain studies concerning the relationship of interests to related academic performance (Travers, 1949; Collins, 1955; Melton, 1955; Burgess, 1956; Lavin, 1965), it was concluded that for students enrolled in a professional curriculum, measures of interest were not related to performance. For example, one would not expect interest in medicine to be correlated with performance in a premedical program, because the amount of variation in this interest probably is minimal, thus, restricting the range on one variable and producing spuriously low correlations. However, for students enrolled in nonspecialized curricula, the research suggested that interest measures were useful for predicting performance in parallel course areas. One limitation of the studies was that they did not control for sex differences. Strong (1943) hypothesized that if a student had enough interest to elect a college course, his grade in it depended far more on his intelligence, industry and previous preparation than on his interest. Strong (1943) further stated that one reason it was difficult to measure the relationship between interest and grades was that when a student discovered he had mistakenly elected a course in which he had little interest, he completed it about as well as other courses but did not elect further courses of a similar nature. It also was noted that interests were not correlated necessarily with academic achievement over a short period of time and yet may have been correlated more highly when achievement involved a considerable period of time.

Berdie (1955) was interested in comparing different ability, achievement, and interest measures to determine how effectively they discriminated various curricular groups with respect to educational outcomes and experiences. These measures were administered to a 1939 freshman class in the College of Science, Literature, and Arts at the University of Minnesota. When those freshmen completed their first year in college, their grade-point averages were obtained and included in an analysis of the test data. In 1949 a follow-up study was conducted, and university records were obtained for the students originally tested as freshmen. From the academic records of the students, the degrees obtained, grades, and the number of credits completed in various types of courses were determined. F-values were determined for the various ability, achievement, and interest measures used. The sizes of these F-values suggested that the vocational interest scores were more effective in differentiating among the curricular groups for both men and women than were any of the other tests used. The achievement tests were more effective differentiators than were the aptitude tests. In assessing the effect of counseling with those students it was suggested that the extent to which the curricular groups were differentiated by the tests was not influenced by the varying effectiveness with which counselors used those tests. In general, the results indicated that vocational interest tests differentiated better among curricular groups than did other kinds of tests, and that prediction of which curriculum a student would graduate from could be made better with an interest test than with either aptitude tests or achievement tests.

In considering the relationship between motivational dimensions of interest and academic performance, Lavin (1965) summarized the research related to clarity of vocational choice by stating that students who were more certain of their occupational choice or who had definitely chosen a major field of study were more likely to perform at a higher level than students who were unsure of what goals they desired to pursue. Choice of major field appeared to be directly related to academic performance in the case of males but no such relationship existed for females.

Another related research question in the area was: Did students choose their own goals or were goals set for them by others? In a study conducted by Weigand (1953) with a group of college students admitted on probation, it was found that the academically successful students were more likely to have set their own goals and that those goals were more often in line with their measured interests. A study conducted by Cooper (1956) to determine social and personal adjustment factors which differentiated successful from unsuccessful students at Texas Southern University, resulted in findings which were the opposite of the Weigand (1953) study.

Berdie suggested that motivation to pursue a satisfying curriculum was confused with ability to succeed academically in a training program. Berdie (1944) found no relationship between the engineer scale of the SVIB and satisfaction with the engineering curriculum. The only significant measure of satisfaction with the engineering curriculum was high school rank. Strong (1943) stated that interest was not directly related to academic achievement because: (1) interests were an indication of satisfaction in an activity but not necessarily success; (2) the activity may or may not be liked after it has ceased to be carried out; (3) interests were often attached to an activity not in terms of its essential characteristic but rather in a trial aspect. Cronbach (1949) noted the motivational aspect of interests when he stated that the intensity of interests as measured by the Strong Vocational Interest Blank was directly related to grades.

In considering interests as related to academic achievement, Lavin (1965) observed that several studies have failed to control for academic ability. An exception to that observation was found in a study of the way under and overachieving freshmen viewed themselves and their college situation (Kerns, 1957). The underachievers appeared to have stronger interests in social activities than in intellectual activities and that the opposite was true for overachievers.

In a study of students with high level ability, Terman (1954) considered the interests of these students as related to high level scientific achievement. The results indicated that given a definite minimum level of ability, gifted persons with measured interests, which were appropriate to their chosen occupation, were more likely to achieve a higher level of success than were individuals of similar ability in occupations which did not correspond with their primary interest pattern. The results of that study were supportive of a tendency for interests to be related positively to success when the ability factor was held relatively constant. Lavin (1965) also noted a sex difference in academic performance when ability was controlled adequately in studies of interests as related to academic achievement.

In two studies concerning the educational goals of men and women as related to curriculum choice and academic performance, it was observed that choice of major field was related directly to academic performance in the case of males, but no such relationship was evident for females (Weitz et al., 1955; Weitz and Clover, 1959). It was speculated that the psychological significance of commitment to a major area of study was different for males than for females. As previously noted by Berdie (1960), the relationship between interests and academic achievement has generally been low. Nearly all the studies in this area have used grade point average as the criterion variable rather than a differential measure of academic performance. Segel (1934) explored the potential of a differential measure of academic achievement. SVIB interest scores were correlated with differences between pairs of scores on the Iowa High School Content Examination (IHSCE). The results indicated a number of correlations in the .40's - .50's. It was concluded that SVIB interests had more power to reveal differences between achievements rather than to show achievements themselves. It was observed that the difference score served as a measure of intra-individual variability. Research has indicated that if interests were significantly related with differential achievement, they could become important factors in aiding students to select among different curricula (Segel, 1934; Strong, 1943; Cronbach, 1960; Super and Crites, 1961).

Johnson (1965) also investigated the use of an achievement difference score as a criterion in interest measurement. Differential academic achievement referred to the difference score found in subtracting the student's achievement score in one academic area from his achievement score in another area. Absolute academic achievement indicated the student's achievement in any single area without reference to his achievement in any other area. The sample consisted of 1875 male freshmen at the University of Minnesota, who completed the SVIB, ACT Achievement tests, Minnesota Scholastic Aptitude Test (MSAT). The ACT was used as the measure of achievement. Scores on 25 SVIB scales were correlated with scores on the four ACT tests and the achievement difference scores by means of the Pearson *r*. In addition to zero order correlation coefficients, first order partial correlation coefficients with MSAT scores held constant also were computed between the SVIB scores and both the ACT scores and the ACT difference scores. The median correlation coefficient between SVIB interests and absolute achievement was compared with the median correlation coefficient between SVIB interests and differential achievement scores. When scholastic aptitude was not held constant, there was no difference in the magnitude of the *r*'s using comparisons of median *r*'s between SVIB interest and ACT absolute versus ACT differential scores. The median correlations all were uniformly low ranging from .10 to .17, indicating a minimal relationship between measured interests and both indices of academic achievement. The median correlation between the SVIB and the ACT difference scores was significantly greater than was the median correlation between the SVIB and the ACT test scores when scholastic aptitude was held constant. When scholastic aptitude was controlled, the median *r* between interests and absolute achievement dropped from .11 to .05. The lowered relationship was thought to reflect the degree to which the correlation between the two variables was influenced by their mutual covariation with scholastic aptitude. The relationship between the SVIB scales and ACT difference scores was little affected by controlling for scholastic aptitude test scores. That finding emphasized that the relationship between interests and absolute or differential achievement even for scales which showed the highest degree of correlation, the Scientific Scales and two Social Welfare Scales, was at best a moderate one. It was suggested that other measures of differential academic achievement, such as grades in courses, be used to determine that relationship.

Traditionally, academic interests have been used with reference to "liking" specific subject matter, whereas, other usages are less clear. Research has indicated that SVIB inventoried interests were predictive of academic retention or persistence (Strong, 1943; Pierson, 1947; Sadler, 1950). In a comparison of students who remained in the engineering curriculum with those who transferred out, Sadler (1950) found significant differences between the measured interests of those groups using the SVIB. The continuing engineer group had interests like those of successful engineers and chemists, whereas the transfers did not. The majority of the engineer group had interests and patterns in the professional physical science group, while the transfer group had a pattern of practically no interest in that area.

The definition of interests that was used in the present study was the same as that utilized by Strong (1955). Interests were considered as liked or disliked activities which differentiated members of an occupation from non-members.

Interests as Differential Predictors of Academic Success in Various Curricula

Before interests were considered as related to academic achievement in engineering, a general overview of interests as predictors of academic achievement in other curricula was presented. As previously indicated, the correlations between interests and academic achievement generally have been low. Interest scores in certain instances were more related to persistence than to academic achievement (Hilgard, 1939; Mather, 1942). In other academic achievement studies, academic interests both singly and in combination with other achievement and ability measures, significantly correlated with academic achievement (Mercer, 1942; Layton, 1952; Hendrix, 1953).

Psychology - Dimmick (1936) contrasted the interests of 72 superior and 61 inferior students among 250 students in elementary psychology. Interests were measured on Miner's Blank for the Analysis of Work Interests. One critical ratio of three and five critical ratios ranging from 1.9 to 2.2 were obtained between the 28 pairs of interest items. However, both the number of subjects and number of items were too few to establish a valid scale. The study was further criticized for failure to control for ability and failure to cross-validate the scale on a different sample (Strong, 1943).

Kelly and Fishe (1951) in a study of the relationship between Kriedt's Psychologist Scale and a content examination of achievement in clinical psychology found a correlation of .46. They also reported a correlation of .35 between rating of clinical competency and scores on the SVIB Advertiser Scale. It was concluded that the SVIB could make substantial predictions of varying degrees of success for clinical psychology trainees.

Home Economics - A preliminary study conducted by Mercer (1942) suggested the possibility of differentiating successful home economic students. The Ss were 60 pairs of women who were thought to be comparable in achievement and ability as determined by New York Regent's Examination and the American Council Examinations but who differed in college grades over two years in the New York College of Home Economics at Cornell University. Significant differences were found between the two groups on interest responses to the SVIB for women.

Mather (1942) administered the SVIB for women to 220 home economics freshmen, during 1939 and 1940. The interest scores on the Home Economics Scale were not found to be useful in predicting success in student teaching when grades were used to measure such success. But a low interest score on the Home Economics Scale appeared to indicate a lack of interest in student teaching. Students who withdrew from Home Economics because of marriage, illness or for financial reasons, had Home Economic interest scores similar to those who continued in the program. Those students who withdrew because of poor scholarship or transferred to other curricula had a mean score of 31.4 in contrast to a mean of 44.6 for all students and a mean of 49.1 for all students majoring in teaching home economics.

Medical Sciences - In a study of the relationship between SVIB scores on the physician's scale and grades earned by students during their pre-medical college studies, Hewer (1954) found that pre-medical grades could not be predicted on the basis of SVIB scores. In another study comparing the SVIB Physician Scale scores of 106 freshmen who failed to graduate, Hewer (1955) observed that the mean Physician Scale standard scores of those two groups were respectively 43 and 42.05. That difference was not statistically significant. The two groups differed significantly on high school ranks and other ability measures.

Layton (1952) studied the relationship between the Veterinarian Scale scores on the SVIB and first year grades earned by students in veterinary medicine. The scale scores contributed significantly to a multiple correlation of .60, but the zero order correlation between veterinary score and grades was .30 which was small but significant.

In two studies of the relationships between nursing grades and the SVIB Nursing Scale Scores, Navran (1950) and Hilgard (1939) found low order correlation. The results of the Hilgard (1939) study indicated that low interest scores predicted those who would leave training in spite of their ability to succeed academically.

Accounting - In a study of the relationship between scores on the SVIB Accounting Scale and grades in an elementary accounting class of 95 freshmen, Hendrix (1953) reported a correlation of .36 between accounting grades and SVIB scores. The multiple correlation of the ACE and SVIB as related to accounting grades was .51. The ACE correlated .36 with grades.

Interests as Differential Predictors of Academic Success in Engineering Curricula

Similar to other curricula, the relationship between interests and academic achievement in engineering curricula has generally been low. As previously mentioned, such factors as the failure to control for ability and the restriction of the sample group to a particular class of engineering students were suggested as a partial explanation of this low relationship (Mellville and Fredericksen, 1952). The failure to account for other personality variables, such as, compulsiveness, also was thought to contribute to this confused relationship (Fredericksen and Melville, 1954).

In one of the earliest studies conducted in this area, Holcomb and Laslett (1932) studied freshman engineering students to determine the prognostic value of certain achievement, ability, and interest instruments in predicting achievement in engineering curricula. It was concluded that an interest inventory such as the SVIB would identify extreme cases of lack of interest in engineering. However, such an inventory was not considered useful as a predictor of college engineering success. Long and Perry (1953) considered the relationship between the four-year college grade-point average of engineering students and ratings on the Strong and Kuder inventories. Correlation between grades and the SVIB Scale Scores was low and statistically insignificant even for the engineer scale. The authors also indicated that Kuder inventoried interests, unlike SVIB scores reported in other studies (Strong, 1943) varied considerably from freshman to senior year, suggesting a certain instability of interests as measured by the Kuder during that period of development.

Melville and Fredericksen (1952) investigated the relationship between measures of freshman academic achievement and scale scores on the SVIB for a group of 93 freshman engineering students at Princeton University.

Each of the SVIB Scale scores was correlated with freshman grade-point average and an adjusted grade-point average (difference between the predicted grade-point average and the obtained grade-point average). The average engineering student had relatively high interest in activities associated with occupations stressing scientific work and business sales administration. His scores were relatively low in areas associated with men in certain welfare, biological science and business detail occupations. In regard to academic success, eight of the correlations between freshman grade-point average and the SVIB scale scores were significant. Those correlations suggested that academic success for that group of engineering students was related directly to interest in activities associated with men in scientific occupations and inversely related to business details and sales. Correlations between 12 SVIB scale scores and adjusted grade-point average were .20 or higher when ability was controlled; the relationship between SVIB scale scores and freshman grade-point average was increased, similar to the findings of Segel (1934) and Johnson (1968). Two limitations of that study included the restriction of the sample group and difficulty in estimating either the direction or amount of distortion produced by basing the statistics on such a group.

Similar to Strong (1943), Fredericksen and Melville (1954) hypothesized that the use of interest tests in predicting students' grades is appropriate for some students (those whose effort varies with interest) and inappropriate for others (those whose effort is unrelated to interest). Compulsiveness, the tendency to be thorough in one's work with regard to the amount of intrinsic enjoyment of the work itself, was thought to explain the difference in the academic efforts of these two groups. Separating a group of 154 engineering students into "compulsive" and "non-compulsive" sub-groups, it was hypothesized that the interest scores of the "compulsive" group would not yield significant correlations with grades because they could not be expected to give maximum effort to all their work. However, one would expect a correlation between interest and achievement for the "non-compulsive" group. As hypothesized, the coefficients were near zero for the compulsives and .30 or higher for the non-compulsives.

Development of Academic Achievement Interest Scales

In developing an interest scale to predict academic achievement, Rust (1954) noted the influence of personality variables on academic achievement. Campbell (1940) observed that different curricular groups had different academic interests. England (1956) indicated that interests added nothing to achievement and ability measures which had been used to predict engineering academic achievement.

Rust (1954) was concerned with developing an academic achievement interest scale to differentiate students who were underachieving from those students who were overachieving. It was hypothesized that the extent to which behavior favorable to high grades will persist at the college level will be a function of the degree to which certain moral and cultural values have been internalized. It also was hypothesized that positive deviation from predicted scores would be directly related to phenomena labeled "conscience," moral fiber," or "goodness" (Rust, 1954, p. 344). Three groups of junior and senior students at Yale University were divided into overachievers, underachievers and normal students on the basis of obtained grades and predicted grade-point averages. Comparisons among the groups were made by means of the Chi-Square test with the cut-off point for each of the 44 SVIB scales taken at the median of the total group. None of the 44 scales differentiated the underachievers from the normal group. Overachievers differed significantly from underachievers on 11 scales, and from the normal group on 12 scales, nine of those scales were the same. Overachievers scored higher than did the two other groups on scales for Artist, Psychologist, City School Superintendent, Minister, Musician, and C.P.A. A key for each achievement group was developed from item analysis of the two samples. The underachiever key yielded significant differences between both overachievers and underachievers and between overachievers and the normal group. Whereas the overachievers' key differentiated only overachievers from underachievers, the normal key produced no significant differences. More than half of the overachievers exceeded the median score in Group V. These findings were considered indicative of a relationship between Group V and academic achievement as hypothesized.

Campbell (1940) hypothesized that interest related to scholastic achievement in one subject area might not be related to achievement in other subject areas. He noted that interests of a heterogeneous group of superior and inferior liberal arts students were different from comparisons of superior and inferior engineering students or superior and inferior business school students. In testing his hypothesis, Campbell (1940) developed three scales from the SVIB which differentiated superior students in engineering and social science subjects. Data in both subject areas were obtained from 100 SVIB profiles of engineering and social science students who had completed 12 or more units of work in their chosen fields. The results of his data indicated that interests were related to engineering achievement (Engineering Achievement Interest Scale correlated .47 with the students' GPA's in engineering subjects).

Three scales were developed which included an Engineering Achievement Scale, 79 items with a reliability coefficient of .66, a Social Science Achievement Interest Scale, 110 items with reliability coefficient of .89, and an Intelligence Interest Scale which included 136 items, and a reliability coefficient of .80.

Correlations between those three scales were not significant which indicated that endorsement for items which might be predictive of achievement in one area was not predictive to the same degree for achievement in the other two areas. Correlation between the SVIB scales and achievement in engineering or social sciences was low and approximated the correlation between the Intelligence Interest Scale and intelligence test scores. Thus, it was impossible to state that the relationship of the scales to achievement was distinct from that of the scales to intelligence.

Further research appeared to be warranted because Campbell (1940) did not cross-validate his scales; thus it was difficult to apply the scales in academic counseling situations.

England (1956) developed two scales from the SVIB, the first, to predict first term grade point average and the second, to predict persistence in an engineering curriculum as measured by the number of credits completed. The first scale consisted of 64 weighted responses on a total of 48 items. The second scale included 41 weighted responses on 36 items. The second scale included 41 weighted responses on 36 items. No reliability was reported for either scale. In cross-validation it was found that neither scale added significantly to the multiple correlation obtained by using standard tests of aptitude and achievement along with high school rank in class as predictors. Mayfield (1960) noted that England (1956) made no attempt to investigate the relationship of the existing SVIB engineer scale to either of those criteria.

Specification and Differentiation of Engineering Interests

In addition to academic information, the student is frequently interested in finding out how well he will be able to adapt to the position for which his academic training has prepared him. In this respect, it would appear that the SVIB would have great utility for the counselor and counselee because its scales were designed to provide an index of similarity between the individual's interests and the interests of men in the specified occupations (Campbell, 1967). Because those empirical scales included all of the discriminating items for each occupation, a counselor could make a statement such as, "You have interests similar to the interests of engineers." But if the individual asked, "What does it mean to have interests similar to engineers?" the counselor must rely on what he has learned about engineers from other sources. Although related scales on the SVIB Profile can provide the student with further information, the interpretation would be rather shallow except when interpreted by a counselor who had much experience in working with the SVIB, and who was familiar with the research literature (Campbell, 1967). While certain research conducted by Dunnette (1957b), Sadler (1950) and Lewis, Wolins, and Hogan (1965) has considered differentiating the interests of engineering students who continue in a program from those who transfer or withdraw, those studies have used the scales of the SVIB rather than item analysis. However, Lewis, Wolins and Hogan (1965) noted that in guiding prospective engineering students, comparisons on each of the Strong Scales would be extremely time-consuming and probably confusing to many students. It was suggested that the use of a small number of scales would be more efficient. In view of that suggestion, the research of Mayfield (1960), McCampbell (1966) and

Haddock (1968) stressed the potential of developing a general engineering scale and engineering speciality scales based on item analysis of SVIB items.

In a classical study of engineering interests, Estes and Horn (1939) investigated interest patterns as related to fields of concentration among engineering students. Scoring scales were developed to differentiate various engineering specialties. Those scales correlated significantly with the Strong Engineer Scale in the case of mechanical and electrical engineering only. Negative correlations of -.09, -.27, and -.63 were found between the Strong Engineer Scale and the scales for civil, chemical, and industrial engineering respectively. Estes and Horn (1939) noted that the interests of liberal arts students appeared to be similar to those of successful individuals in the social science, business and literary fields, including such occupations as YMCA secretary, social science teacher, banker, office manager, and lawyer. In contrast, the engineers had interests significantly related to individuals in the science and technical fields, as indicated on the scales for Engineer, Chemist, Production Manager, Farmer, Carpenter, Printer, and Mathematics Science Teacher.

Goodman (1942) was interested in determining whether or not it was possible to differentiate specified interests and certain personality traits between engineering students and liberal art students as measured by the SVIB and Bernreuter personality inventories. The sample consisted of 237 male freshman engineers and 166 male freshman liberal arts students who entered college in 1940. Critical ratios were obtained for the engineering and liberal arts students on the 34 SVIB occupational scales similar to Estes and Horn (1939). The results indicated significant differences favoring the engineering student on the Chemist, Engineer, Production Manager, Farmer, Carpenter, Printer, Policeman, Mathematics and Physical Science Teacher Scales.

The interests of the liberal arts students appeared to be similar to those of individuals endorsing the YMCA secretary, high school Social Science Teacher, Musician, Banker, Office Manager, Sales Manager, Real Estate salesman, Life Insurance salesman, Advertising Manager, and Lawyer Scales.

In a comparative study of students preparing for five selected professions, Blum (1947) observed that engineers scored high on the scales for physical science occupations on the SVIB. It was noted that mechanical engineers had the lowest occupational interest level of the five groups studied. Low correlations between interest and personality traits were also observed. Blum (1947) concluded that the greatest difference between the five groups was in their vocational and nonvocational interests, rather than in personality traits, and that there appeared to be little in common between those two variables.

Sadler (1950) attempted to find factors which would be indicative of success or lack of success in pursuing an engineering program. Comparing a sample of students who had entered and continued in engineering at the University of Missouri but transferred into other curricula, he found that certain occupational scales of the SVIB indicated significant differences between the measured interests of the two groups. Differences in the interest patterns of the two groups also were significant. The engineering students had interests similar to those of successful engineers and chemists, while the transfer students did not share their interests. The majority of the engineering group also had interest patterns in the technical occupation group and physical science occupation group. The transfer students had some technical interest patterns but practically no physical science interest pattern. It was concluded that the transfer students originally selected engineering training on the basis of some technical interests which were not supported by technical-professional-physical science interests.

Korn (1962) differentiated various curricula according to occupational families on the SVIB. The sample was composed of freshmen from the 1959 school year. They were divided into three groups: A physical science group composed of chemistry, mathematics, and physics majors (*N*=55), a technology group consisting of engineering majors (*N*=156), and a comparative group of undeclared majors (*N*=444). Separate Chi Squares were completed for each of the seven SVIB occupational families for all possible combinations of those three groups. In the biological science area, the physical science group had significantly more primary patterns than did the engineering group. The difference between those two groups was not significant in the Physical Science Family. The engineering group had more primary and secondary interest patterns in the Technical area. In considering the Physical Science and Social Service occupational families, physical science majors had significantly more primary patterns than secondary patterns, whereas that was reversed for the engineering students. In comparison with the general group, the engineering students had significantly fewer primary and secondary patterns in the Social Services, Business Contact, and Verbal Linguistic areas.

In a similar manner, Lewis, Wolins, and Hogan (1965) considered whether or not the SVIB interest patterns of students entering the engineering program at Iowa State University differed according to ultimate academic outcome of the students. The Ss were 691 males in the college of engineering who had taken the SVIB in the fall of 1957 and, by 1962, had either graduated from the University of left without graduating. For each S high school rank in class, grade-point average, Iowa State University Placement Test scores, and scores on 48 scales of the SVIB were obtained. An F-ratio was calculated for each of the 50 predictor variables to see whether or not it differentiated significantly among the criterion groups. An epsilon coefficient (E^2) was computed as an index of the validity of each variable. All variables produced statistically significant and valid differentiations among the criterion groups at the .01 level of significance. The authors concluded that among entering engineering students, measures of ability, achievement, and interest would distinguish those who would graduate from that college and those who would not. It was not possible to distinguish between those students who would transfer to another program in the university and those students who would withdraw from the university. It appeared that the decision to transfer or withdraw was not greatly influenced by interest factors but was primarily related to ability and academic background. Compared with the entire sample, the interests of the electrical, mechanical and civil engineering groups were more "masculine." The electrical engineers differed from the other two groups in having interests more similar to those of physicans and psychologists, having more aesthetic interests, and having earned better high school grades. The interests of civil engineers were less like those of men in psychology and were more similar to the interests of men engaged in outdoor occupations.

Wolins and Hogan (1965) stated that how much interest variables would contribute to the prediction of academic outcome for students in engineering only could be ascertained by further replication. They also indicated that any conclusion drawn from the data only could be applied to this particular group of male freshmen in the College of Engineering at Iowa State University.

Interests as Related to Engineering Function

In addition to considering general, engineering interests and engineering specialties, Dunnette (1957b) thought that identificaiton of engineering interests according to engineering function would enhance the interest measures which have been used previously in this area. He also observed that item analysis would provide a more powerful measure than SVIB scale scores in differentiating engineers engaged in different functions.

Dunnette (1957b) was interested in determining whether or not the SVIB Scale scores would discriminate engineering groups on the basis of engineering function. The SVIB was administered to 238 engineers, scientists, and other technically-trained persons employed with the Minnesota Mining and Manufacturing Company (3-M). On the basis of job analysis, the 238 technical people of 3-M were divided into four groups composed of pure research scientists, applied research and development engineers, production engineers, and sales and technical service engineers. Each of those functional groups was subdivided further to provide validation and cross-validation samples. The SVIB Profiles for persons in the validation samples were examined in order to develop scoring keys for the four functions which would accurately place engineers in the cross-validation samples into their appropriate functional categories. Two methods, discriminate function analysis and weighted SVIB Scales, were investigated to discriminate among the four functions on the basis of SVIB Scale scores. Scoring keys were then developed for each engineering function. Each method of analysis was "tested" by application to the profiles of persons in the cross-validation samples.

Finally, to test the extent of validity generalization for the newly-developed scoring keys, an independent sample of 60 technical persons was selected and the scoring keys applied to their SVIB Profiles.

The results indicated that the persons in those four groups scored differently on various parts of the Inventory. The pure research scientists appeared to have interests somewhat more similar to those of persons employed in basic scientific and theoretical areas, such as, medicine, physics, mathematics and psychology. Development engineers showed the same tendencies, to a lesser degree and appeared to be relatively more similar to persons engaged in application of scientific principles, such as, engineers and production managers. Sales and technical service engineers scored highest in selling occupations and in areas involving independent business management such as pharmacist and mortician. Production engineers appeared to possess a hybrid interest pattern lying between those of development and sales persons. It was concluded that measured interests could give important clues concerning the placement of a technical person into the broad range of duties most compatible with his likes and dislikes. Because of the success with which their relatively coarse keys, based on scale scores, differentiated engineering function; it was thought that item analysis would provide a more powerful guide toward discriminating engineers engaged in different functions.

In a second study which further explored interest differences among certain types of engineers, Marvin, Dunnette, and Abrahams (1964) observed that engineering freshmen with high scores on the Research key developed in the previous study had histories of ineffective personal-social contacts, of superior achievement in science courses, and greater enjoyment of quantitative and scientific courses than linguistic or social studies courses. Biographical data also revealed that these students had histories of long career planning and a preference for working with things and ideas over working with people. Finally, they appeared more intellectually independent and had greater academic curiosity.

Engineering freshmen with high Sales scores had personal and biographical characteristics almost reversed from those students with high Research scores. High Sales score students were described as having success in dealing with people liking linguistics and non-science courses, and enjoying people more than things and objects.

It was concluded that instead of lumping engineering interests, counselors might utilize such a pattern of interests to draw inferences about general ability levels, technical knowledge, and interpersonal effectiveness of engineering students.

Longitudinal Engineering Interest Studies

While longitudinal, interest studies of engineering students have shown some variation in interest patterns (Glass, 1934; Clemens, 1969), in general, engineering interests have remained relatively stable over time (Strong, 1952; Benjamin, 1967). Because of that trend, it was thought that the early identification of engineering interests would assist the engineering student in better understanding his interests and possible curricular alternatives.

Glass (1934) investigated the stability of engineering students' interests over a four-year period. The SVIB was administered to 286 engineering students in their freshman year and again in their senior year. At the latter time 85 of them had dropped out of college. The SVIB also was administered to 50 seniors on two occasions separated by a one month interval to determine the reliability of the Engineer Scale. The SVIB Interest Blanks were scored with engineering scale comparisons and correlations were made between the initial and final scores of groups in and out of college, in different schools of engineering, and between different ages.

The results indicated a significant decrease from the initial to the final average Engineering Interest Scales scores for all continuing engineering students.

For the group which dropped out of college, there was a slight increase on the Engineering Scale Scores. The correlation between senior interest scores and scholarship was practically 0. The reliability of the Engineer Scale was high (.920 ± .015). The occupational items were least stable.

Strong (1952) conducted a 19 year follow-up study of engineering interests to consider permanence of interests and if measured interests predicted occupational choice. Data were based on the Vocational Interest Blanks of 306 college freshmen who completed the SVIB in 1930, 1931, 1939, and 1949). On each occasion, extensive information was obtained regarding the students' educational backgrounds, their vocational choices, and the positions they had held, together with a varying amount of reaction to their past and present activities. Results indicated that permanency of Engineer Interest scores with college freshmen was .91 for one year, .77 for nine years, and .76 for nineteen years. In comparing a criterion group of 513, 1949 engineers with the 306 freshman engineering students, a 46 per cent interest overlap was found between the two groups. When subgroups were isolated from the heterogeneous freshman group, it was observed that freshmen who later became engineers overlapped 99 per cent with the criterion group; those who became chemists, physicists, and geologists overlapped 91 per cent, physicians overlapped 48 per cent; while the interests of students who became lawyers overlapped 16 per cent. There appeared to be a close relationship between Engineer Interest scores of freshmen and the subject matter of their academic work. As the Engineer Scale Score decreased, the students' majors progressively shifted from the physical sciences to: The biological sciences; accounting and business; the social sciences; law; and foreign languages. There also was a clear indication that as the mean Engineer Interest scores decreased, the occupation chosen by the freshmen differed more from engineering. Strong (1952) noted that some formula was needed to express that relationship, because it could not be concluded on the basis of correlations whether a shift from engineering to medicine was greater or less than was a shift to law.

Benjamin (1967) conducted a longitudinal study to determine the stability of interests of engineering graduates at Purdue University who completed the SVIB as freshmen in 1935. During the period 1935 to 1966, the results of the 1935 SVIB's had never been interpreted to the subjects. Benjamin (1967) considered the predictive and concurrent relationships between interest and a number of educationally and occupationally related criteria. Those criteria included: (1) grades in college, (2) job satisfaction, (3) salary and (4) level of supervisory responsibility.

Using Pearson r correlations, t tests, and single classification analysis of variance, Benjamin (1967) concluded that interests of engineering students were relatively stable over long periods of time; interest changes that did occur showed a tendency to become more like men-in-general; and interests were meaningfully related to important academic and occupational criteria.

In a similar manner, Clemens (1969) investigated measurable statistical differences in SVIB inventoried interests among three engineering groups, using multiple discriminant function analysis. Standard t score data for each of the 56 occupational scales of the SVIB, plus six special scales were utilized in the analyses. The sample was composed of 229 engineers who completed the SVIB at Purdue University as freshmen in 1935 (1935 Fr ENGR'S) and were retested in 1966 (1966 RT ENGR'S). A third group was composed of 210 engineering students who had completed the SVIB as freshmen in 1966 (1966 FR. ENGR'S).

Two multiple discriminant function analysis sequences were used. In the first analysis, the data were considered as three overall groups of engineers with a cross-validation sample being withheld from each sample group. Sample subjects were divided into 15 specialty subgroups for the second analysis.

The first discriminant function was observed to differentiate all three groups - 1935 FR ENGR'S, 1966 RT ENGR'S and 1966 FR ENGR'S. The 1935 FR ENGR group appeared to have interests similar to Mathematician, Office Worker and Mathematics Physical Science Teacher. The 1966 RT ENGR'S responded in a manner similar to Biologist, Credit Manager, and Physicist. The 1935 FR ENGR appeared to be an object oriented and quantitatively-oriented individual having interests which required attention to routine and practical applications. The 1966 RT ENGR had interest preferences for organization, management, non-person and status striving occupations. The Occupational Level and Introversion Scales also appeared to differentiate the three groups. The 1966 FR ENGR'S appeared to have been somewhere in between the 1935 FR and 1966 RT groups with respect to the above mentioned occupational interests. The 1966 FR ENGR group had interests which were oriented toward management and less oriented toward the applied and object related interests of the 1935 FR ENGR group.

The second function differentiated the 1966 FR ENGR'S from the 1935 FR ENGR'S and the 1966 RT ENGR'S. Results indicated that the 1935 FR ENGR'S appeared to prefer occupations which involve technical application of knowledge and classification of objects and/or things. Similarly, when repeated this group seemed to prefer occupations which required technical, applied, and managerial skills. The 1966 FR ENGRS' responses were more sililar to those of men in occupations requiring more sophisticated quantitative and research skills than was true of the 1935 FR and 1966 RT criterion groups. Also, the 1966 FR ENGR group demonstrated more interest in management and business activities than did the 1935 FR ENGR'S.

Item Analysis Used In Developing General and Specialized Engineering Scales

Similar to Benjamin (1967) and Clemens (1969), certain other researchers have been concerned with measuring the stability of engineering interests and the differentiation of both general and specialty engineering groups. Mayfield (1961) and McCampbell (1966) considered whether or not the rich item pool of the SVIB could be utilized in developing both general engineering and engineering specialty scales which would differentiate engineering groups and add to the prediction of academic performance.

Using item analysis, Mayfield (1961) attempted to answer three questions. First, did the SVIB Engineering Scale predict graduation of engineering students at the time of its revision in 1938? Second, would a scale developed to differentiate mechanical engineering graduates from non-graduates prove superior to the

SVIB Engineer Scale? Third, have such scales retained their predictive validity over a twenty-year time period? The data consisted of SVIBs which had been administered to engineering freshmen at Purdue University in 1935. Fifty blanks were obtained for each of the following groups: Mechanical engineering graduates, electrical engineering graduates, chemical engineering graduates, and the students who had entered the engineering curricula but were not graduated. A _t_-test was conducted to differentiate the 191 engineering graduates from the 50 non-graduates. Analysis of variance was used to determine whether or not the predictive validity of the SVIB Engineer Scale was specific for certain majors within the schools of engineering. Item analysis was used to develop a scale from the SVIB to predict the criterion of graduation in mechanical engineering. The criterion groups for item analysis consisted of 100 blanks for mechanical engineering graduates and 100 blanks for non-graduates. The resultant scale was analyzed in the same manner as was the SVIB Engineer Scale. A point biserial correlation was computed between the item analyzed (IA) scale and the criterion of graduation in mechanical engineering. The resultant coefficient was compared to that obtained for the SVIB Engineer Scale with respect to the same criterion. It also was determined whether or not the two interest scales contributed to the prediction of graduation in mechanical engineering provided by academic aptitude and achievement tests. The Wherry-Doolittle technique was used in testing the five predictors, the two interest scales, and the three orientation tests the students had taken upon entrance to the university. The two interest scales then were tested for retention of validity over a twenty-year time period. Two criteria were used in that portion of the investigation. The first was the grade-point average of engineering students who entered Purdue University in 1959. The second was graduation in mechanical engineering for students who entered the University of Minnesota in 1954.

Results indicated that the SVIB Engineer Scale, at the time it was current, did differentiate those Purdue University students who were graduated in engineering from those who were not graduated. But the SVIB did not differentiate equally well for each field of engineering. The item analyzed (IA) Scale was at least as good as, and probably superior to, the SVIB Engineer Scale in differentiating mechanical engineering graduates from non-graduates. The IA Scale was not identical with the SVIB Engineer Scale or any of the other occupational scales. The IA Scale also added significantly to the prediction of graduation provided by standard mental aptitude and achievement tests. The

IA Scale appeared to retain some degree of predictive validity over a twenty-year time period with respect to the criterion of grade-point average of engineering students who entered Purdue University in 1959. Neither the IA Scale nor the SVIB Engineer Scale was related significantly to the criterion of graduation in mechanical engineering for students who entered the University of Minnesota in 1954.

Similar to Benjamin (1967) and Clemens (1969), McCampbell (1966) was interested in whether or not the SVIB developed and revised in 1938 was still valid in determining the interests of today's engineers. A second question asked was whether or not the interests of specialty groups of engineers could be differentiated from a group of engineers-in-general and among the specialty groups themselves. The sample consisted of 500 inventories collected from members of each of seven professional engineering organizations for the engineering specialty scales. The General Engineering Scale was composed of 500 blanks obtained from all seven specialty groups. From each set of 500 inventories, 100 were kept to serve as cross-validation groups, and the other 400 were used to construct the new engineering scale and seven engineering specialty scales. The engineering specialty scales were developed from SVIB profiles from seven professional engineering associations representing the following areas: Mining engineering, mechanical engineering, civil engineering, electrical engineering, agricultural engineering, clerical engineering, industrial engineering, petroleum engineering, and metallurgical engineering.

In considering the first problem two hypotheses were tested: (1) that a new Engineer Scale, based on the responses of a recent sample of engineers-in-general to the SVIB would be more appropriate for use today than is the 1938 Engineer Scale now in use; (2) if there were manifest changes in interest, they could be described by comparing the responses made by Strong's group to the responses made by the new engineering group to the individual items of the SVIB. The first hypothesis was tested with: (1) a one-tailed t test to determine whether or not an independent group of engineers, not used in construction of either the 1938 or 1966 Engineer Scale scored higher on the 1938 Scale than they did on the one now in use; (2) a comparison of the letter ratings obtained by engineers on the 1938 scale and on the 1966 Engineer scale; and (3) a comparison of the raw zero score for the 1938 group with that for the 1966 group to estimate which was the more likely to obtain a high score by chance.

The second hypothesis was tested by comparing the actual percentage of response by the 1938 group and by the 1966 group to each item on the SVIB-M with a test of the significance of the difference between percentages.

In considering the second problem of the study, scales for each engineering specialty were constructed on the basis of how the responses of each specialty group differed from the 1966 engineers-in-general group. Those scales were developed in a fashion similar to the 1966 Engineer Scale.

In differentiating specialty groups, three hypotheses were tested: (a) that seven engineering specialty groups could be differentiated effectively from the reference group of engineers-in-general by means of specialty scales constructed for the purpose; (b) that the seven specialty groups could be differentiated adequately from each other by their respective scales; and (c) that certain interests unique to each specialty group could be described by comparison of their responses to individual items of the SVIB-M. Analysis of Variance and *t* tests were used in determining if the engineers-in-general and the seven groups differed on each of the seven specialty scales. The amount of scale overlap and a comparison of letter ratings obtained by the engineers-in-general with each specialty group on its own scale provided a measure of the efficacy of the specialty scales in differentiating specialty group from engineers-in-general.

Hypothesis (c) was tested by listing, for each scale, those item-categories that appeared on only one specialty scale, then those that appeared on two specialty scales, and finally those which appeared on three specialty scales. Those items were compared and an effort was made to describe the interests of each specialty group from item-content description.

The scores of the groups used in developing the general engineering and specialty scales were compared with their cross-validation groups by t-test to determine the degree of generalization possible from the use of the new scales. The Kuder-Richardson formula 21 was used to provide an estimate of the internal consistency of each of the eight new scales.

The development and cross-validation of McCampbell's General Engineering Scale resulted in the following findings: (a) An independent group of engineers in 1966 did not score as high on the 1938 Engineer Scale as they did on the new Scale; (b) More of the engineers of 1966 responded like and fewer responded dislike to items on the General Engineering Scale, as compared with responses on the Engineer Scale of 1938; (c) Occupations, amusements, and activities involving contact with people were less distasteful to today's engineer than previously, as were peculiarities of people reflected by the SVIB; (d) It appeared that, "typical," item responses of engineers were likely to be reinforced -- the engineers more strongly endorsed an interest for inventor, algebra, mathematics, and solving mechanical puzzles than previously; (e) Finally, the Engineers appeared to dislike change much less than before, were less competitive, and were more sociable and more confident in their own abilities.

When independent specialty groups of 100 engineers each were compared with 100 independent engineers-in-general on the new Specialty Scales, the keys were successful in differentiating the specialty groups in all cases with the exception of the electrical engineers. This was attributed to the number of electrical engineers included in the engineer-in-general group. Overlapping of the specialty scores with the engineers-in-general scores on each scale ranged from 49 per cent to 62 per cent. Those scores were from 5.3 per cent to 15.4 per cent above the mean. However, in cross-validation, the mechanical engineer group overlapped 80 per cent with the engineers-in-general groups, and the electrical engineers cross-validation group overlapped 91 per cent with that group.

Compared with other engineers, the agricultural engineer was a man with outdoor, rural type interests. The chemical engineer appeared to be different from other engineers in his endorsement for art, music, poetry and drama, and in his interest in things connected with the medical field. The civil engineer appeared to prefer greater seclusion than did other engineers, seemed more conservative, admired hard work, and took an interest in civic affairs. The electrical engineer appeared to have less preference for physical activity than other engineers and to admire self-sufficiency, patience, music, and abstract pursuits. The industrial engineer had a preference for business and people -- contact-type activities of a manupulative nature, and enjoyed competition and taking chances. The comparative interests most descriptive of the mechanical engineer included his greater interest in designing and working with machines and in working with his hands.

In estimating the internal consistency of the various scales, over half of the reliability coefficients were unusually low. It was thought that test-retest measure would be the better estimate of reliability. Further implications of that study have been considered in the following section.

Haddoch (1968) attempted to cross-validate McCampbell's revised engineering scale with a sample of 479 engineering students who had entered Purdue University in 1966 and had completed three semesters in an engineering program. It was hypothesized that those students remaining in the engineering program would score higher on McCampbell's revised general engineering scale than would those students who had withdrawn from the program. It was also hypothesized that when the various groups of engineering students were scored on McCampbell's specialty scales, the group whose specialty corresponded to the specialty scale would score higher than all other groups. The results indicated that McCampbell's revised key for the SVIB Engineering Scale differentiated engineering students who were still enrolled in the program after three semesters from students who had withdrawn. The experimental data also appeared to support the validity of McCampbell's specialized engineering keys. However, Haddoch was working with small *N*s in the case of the specialty scales, i.e., agricultural engineering *N*=4, chemical engineering, *N*=18.

Summary of Research

In regard to the prediction of academic achievement and continuance in an engineering program, certain authors (Harris, 1940; Moore, 1949; Mayfield, 1960) noted the scarcity of research using the SVIB Engineer Scale in that area. It also was indicated that the relationship between inventoried interests and academic success had been low. Certain factors were suggested as contributing to the confused relationship between interests as predictors of academic achievement (Strong, 1944; Fredericsen and Melville, 1954; Terman, 1954; Lavin, 1965). Those factors were: Restriction of range, the fact that the AVIB was not intended originally to predict academic achievement, the questionable criteria and definitions of interests as related to academic success, the failure to hold level of ability constant, and the failure to account for other motivational factors such as "compulsivity."

It has been previously stated that the relationship between interests and academic achievement generally has been low (Hilgard, 1939; Layton, 1952; Long and Perry, 1953). Three scales from the SVIB which differentiated superior from inferior students in engineering and social science subjects were developed by Campbell (1940). It also was noted that interests which were predictive of academic success in one area were not necessarily related to academic success in other areas. Also, it was observed that the correlation between the SVIB scales and academic achievement in engineering was low and approximated the correlation between the Intelligence Interest Scale and intelligence test scores. Thus, it was difficult to state whether or not the interest scale added a unique contribution to the prediction of variance in engineering academic achievement. Further research in that area appeared necessary because Campbell (1940) did not cross-validate his scales, thus making it difficult to apply the scales in a counseling situation.

England (1956) also developed two Academic Achievement Interest scales to predict first term G.P.A. and to predict persistence in an engineering curriculum. However, in the cross-validation of the scales, it was found that neither scale added significantly to the multiple correlation obtained by using standard ability and achievement measures together with high school rank in class as predictors of academic performance. It was noted further that England (1956) made no attempt to investigate the relationship of the existing SVIB Engineer Scale to either of his criteria.

In regard to the specification and differentiation of engineering interests, Sadler (1950) found that continuing engineering students had interests similar to those of successful engineers and chemists, while the transfer students did not share those interests. It was concluded that transfer students originally selected engineering training on the basis of certain technical interests which were not supported by technical-professional-physical science interests.

Similarly, Lewis, Wolins, and Hogan (1965) found that, on the basis of ability, achievement and interest measures, it was possible to distinguish, among entering engineering students, those students who would graduate from that college and those students who would not graduate. However, it was not possible to distinguish between those students who would transfer to another program in the university and those students who would withdraw from the university. It appeared that the decision to transfer or withdraw was primarily related to ability and academic background.

The lack of generalization because of the restricted sample and the question of how much the interest variables would contribute to the prediction of academic outcome in engineering suggested the need for further research in that area.

Dunnett (1957b) added a new dimension to the measurement of engineering interests. The successful differentiation of engineers according to engineering function suggested the possibility of further defining engineering interests according to specialty and function.

The research of McCampbell (1966), Benjamin (1967), and Clemens (1969) suggested that while engineering interests have remained relatively stable over a period of time, certain changes in interest have occurred. Because it was possible to develop a general engineering scale and specialty scales from professionals in the field, further effort in developing interest scales to differentiate the interests of engineering students who persist in their curriculum would appear to be feasible. Such scales would aid the counselor in the early identification of engineering interests which persist over a certain period of time.

The research of Mayfield (1961) and Haddoch (1968) added further support to developing engineering specialty scales which were useful in predicting both persistence and academic achievement in an engineering curriculum. Mayfield (1961) found that the IA Engineering scale added significantly to the prediction of graduation provided by standard aptitude and achievement measures and the IA appeared to have fair predictive validity over a twenty-year period with respect to the criterion of grade-point average of engineering students. Similarly, the results of the Haddock (1968) study indicated that McCampbell's Revised Engineering Scale differentiated engineering students who remained enrolled in the engineering program after three semesters from students who had withdrawn.

CHAPTER 3

METHOD

Instrumentation

The Strong Vocational Interest Blank, Male Form (SVIB T399) was used in this study for two reasons, first to provide a rich item pool for the development of the two engineering scales and second, because of its reported reliability and validity (Campbell, 1966). The SVIB is a 399-item interest inventory (1966 version) on which respondents indicate their preference (like, indifferent, dislike) for various occupations, school subjects, amusements, activities, and types of people. Respondents also are asked to order preference for activities, to compare items of interest, and to rate their present abilities and characteristics. In selecting items for inclusion on the various scales, weighted item alternatives were selected which separated an occupational group from a men-in-general group.

The SVIB is scored in such a manner as to compare an individual's responses with those of individuals on 54 different occupational scales. Special scale scores also are available based on five non-occupational scales: academic achievement, occupational level, specialization level, social introversion, and sex.

The assumption for using the SVIB in academic and vocational counseling is that if the student's likes and dislikes are similar to those of people in a given occupation, he might enjoy that kind of occupation. If his interests are dissimilar, it is believed that he is rejecting that area (Benjamin, 1967).

As was previously pointed out in Chapter Two, the interpretation of the present scales is somewhat limited because of the lack of information concerning the nature of a particular interest pattern. This provided the rationale for the 1969 revision of the SVIB Men's Blank. The basic change was the introduction of a new kind of scale on the profile: The Basic Interest Scales. These 22 new scales are content oriented instead of occupation oriented: each scale containing a cluster of homogeneous items, covering a single content area. On the men's forms, the scales were normed to include a cross-section of 650, 52-year-old men whose average response was 50, with a standard deviation of 10. The profile also shows the mean score of these same men when they were 16 years old. Thus, an individual's score can be compared with both teenagers and adults.

Reliabilities of the various SVIB occupational scales have been estimated by the test-retest method and have demonstrated the stability of SVIB measured interests of individuals over time relatively well (Campbell, 1966). However, the reliability does vary both with age tested and with the time interval between two testings. As previously mentioned in Chapter 2, several authors (Benjamin, 1967; McCampbell, 1966; and Clemens, 1968) noted that Strong's research dealt with the question of interest stability of individuals over time; thus, the same subjects were used for retesting. This method established the interest stability of the engineering students which he sampled but indicated nothing of his S's counterparts, thus, generalization to interests of today's engineering freshmen are limited. Reliabilities for the Basic Scales also have been estimated using the test-retest method over varying lengths of time and have shown stability for the Basic Scale interests relatively well (Campbell et al., 1969). It was noted that the Basic Scales were slightly but consistently less stable over time as compared with occupational scales. This difference was attributed to the longer length of the Occupational Scales. Using Strong's original sample of Stanford freshmen, test-retest correlations were determined for the same time intervals as the original sample with the following conclusions: their interests became more similar to the interests of the norm group on the nature, adventure, and teaching scales over time. Their interests reflected a general trend toward "middle-aging intellectual responsibility" over time. Interests on certain scales such as Public Speaking, Mathematics, Science, and Religious activities remained relatively stable over time. Finally the stability of the ten-year adult span, 1939 to 1949 was equal to the one-year freshman-sophomore period, supporting the finding that interests remarkably are stable after age 25.

The SVIB has been widely used in educational and vocational counseling and has demonstrated both predictive and concurrent validity (Strong, 1952; Campbell, 1966; Benjamin, 1967). Similarly, the Basic Scales have shown both concurrent validity and predictive validity.

Concurrent validity refers to the power of the test to distinguish between specified groups at the current moment. Data have been collected on the majority of occupational samples which have been tested with the SVIB since it was first published in 1927. Most of these occupational samples included men with at least three years of experience who indicated they liked their work. The mean scores on the Basic Scales for these groups indicated that the occupational groups which should have scored high did so, e.g., military officers scored highest on the Military Activities Scale, ministers scored highest on the Religious Activities Scale. It was concluded that these scales were significantly related to the occupations of adult men.

Predictive validity refers to the power of the test to show stability over time and to show agreement between Interest test scores and the individual's subsequent vocation. The predictive validity of these scales had been determined by reanalyzing some SVIBs collected by Berdie and Schletzer (Berdie, 1960; Schletzer, 1963). An analysis of the difference between the test and retest means, revealed that the scales upon which each group scored highest, both at test and retest were, with few exceptions, those most related to their work. The exceptions occurred on the Adventure Scale; this was among the three highest scores for five of the samples at "test" and was among the highest for three samples at the "retest." It was observed that other than this scale, the high scores were appropriate, e.g., the accountants scored highest on the business oriented scales: Office Practices, Sales, and so forth. The patterns of high scores on both the test and retest administration indicated that these scales have a substantial relationship to the individual's occupational choice.

Sample

In this study, data used in developing both engineering interest scales were analyzed from a total group of 507 engineering students who completed the SVIB (Form T 399) as freshmen in 1966. These students were sampled from Engineering 100, a freshman engineering orientation course. This group was thought to be representative of the freshman engineering class as described by such factors as: high school rank in class, academic background, and certain ability measures. In constructing an Engineering Persistence Scale, the sample was divided into two groups (231 engineering students who had continued in engineering for four semesters and 90 students who had either transferred from or withdrawn from the engineering program during this period). Both groups had graduation indexes above 4.00 after completion of both their first and fourth semesters.

In developing an Academic Achievement Interest Scale, the sample also was divided into two groups (235 engineering students who had completed two semesters in the engineering program with at least a 4.40 graduation index after the second semester and 251 engineering students who had completed two semesters in the engineering program with a second semester graduation index below 4.40). A 4.40 graduation index was used in the initial study because it provided an approximately equal division of second semester engineering students on the basis of their second semester graduation index. This was considered to be a better measure of academic success than the 4.00 graduation index required for graduation in engineering for the purpose of differentiating the more successful students from the less successful students over a two semester period.

The results of the initial study were cross-validated using data obtained from a comparable group of 286 freshman engineering students who completed the SVIB as a part of a program to collect certain biographical and test data from the 1967 freshman class. In cross-validating the Engineering Persistance Scale, this sample was divided into two groups (150 engineering students who had continued in engineering for four semesters and 54 students who had either transferred out of, or withdrawn from, the engineering program during this period). In cross-validating the Academic Achievement Interest Scale, the entire cross-validation sample composed of 286 engineering students who had completed two semesters in the engineering program was used.

To determine the comparability of the original and cross-validation samples with respect to certain achievement and ability measures, High School Rank (HSR), the Verbal Scores of the Scholastic Aptitude Test (SAT-V), and the Mathematics Scores of the Scholastic Aptitude Test (SAT-M), the means of the two engineering samples and populations were compared using a *z* test. In general, the two samples were similar with respect to high school rank and SAT Mathematics Scores. The two groups differed significantly (.01 level) on the SAT Verbal Scores.

The 1966 Sample appeared to be more representative of the 1966 freshman engineering population than was the 1967 sample representative of the 1967 freshman engineering population on these academic measures. However, none of these differences between the 1967 sample and 1967 population on these particular achievement and ability measures were significant (Refer to Tables 1-5 following). As previously noted in Chapter One, when the sample means were compared, it was concluded that the results of this study were to be restricted to these two samples of freshman engineering students.

Procedures

The experimental design used in the present study was similar to that of Mayfield (1961), McCampbell (1966), and Haddock (1968). The answer sheets for 507 of the 1966 incoming freshman engineering students were used

Table 1

1966 Freshman Engineering Population and
Sample Means and Standard Deviations
on HSR, SAT-V, and SAT-M Scores

	1966 Population N = 1406		1966 Sample N = 409	
Variable	$\bar{X}$	Q	$\bar{X}$	S
HSR	84.46	12.04	84.90	11.16
SAT-V	51.72	8.77	51.07	8.73
SAT-M	62.55	7.53	62.40	7.42

Table 2

1967 Freshman Engineering Population and
Sample Means and Standard Deviations
on HSR, SAT-V, and SAT-M Scores

	1967 Population N = 1624		1967 Sample N = 288	
Variable	$\bar{X}$	Q	$\bar{X}$	S
HSR	84.34	11.42	85.49	11.23
SAT-V	52.23	8.57	53.09	8.76
SAT-M	62.85	7.65	62.96	7.73

Table 3

1966-1967 Freshman Engineering Population and Sample $\underline{Z}$ Values for High School Rank

$\bar{X}_2$	$\bar{X}_1$			
	1966 Samp.	1966 Pop.	1967 Samp.	1967 Pop.
1966 Sample		-.69		-.90
1966 Pop.				
1967 Sample	-.68	1.40		-1.62
1967 Pop.		.27		

-Indicates direction in favor of X_2

*Significant value at .05 level of significance.

**Significant value at .01 level of significance.

Table 4

1966-1967 Freshman Engineering Population and Sample $\underline{Z}$ Values for SAT Verbal Scores

$\bar{X}_2$	$\bar{X}_1$			
	1966 Samp.	1966 Pop.	1967 Samp.	1967 Pop.
1966 Sample		1.32		2.40
1966 Pop.				
1967 Sample	-2.98**	-2.41		-1.60
1967 Pop.		-1.61		

Table 5

1966-1967 Freshman Engineering Population and Sample Z Values for SAT Mathematics Scores

$\bar{X}_2$		$\bar{X}_1$		
	1966 Samp.	1966 Pop.	1967 Samp.	1967 Pop.
1966 Sample		.34		1.05
1966 Pop.				
1967 Sample	-.94	.82		- .22
1967 Pop.		-1.82		

for the purpose of developing an Engineering Persistence Scale and the Academic Achievement Interest Scale. The "stay" engineering criterion group for the Engineering Persistence Scale consisted of those continuing engineering students who entered Purdue University in 1966 and had earned first and fourth semester graduation indexes above 4.00. The "leave" engineering criterion group was composed of those students who entered the engineering program in 1966 and either transferred out of or withdrew from the program during their first four semesters but who had graduation indexes above 4.00 after completing their first and fourth semesters or at the time of their withdrawal. The "high" criterion group for the Academic Achievement Interest Scale consisted of continuing engineering students who entered Purdue University in 1966 and had completed two semesters in the engineering program with a second semester graduation index of 4.40 or above. The "low" criterion group was composed of continuing engineering students from 1966 with graduation indexes below 4.40 after completing their second semester.

The responses of each of the four criterion groups on 1194 item alternatives on the SVIB were tallied. Significance of the difference between the per cent of those in the "stay" and "leave" criterion groups and between those in the "high" and "low" criterion groups answering each item alternative was evaluated through the use of the Chi-square statistic. The level of significance for inclusion of an item alternative was .10 in the initial study. A weighting system similar to that utilized in developing the SVIB 1966 revision (Campbell, 1966) was employed, assigning ±1 weights to each item depending on the demonstrated efficiency of the item to discriminate the "stay" from the "leave" criterion groups and the "high" from the "low" criterion groups.

The scales, thus developed, were cross-validated with the previously mentioned sample of freshman engineering students from 1967. The item responses of the samples were scored with the scale weights.

The point-biserial correlation coefficient was used in determining the relationship between the Engineering Persistence Scale scores and the criterion measure, "stay" or "leave" engineering. In addition similar correlation coefficients were computed between the SVIB 22 Basic Scales, McCampbell's General Engineering Scale, the SVIB Engineering and Academic Achievement Scales, HSR, the SAT-V scores, the SAT-M scores, and the criterion measure.

The Pearson product-moment correlation coefficient was used in determining the relationship between the Academic Achievement Interest Scale scores and the criterion measure, second semester graduation index in engineering. Correlation coefficients also were computed between the SVIB 22 Basic Scales, McCampbell's General Engineering Scale, the SVIB Engineering and Academic Achievement Interest Scales, HSR, SAT-V scores, SAT-M scores, and the criterion measure, second semester graduation index. Each variable correlation with the criterion measure was tested for significant departure from a zero order relationship using t tests. The .10 level of significance was used in determining which variables further would be analyzed with multiple discriminant function analysis (Cooley and Lohnes, 1962) and stepwise regression analysis.

As previously mentioned, the purpose of the Engineering Persistence Scale was to differentiate the interests of those students who continued in engineering for four semesters from the interests of those students who left the engineering program during this period.

Multiple discriminant function analysis was used to find out if the individual's interest, scale scores were more similar to the interest scores of those students in the 1967 sample, who persisted in engineering for four semesters or were more similar to the interest scores of students who left engineering during this period. The rationale for this statistical procedure is discussed in the Statistical Methods Section.

In addition to the author's Engineering Persistence and Academic Achievement Interest Scales, 11 other scales, which appeared to be related with the criterion measure were tested with multiple discriminant function analysis to determine if they effectively discriminated between the two criterion groups of the 1967 sample. These scales included certain SVIB Basic Scales, the SVIB Engineering Scale, High School Rank, SAT Verbal Scores, and SAT Mathematics Scores. Multiple Discriminant Function Analysis provided a vector of multivariate weights which were derived to maximize a given prediction. In the case of stepwise regression analysis, a continual univariate criterion, second semester graduation index, was predicted from the sample of freshman engineering students who entered Purdue University in 1967.

A Stepwise Regression Analysis Program was used to determine the interrelationships between the academic ability, achievement, and interest measures and to determine the proportion of the criterion variance which each measure independently provided. The BMD02R Stepwise Regression Program which was designed for the IBM 360 model 65 computer was used in this analysis to determine the best combination of variables which singly and in combination with one another contributed significantly to the prediction of the criterion measure, second semester graduation index.

The Engineering Persistence and Academic Achievement Interest Scales were then compared with the SVIB Engineer Scale, the SVIB Academic Achievement Scale, and McCampbell's Revised General Engineering Scale in terms of the Pearson product-moment correlation between them, the number of significant items and response alternatives included on each scale, the magnitude of the weights received by the item alternatives on the six scales, and the per cent of directional overlap in the scoring of the items common to the six scales.

The 22 Basic Scales of the SVIB also were correlated with the responses of the criterion groups in the cross-validation sample to describe the content of the author's two engineering scales.

While test-retest reliability estimates would have provided the best measures of the reliability for the author's two engineering scales, such an undertaking was not within the scope of the present study. The best alterantive appeared to be to employ the Kuder-Richardson formula 21, modified for use with multiple-category, weighted items developed by Magnusson (1966). The formula provided an estimate of the internal consistency of the two new engineering scales. In using this formula, it was assumed that every item had the same mean and the same variance. Each item was considered to be parallel to each of the other items in the sense of having the same frequency of correct responses and the same intercorrelation with other items. Such assumptions produced the rationale for using the Kuder Richardson formula 21.

Statistical Methods

Statistical procedures previously cited, i.e., the Chi-square test, a ± weighting system, the point biserial correlation coefficient, the Pearson product-moment correlation coefficient, the *t* test, Multiple Discriminant Function Analysis, and the Stepwise Regression Analysis Program were used. The formula used by Mayfield (1961) was used in comparing the two new scales with various other scales to determine the per cent of directional overlap.

The Chi-square test was considered appropriate to determine the item response weights for the Engineering Persistence Academic Achievement Interest Scales, as the data were expressed as frequencies or proportions of engineering groups who responded to the SVIB items. The purpose of these scales was to identify those interests which differentiated students who continued and were academically successful in an engineering program as opposed to those who did not continue or who continued but were less academically successful.

The .10 level of significance becomes .01 upon replication or cross-validation, since the probability level is multiplied by itself. This level of significance also was chosen to maximize the possibility that a sufficient number of potentially relevant items were identified to be submitted to cross-validation analysis.

As previously mentioned, a weighting system similar to the SVIB 1966 Revision (Campbell, 1960) was used, assigning ± 1 weights to each alternative item response depending on its ability to differentiate the "stay" and "high" criterion groups from the "leave" and "low" criterion groups. A +1 weight was assigned to each alternative response where a significantly greater proportion of the "stay" and "high" criterion groups responded with this alternative. A -1 weight was assigned to each item alternative where a significantly greater proportion of the "leave" or "low" criterion groups responded with this alternative. If neither group responded significantly, the item alternative was not weighted.

The point-biserial correlation coefficient was used to determine whether or not a relationship existed between the Engineering Persistence Scale Scores and the criterion measure, whether or not the student stayed or left engineering, during his first four semesters. This statistic was considered to be appropriate because the data were expressed as continuous variables and dichotomous variables.

The Pearson product-moment correlation coefficient was used to determine if a relationship existed between the author's Academic Achievement Interest Scale and the criterion measure, second semester graduation index. This statistic was thought to be appropriate because both the scale scores and the criterion measure were continuous variables.

The *t*-statistic was used to test the significance of these correlations. The .10 level of significance was used to insure that any of the scales which provided a unique contribution to the prediction of the variance of the criterion measures were included in the Multiple Discriminant Function Analysis and the Stepwise Regression Analysis Programs.

The data utilized in the construction and cross-validation of the Engineering Persistence Interest Scale were considered to be nominal and the problem was fundamentally one of classification. In this sense, the Multiple Discriminant Function Analysis technique (Cooley and Lohnes, 1962) appeared to be appropriate. Such a procedure may be used for estimating the position of an individual on a line that best separates classes or groups. This technique also can be used to show the relative contributions of the discriminate variables to a given discriminant function. The procedure which was used is briefly outlined below. The reader is referred to the work of Cooley and Lohnes (1962) for a further discussion of the technique and its uses.

Multiple Discriminant Function procedures facilitate discrimination between groups by maximizing the ratio of between-groups sum of squares to within-groups sum of squares (Cooley and Lohnes, 1962). This relationship is resultant upon the determination of optimal values for each discriminant variate coefficient. The optimal value for each of these coefficients is determined through the use of simultaneous equations. Latent roots are determined by the product of the inverse of the within group variance-covariance matrix (W^{-1}) and the between group variance-covariance matrix (A). Each latent root is a single vector of discriminant function coefficients equal to or fewer than one less than the number of populations or the number of predictor variables used, whichever is the lower number.

The statistical significance of each latent root is determined by a Chi-square approximation as described by Rao (1952).

The discriminant function can be scaled or weighted to permit a subjective comparison of the significance of each variate's contribution to the discriminating power demonstrated by the entire variate set.

A discriminant score for each S is calculated by multiplying the vectors of coefficients by a S's vector of test scores. Then a centroid, which is the product of a row vector of group means multiplied by a given column vector of coefficients, is constructed. The centroid provides a measure of the central tendency of the distribution of a given discriminant score for a given criterion group. The standard deviations which are derived from appropriate variances are used in conjunction with the centroids to represent graphically the density of the sample surrounding the centroid. In each sample analyzed, a distribution of a given discriminant score is determined.

The vectors of means for each criterion group are multiplied by the vector of the first discriminant function and produce a centroid approximation for each group on the first discriminant dimension. The centroid coordinates of each criterion group are plotted with the centroids representing the weighted means summed across variates of each sample.

After discriminant functions have been determined for the criterion groups, the discriminant scores of each S in the cross-validation sample may be found. Chi-square values to test the probability of the discriminant scores falling in each of the populations are next calculated. Then an array of probabilities for group membership is executed. A contingency table of group assignment successes and failures is constructed and tested with the Chi-square statistic. The degree to which the cross-validation Ss are assigned to their own criterion groups on a variable basis is used as the validity test of a particular discriminant function.

CHAPTER 4

RESULTS AND DISCUSSION

Development and Cross-Validation of the Engineering Persistence Scale

In developing the Engineering Persistence Scale (EPS) from the item alternative responses of 321 Freshman Engineering students, a 177 item scale was constructed. The 283 weighted alternative responses differentiated at the .10 level of significance between those engineering students who continued in engineering for four semesters and were academically successful and those students who either transferred from or withdrew from the Engineering program during this period. The EPS scale was composed of 131 positive and 152 negative alternative weights. The scale correlated .26 with the "stay" in engineering criterion group.

The author's Engineering Persistence Scale was compared with the SVIB Engineering Scale and McCampbell's General Engineering Scale in terms of number of discriminating items and item alternatives, the correlation between the scales, their reliability, and the directional overlap between the scales. In comparing the SVIB General Engineering Scale with the author's interest scale, it was found that the SVIB Engineering Scale was shorter, being composed of 75 items with 81 positive and 97 negative alternative weights. Similar to the EPS, the SVIB General Engineering Scale correlated .26 with the criterion measure upon cross-validation as presented in Table 6. The SVIB General Engineering Scale also correlated .67 with the author's scale which was significant at the .05 level. Using this particular cross-validation sample, the SVIB General Engineering Scale was not as reliable as the author's scale with a reliability estimate of .74 as compared with .95 for the author's scale. The Kuder Richardson Formula 21 as described by Magnusson (1966) was used in computing the reliability coefficients. The percentage of directional overlap between the two scales was 87 per cent as computed by Mayfield's (1960) formula.

$$\text{Per cent of directional overlap} = \frac{\text{Item scores in same direction}}{\text{Total number of common items}}.$$

In comparing the Engineering Persistence Scale with McCampbell's General Engineering Scale, it was observed that McCampbell's Scale was longer than the author's EPS scale with 261 significant items, which included 268 positive weights and 294 negative weights. McCampbell's scale correlated .29 with the criterion measure in

Table 6

Comparison of the Engineering Persistence Scale with the SVIB Engineering Scale and with McCampbell's General Engineering Scale

Comparison	SVIB Engr. Scale	Engr. Persistence Scale	McCampbell's Engr. Scale
Number of Significant Items	75	177	261
Number of Significant Alternatives	178	283	562
Positive Alternative Weights	81	131	268
Negative Alternative Weights	97	152	294
Reliability	.74	.95	.50
Correlation with Criterion	.26*	.26*	.29*
Directional Overlap	87%		56%
Correlation with Engr. Persistence Scale	.67*		.64*

*Significant at or beyond the .05 level.

cross-validation as noted in Table 6. While there was a .03 difference in correlation with the criterion between the Engineering Persistence Scale and McCampbell's Engineering Scale, this was not considered significant. McCampbell's Scale correlated .64 with the author's EPS interest scale which was significant at the .05 level. The Engineering Persistence Scale was more reliable than McCampbell's scale using this particular sample. The reliability estimate for the author's EPS scale as previously noted was .95 as compared with .50 for McCampbell's General Engineering Scale. The percentage of directional overlap between the two scales was 56 per cent.

An analysis of the scale content is presented to describe the difference in interests between those students who continued in engineering for four semesters and those students who withdrew or transferred from engineering during this period. The discriminating items and item alternative weights for the Engineering Persistence Scale are presented in Appendix A. The "stay" engineering group had greater interest in occupations involving science, scientific research, technology and detail work in contrast to the "leave" engineering group. Those students preferred occupations involving sales, social-personal occupations, and occupations of an aesthetic orientation. The "stay" group endorsed the following occupations: Designer, Electronic Equipment, Electronics, Technician, Chemist, Civil Engineer, Draftsman, Electrical Engineer, Inventor, Laboratory Technician, Scientific Research Worker, and Watchmaker. The "leave" criterion group had a preference for Occupations such as Life Insurance Salesman, Manufacturer, Real Estate Salesman, Athletic Director, and YMCA Worker. The students who continued in engineering preferred academic subjects in the area of science, mathematics, humanities and social science subjects. The School Subjects for the "stay" in engineering group included: Algegra, Calculus, Chemistry, Geometry, Mathematics, Mechanical Drawing, Physics, and Shop Work. The School Subjects for the "leave" engineering group were the following: Dramatics, English Composition, Philosophy, Psychology, and Sociology. Concerning Amusements and Activities, the "stay" criterion group preferred amusement activities such as, Solving Mechanical Puzzles, Popular mechanics magazines, Repairing a clock, Repairing electrical wiring, Doing research work, Developing a machine operation theory, and Trying to improve the design of a machine. In contrast the "leave" criterion group preferred more social and personal contact amusements and activities, teaching, and sales related activities. These activities included: Conventions, Leading a Boy Scout troop, Night Clubs, Biographies, Planning a large party, Magazines about art and music, Giving "First-Aid" assistance, Interviewing men for a job, Interviewing clients, Starting a Conversation with a stranger, Teaching children, and Discussing the purpose of life. In response to their abilities, feelings about people and personal characteristics, the students who continued in engineering felt they were inventive, were prompt in their work, and could write well organized reports. Those students who left engineering showed a greater endorsement for certain types of people and political groups, such as, Beachcombers, Public opinion interviewers, Foreigners, Democrats, Republicans and Socialists. This group also expressed an interest in such activities as advertising for a machine, becoming a member of the supreme court, and Chairman of an Entertainment Committee.

As was previously mentioned in Chapter 3, the "stay" and "leave" criterion group profiles in the SVIB Basic Scales were compared to provide further information concerning the content of the Engineering Persistence Scales. The two criterion groups differed significantly on the Office Practices, Mathematics, Science, Mechanical, Adventure, and Writing Scales. The "stay" criterion group scored significantly higher on the Mathematics, Science, and Adventure Scales presented in Table 7. These scales included a preference for such academic subjects as Algebra, Calculus, Geometry, and Physics.

Table 7

Profile of SVIB Basic Scales for the 1967 Freshman Engineering Criterion Groups Utilized in Cross-Validating the Engineering Persistence Interest Scale

Scale	Mean Standard Score: "Stay" Group	Mean Standard Score: "Leave" Group	Mean Difference
Public Speaking	50.54	52.13	-1.59
Law/Politics	51.22	52.35	-1.13
Bus. Management	45.85	47.15	-1.30
Sales	47.64	49.65	-2.01
Merchandising	45.34	47.69	-2.35
Office Practices	46.34	49.96	-3.62[a]
Military Activities	51.82	50.07	1.75
Tech. Supervision	46.13	45.13	1.00
Mathematics	58.64	57.22	1.42[a]
Science	57.06	54.81	2.25[a]
Mechanical	53.52	48.65	4.87[a]
Nature	40.81	40.44	.37
Agriculture	45.62	44.89	.73
Adventure	62.93	60.13	2.80[a]
Recreational Leadership	52.65	51.96	.69
Medical Services	49.46	50.00	- .04
Religious Activities	50.90	50.17	.73
Teaching	47.01	49.09	-2.08
Music	47.78	49.85	-2.07
Art	47.13	48.83	-1.70
Writing	48.04	50.83	-2.79[a]

[a]Difference between means significant at or beyond the .10 level.

The Adventure and Science Scales included occupations and activities, such as Climbing along the edge of a precipice, Auto racing, Taking a Chance, Scientific Research Worker, Chemist, Laboratory technician, Author of a technical book. The "leave" criterion group scored significantly higher on the Office Practices and Writing scales, which included a preference for such occupations and activities as Bank Teller, Office Manager, Retailer, Bookkeeping, Author of a Novel, Editor, Reporter, Literature, and English composition.

Based upon the results of the cross-validation study, the Engineering Persistence Scale, in conjunction with 12 other academic ability, achievement, and interests measures appeared to possess the most discrimination power on a preliminary basis for a two-group discriminant function analysis (BMD 05M-Discriminant Analysis - Several Groups) program. These variates are presented in Table 8, which indicates the interscale correlation and the correlation of each variate with the criterion measure. When these 13 variates were combined to determine whether singly or in combination they were able to differentiate the "stay" from the "leave" criterion groups, the computor program yielded a generalized Mahalanobis D-Square value of 58.84. This value was used as the Chi-square value with 13 degrees of freedom to test the null hypothesis that the mean values were the

Table 8

Intercorrelation Matrix Between 13 Academic Achievement, Ability, and Interest Measures and the Criterion Measure

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1		.7	.07	.21*	-.08	.11	-.09	-.22*	-.19	-.40	-.01	-.10	-.01	-.16
2			.44	.26	.09	-.06	.42*	.32*	.18	.22	.10	-.03	.23*	.15
3				.47	.13	.17	.66*	.54*	.27*	.24*	.04	.02	.06	.13
4					.30*	-.01	.70*	.48*	-.11	.25*	.15	-.10	-.04	.27*
5						.18	.26*	-.13	-.21*	-.11	-.15	-.01	-.01	.13
6							.04	-.29	.08	-.49	.16	.34*	.04	-.12
7								.64*	.11	.28*	-.05	-.06	.02	.29*
8									.29*	.67*	.06	-.07	.09	.26*
9										.29*	.25*	.33*	.27*	.13
10											-.04	-.07	.07	.26*
11												.32*	.32*	.14
12													.39*	.12
13														.16

*Significant at or beyond the .05 level.

(1) Office Practices
(2) Mathematics
(3) Science
(4) Mechanical
(5) Adventure
(6) Writing
(7) McCampbell's Gen. Gngr. Scale
(8) Engineering Persistence Scale
(9) Academic Achievement Interest Scale
(10) SVIB Engineering Scale
(11) HSR
(12) SAT-Verbal
(13) SAT-Mathematics
(14) Stay or leave Engineering

same in the two criterion groups for these 13 variables. The Chi-square value of 58.84 was significant beyond the .01 level as noted in Table 9. Thus, the null hypothesis was rejected and the alternative hypothesis accepted. In an evaluation of the classification function for each case in both criterion groups, the percentage of "hits" for the "leave" criterion group was 68.52 per cent. The percentage of "hits" for the "stay" criterion group was 71.33 per cent. This information is presented in Table 12. From the discriminant function analysis coefficients for the 13 variables, it was observed that the Mathematics Basic Scale appeared to add the most significant contribution to the discrimination of these two groups. The author's scale appeared to contribute very little to the discrimination between these two groups as noted in Table 15. A second discriminant function analysis program was conducted to determine whether these two criterion groups could be separated without the SVIB Mathematics Basic Scale and to determine which variables singly and in combination contributed to the discrimination of these two groups. The Chi-square value of 58.54 was significant beyond the .01 level demonstrating that the two groups could be differentiated effectively without the Mathematics Scale. The Percentage of "hits" for the "leave" criterion group was 68.52 percent as in the

Table 9

Approximate Chi-Square Value for the Latent Root of 13 Academic Achievement, Ability and Interest Variates from a Two-Group Analysis

Root	df	Approximate Chi-Square Value
1		58.84**

**Significant at or beyond the .01 level.

Table 10

Approximate Chi-Square Value for the Latent Root of 12 Academic Achievement, Ability and Interest Variates from a Two-Group Analysis

Root	df	Approximate Chi-Square Value
1	12	58.54**

**Significant at or beyond the .01 level.

Table 11

Approximate Chi-Square Value for the Latent Root of Three Interest Variates and One Academic Achievement Variate from a Two-Group Analysis

Root	df	Approximate Chi-Square Value
1	4	19.52**

**Significant at or beyond the .01 level.

Table 12

Classification Matrix of Two-Group Analysis for 13 Academic Achievement, Ability, and Interest Variates

	Predicted Group Membership			
Actual Group Membership	(1) Leave Engr.	(2) Stay in Engr.	Totals	Percentage of Hits
(1) Leave Engineering	37	17	54	68.52
(2) Stay in Engineering	43	107	150	71.33
Totals	80	124	204	

Table 13

Classification Matrix of Two-Group Analysis for 12 Academic Achievement, Ability and Interest Variates

Actual Group Membership	Predicted Group Membership (1) Leave Engr.	Predicted Group Membership (2) Stay in Engr.	Totals	Percentage of Hits
(1) Leave Engr.	37	17	54	68.52
(2) Stay in Engr.	42	108	150	72.00
Totals	92	125	204	

Table 14

Classification Matrix of Two-Group Analysis for Three-Interest Variates and One Academic Achievement Variate

	Predicted Group Membership			
Actual Group Membership	(1) Leave Engr.	(2) Stay in Engr.	Totals	Percentage of Hits
(1) Leave Engineering	33	21	54	61.11
(2) Stay in Engr.	53	97	150	64.67
Totals	86	118	204	

Table 15

Discriminant Function Analysis Coefficients for 13 Academic Achievement, Ability, and Interest Variables Utilized in a Two-Group Analysis of the Cross-Validation Sample for 1967 Freshman Engineering Students at Purdue University

Variables	Coefficient
Office Practices	.71
Mathematics	3.69
Science	.88
Mechanical	.43
Adventure	.26
Writing	.50
McCampbell's General Engineering Scale	- .68
Engineering Persistence Scale	- .39
Academic Achievement Interest Scale	- .46
SVIB Engineering Scale	1.00
High School Rank	.75
Scholastic Aptitude Test-Verbal	.04
Scholastic Aptitude Test-Mathematics	.00

first analysis. The percentage of "hits" for the "stay" criterion group was 72 per cent, as presented in Tables 10 and 13. A combination of four variables was observed to add the most significant contribution to the discrimination of these two groups, as indicated by their discriminant function analysis coefficients. These variables were the Office Practices Basic Scale, the Science Basic Scale, the SVIB Engineering Scale and High School Rank. Similar to the first analysis, the contribution of the author's scale to the discrimination of these two groups was insignificant, as noted in Table 16.

The four variables which contributed the most both singly and in combination for these two discriminant factor analyses were combined to determine if they could discriminate the criterion group and which variates added the most unique contribution to this discrimination. Again, the Chi-square value of 19.52 with four degrees of freedom was significant at the .01 level indicating that these four variables in combination discriminated the "stay" and "leave" criterion groups. The percentage of "hits" for the "leave" criterion group was 61.11 per cent. The percentage of "hits" for the "stay" criterion group was 64.67 per cent as presented in Tables 11 and 14. In considering the discrimination power of these four variables, the SVIB mathematics Basic Scale, both singly and in combination contributed more than did the

Table 16

Discriminant Function Analysis Coefficients for 12 Academic Achievement, Ability, and Interest Variables Utilized in a Two-Group Analysis of the Cross-Validation Sample for 1967 Freshman Engineering Students at Purdue University

Variables	Coefficient
Office Practices	.92
Science	1.10
Mechanical	.13
Adventure	.55
Writing	.31
McCampbell's General Engineering Scale	.20
Engineering Persistence Scale	- .47
Academic Achievement Interest Scale	- .32
SVIB Engineering Scale	1.26
High School Rank	.84
Scholastic Aptitude Test-Verbal	.03
Scholastic Aptitude Test-Mathematics	.00

other three variates to the discrimination of these two criterion groups, as indicated by its discriminant function analysis coefficient, 3.48, presented in Table 17.

The Mathematics Basic Scale is a six-item scale composed of the following items: Algebra, Arithmetic, Calculus, Geometry, Mathematics, and Physics. The content and item weights are presented in Table 18. In a comparison of the Mathematics Basic Scale item alternative weights with the Engineering Persistence Scale item weights, it was observed that these items were heavily weighted on the Engineering Persistence Scale, two items with multiple weights of three, and three items with multiple weights of two. A further discussion of the relationship between these two scales in presented in the Discussion section of the present chapter.

Development and Cross-Validation of the Academic Achievement Interest Scale

Similar to the Engineering Persistence Scale, an Academic Achievement Interest Scale (AAIS) was developed based on the item alternative responses of 494 engineering students who had completed two semesters in the engineering program at Purdue University. The scale was composed of 118 items which differentiated the academically more successful engineering students, (second semester graduation index above 4.40) from the less

Table 17

Discriminant Function Analysis Coefficients for Three Interest Variables and One Academic Achievement Variable Utilized in a Two-Group Analysis of the Cross-Validation Sample for 1967 Freshman Engineering Students at Purdue University

Variables	Coefficient
Mathematics	3.48
Science	.25
SVIB Engineering Scale	.00
High School Rank	.90

Table 18

Comparison of the Mathematics Basic Scale Weights with the Engineering Persistence Scale Weights

	Mathematics Basic Scale			Eng. Pers. Interest Scale		
Item	L	I	D	L	I	D
101 Algebra	1		-1	1	-1	
103 Arithmetic	1		-1			
107 Calculus	1		-1	1	-1	-1
115 Geometry	1		-1	1	-1	-1
120 Mathematics	1		-1	1	-1	
128 Physics	1			1		-1

successful engineering students (second semester graduation index below 4.40) over a two semester period. This scale was composed of 91 positive alternative weights and 82 negative alternative weights and in cross-validation correlated .27 with second semester graduation index, used as the criterion measure in the cross-validation study. This information is presented in Table 19. In comparison, the SVIB Academic Achievement Scale is composed of 122 items with 51 positive alternative weights and 65 negative alternative weights and correlated .19 with the cross-validation measure. There was a directional overlap between the two scales of 79 per cent. The correlation between the two scales was .45 which was significant at the .05 level, as noted in Table 19. The magnitude of the internal consistency estimates of reliability for the Academic Achievement Interest Scale with the cross-validation sample was found to be greater than the SVIB Academic Achievement Scale using the Kuder Richardson Formula 21. The author's interest scale had a reliability estimate of .90 while the estimate of reliability for the SVIB Academic Achievement Interest Scale was .67.

In comparison with the author's Engineering Persistence Scale, the Academic Achievement Interest Scale was shorter (177 items versus 118 items) with fewer weighted alternatives (283 versus 173). Both scales had similar

Table 19

Comparison of the Academic Achievement Scale with the SVIB Academic Achievement Scale

Comparison	Academic Achievement Scale	SVIB Academic Achievement Scale
Number of Significant Itesm	118	55
Number of Significant Alternatives	173	122
Positive Alternative Weights	91	57
Negative Alternative Weights	82	65
Reliability	.90	.67
Correlation with Criterion	.27*	.19[a]
Directional Overlap	79%	
Correlation between Scales	.45*	

[a]Significant at or beyond the .10 level.

*Significant at or beyond the .05 level.

correlation with their criterion group (Engineering Persistence Scale .26, Academic Achievement Interest Scale .27). The directional overlap between the two scales was 63 per cent. The scales had an intercorrelation of .29 which was significant at the .05 level. The Engineering Persistence Scale was slightly more reliable with a .95 coefficient as compared with .90 for the Academic Achievement Interest Scale as presented in Table 20. This difference was attributed to the greater length of the author's EPS scale.

A description of the item content is presented to provide a better understanding concerning the difference between the interests of these two groups. The discriminating item and item alternative weights are presented in Appendix A. The "high" academic achievement engineering students endorsed occupations in the physical and social science areas, as well as positions of an academic and political nature. The Occupations included Auctioneer, Chemist, College Professor, Employment Manager, Judge, Magazine Writer, Psychologist, School Teacher, Scientific Research Worker, and Social Worker. In contrast, the "low" academic achievement engineering students had fewer endorsements in the Occupational area, but expressed a disinterest in certain of the above occupations which included: Chemist, College Professor, Judge, Politician and School Teacher.

Table 20

Comparison of the Engineering Persistence Interest Scale with the Academic Achievement Interest Scale

Comparison	Persistence Engr. Interest Scale	Engr. Acad. Achievement Interest Scale
Number of Significant Items	177	118
Number of Significant Alternatives	283	173
Positive Alternative Weights	131	91
Negative Alternative Weights	152	82
Reliability	.95	.90
Correlation with Criterion	.26*	.27*
Directional Overlap	63%	
Correlation Between Scales	.29*	

*Significant at or beyond the .05 level.

The more academically successful engineering students expressed an interest in School Subjects which involved mathematics, theoretical and philosophical subjects, and the physical and social sciences. These subjects included Calculus, Chemistry, Philosophy, Psychology, and Sociology. Again, the less academically successful group had fewer endorsements for school subjects and a disinterest for the subjects which the academically more successful students had endorsed. This disinterest included subjects such as Calculus, Chemistry, Geology, and Psychology. Concerning interests in Amusements and Activities, the "high" academic group preferred two amusements which included Solving mechanical puzzles, and Writing a one-act play. They expressed interest in activities which involved discovery, the possibility of advancement and promotion, supervisory activities and prestigeous activities. Such activities included the following: Taking responsibility, continually changing activities, Developing business systems, Discover an improvement in the design of the machine, Opportunity for promotion, Member of the Supreme Court, and Chairman, Educational Committee. In terms of a Preference Between Two Items, this group had a preference for independence in their work, inside work involving mental activity, and a preference for few close friends. In contrast, the lower academically achievement group had a stronger endorsement for amusements which included diverse amusements such as Sketching pictures of wild animals, Playing the piano, Amusement Parks, Picnics, Night clubs, and Biographies. The activities of this group included: Starting a conversation with a stranger, Drilling soldiers, Supervising the manufacture of the machine, a preference for salary received for work, General of the Army, and Chairman, Entertainment Committee. In terms of a preference for one of two activities, this group preferred: to be a Taxi cab driver, and Thrilling, dangerous activities.

In terms of preference for certain Types of People and an estimate of one's own Abilities and Characteristics, the academically "high" group did not strongly endorse any one group of people but had a dislike for the following types: Socialists and Nonconformists. Considering their own abilities and characteristics, the "high" criterion group described themselves as: Have more than my share of novel ideas, My grades in high school were a fairly accurate reflection of my abilities, Am always on time with my work, and Can write a concise, well-organized report. The "low" academic group had a stronger endorsement for different types of people which included the following: Ballet dancers, famous Chefs, Women athletes, Acrobats, Artistic men, and Very old people. This group perceived their abilities and characteristics in the following manner: Make decisions immediately, not after considerable thought, Win friends easily, Usually liven up the group on a dull day, and Can smooth out tangles and disagreements between people. Similar to the Engineering Persistence Scale, the profiles of the "high" and "low" Academic Achievement group were compared on the 22 SVIB Basic Scales to further explain the differences in interest content between the two groups. The Mathematics Basic Scale was the only scale upon which these two groups differed significantly (.10 level), as presented in Table 21. The "High" academic group had a stronger endorsement for Mathematics School Subjects than the "low" academic group as in the case of the "stay" criterion. The more academically successful group had a higher Mean Standard Score on the following scales: Public Speaking, Business Management, Office Practices, Mathematics, Science Mechanical, Nature, Teaching, and Music Scales. While the less academically successful group had a higher mean standard score on the Military Activities, Nature, Adventure, and Art Scales. These results appeared to be supported by the differences between the two groups on the 22 SVIB Basic Scales.

In cross-validating the Academic Achievement Interest Scale to determine if it were significantly related to the criterion measure, second semester graduation

Table 21

Profile of SVIB Basic Scales for the 1967 Freshman Engineering Criterion Groups Utilized in Cross-Validating the Academic Achievement Interest Scale

Scale	Mean Standard Score		Mean Difference
	High Group	Low Group	
Public Speaking	51.57	50.09	1.48
Law/Politics	52.37	50.93	1.44
Bus. Management	46.60	45.00	1.60
Sales	48.48	48.42	.06
Merchandising	46.17	45.64	.53
Office Practices	47.77	46.38	1.39
Military Activities	50.87	52.47	-1.60
Tech. Supervision	46.45	44.97	1.48
Mathematics	58.42	57.34	1.08[a]
Science	56.48	56.09	.39
Mechanical	52.80	52.48	.32
Nature	40.61	41.45	- .84
Agriculture	45.89	45.86	.03
Adventure	62.22	63.92	-1.70
Recreation Leadership	52.94	52.16	.78
Medical Services	49.57	49.51	.06
Social Services	51.34	51.87	- .53
Religious Activities	50.80	50.21	.59
Teaching	47.32	45.98	1.34
Music	48.30	47.25	1.05
Art	47.57	48.37	- .80
Writing	48.87	48.52	.35

[a]Difference between means significant at or beyond .10 level.

index, it was found that the author's scale correlated .27 with the criterion measure, which was significant at the .05 level. As in the case of the Engineering Persistence Scale, 29 other academic achievement, Ability and interest measures were correlated with the criterion measure. The results indicated that five of these variables correlated significantly at or beyond the .10 level with the second semester graduation index, as presented in Table 22. These variables included the Author's Academic Achievement Interest Scale, The SVIB Academic Achievement Scale, High School Rank, the Scholastic Aptitude Test-Verbal section, and the Scholastic Aptitude Test-Mathematics section. It was observed that High School Rank had the highest correlation, .51 with the criterion measure and the SVIB Academic Achievement Scale had the lowest correlation, .19 with second semester graduation index.

An Intercorrelation Matrix was developed among these five measures, as presented in Table 23. The author's Academic Achievement Interest Scale was related most significantly with the SVIB Academic Achievement Scale and with the Verbal section of the Scholastic Aptitude Test. High School Rank was related significantly to both sections of the Scholastic Aptitude test. Also, both sections of the Scholastic Aptitude Test were related significantly.

Table 22

Correlations Between Five Academic Predictors and the Criterion for the Cross-Validation Sample of 1967 Freshman Engineering Students at Purdue University[1]

Variables	Correlation with Criterion
(1) & (6)	.27**
(2) & (6)	.19*
(3) & (6)	.51**
(4) & (6)	.32**
(5) & (6)	.36**

*Significant at or beyond the .10 level.

**Significant at or beyond the .05 level.

[1] Variable Numbers are as follows:

(1) Engineering Academic Achievement Interest Scale

(2) SVIB Academic Achievement Scale

(3) High School Rank

(4) Scholastic Aptitude Test-Verbal (SAT-V)

(5) Scholastic Aptitude Test-Mathematics (SAT-M)

(6) Criterion of Second Semester Graduation Index

Table 23

Intercorrelation Matrix[1] Between Five Academic Predictors for the Cross-Validation Sample of 1967 Freshman Engineering Students at Purdue University

Variable	(2)	(3)	(4)	(5)
(1)	.45*	.25*	.33*	.27*
(2)		.25*	.26*	.21*
(3)			.32*	.32*
(4)				.39*

*Significant at or beyond the .05 level.

[1]Variable Numbers are as follows:

(1) Engineering Academic Achievement Interest Scale

(2) SVIB Academic Achievement Scale

(3) High School Rank

(4) Scholastic Aptitude Test-Verbal (SAT-V)

(5) Scholastic Aptitude Test-Mathematics (SAT-M)

(6) Criterion of Second Semester Graduation Index

The BMD O2R Stepwise Regression Computer Program was used to determine what contribution each variable was making both independently and in combination to the prediction of the criterion measure, second semester graduation index. This program also was used to suggest the otpimal solution in predicting the criterion measure, using all five variables, and by deleting one variable at a time until all possible combinations had been utilized. A summary of the Stepwise Regression results is presented in Table 24.

Using all five variables, the multiple correlation with the criterion measure was .54. A combination of the Academic Achievement Interest Scale, High School Rank, and the Scholastic Aptitude Test-Mathematics Section was the most efficient combination correlating .53 with the criterion measure.

Removing the author's Academic Achievement Interest Scale, the multiple correlation with the criterion was .48. The optimal solution consisted of the SVIB Academic Achievement Scale, High School Rank, and the Scholastic Aptitude Test-Mathematics section.

Subtracting the SVIB Academic Achievement Scale, the multiple correlation was .54 similar to the combination of all five variables. The optimal solution included the author's Interest Scale, High School Rank, and the Scholastic Aptitude Test-Mathematics, which correlated .53 with the criterion measure.

Table 24

Summary of Stepwise Regression Results for Five Academic Predictors for the Cross-Validation Sample of 1967 Freshman Engineering Students at Purdue University[1]

	Variables Utilized					Beta Weights					Multiple	
Problem	1	2	3	4	5	1	2	3	4	5	R	RSQ
A. Tot.	X	X	X	X	X	.03	.00	.02	.01	.01	.54*	.29
A. Opt.	X		X		X	.03		.02		.01	.53*	.28
B. Tot.		X	X	X	X		.01	.03	.01	.01	.48*	.23
B. Opt.		X	X		X		.01	.03		.01	.48*	.23
C. Tot.	X		X	X	X	.03		.02	.01	.01	.54*	.29
C. Opt.	X		X		X	.03		.02		.01	.53*	.28
D. Tot.	X	X		X	X	.04	.01		.01	.01	.46*	.21
D. Opt.	X			X	X	.04			.01	.01	.45*	.20
E. Tot.	X	X	X		X	.03	.00	.02		.01	.54*	.29
E. Opt.	X		X		X	.03		.02		.01	.53*	.28
F. Tot.	X	X	X	X		.03	.00	.02	.01		.54*	.29
F. Opt.	X		X	X		.03		.02	.01		.53*	.28

*Significant at or beyond the .05 level.

[1]Variable numbers are as follows:

(1) Engineering Academic Achievement Interest Scale
(2) SVIB Academic Achievement Scale
(3) High School Rank
(4) Scholastic Aptitude Test-Verbal (SAT-V)
(5) Scholastic Aptitude Test-Mathematics (SAT-M)
(6) Criterion of Second Semester Graduation Index

Deleting High School Rank, the multiple correlation was .46 with the criterion measure. The most efficient combination included the Academic Achievement Interest Scale and both the SAT-V and SAT-M Scales, which correlated .45 with second semester graduation index. Omitting the Scholastic Aptitude Test-Verbal Section, resulted in a multiple correlation of .54 with the criterion, the same as when all five variables were included. The most efficient combination was the author's interest scale, High School Rank, and the Scholastic Aptitude Test-Mathematics section, which correlated .53 with the criterion. Eliminating the Scholastic Aptitude Test-Mathematics Section, produced a similar multiple correlation of .54 with second semester graduation index. The optimal solution for predicting the criterion included the Academic Achievement Interest Scale, High School Rank and the Scholastic Aptitude Test-Mathematics section, which correlated .53 with the criterion. It was observed that only when the Academic Achievement Interest Scale and High School Rank were deleted from the combination of Variables did the multiple correlation with the criterion drop considerably. Thus these two variables in combination with the SAT-M Scale appeared to be the optimal solution to predict second semester graduation index.

Discussion

On the basis of a preliminary cross-validation, the Engineering Persistence Scale appeared to be both statistically related and content related to the interests of students who successfully pursued an engineering curriculum for four semesters. When analyzed further with 12 other academic achievement, ability and interest measures to determine if such a combination could discriminate the "stay" from the "leave" engineering criterion groups it was found that such a combination effectively discriminated these two groups but the author's scale contributed very little to this discrimination. The SVIB Mathematics Basic Scale, a six item mathematical content scale, appeared to contribute more significantly to the discrimination of these two groups than any other variable. The items composing this scale are highly intercorrelated, e.g., the Mathematics item correlates .75 with the Algebra item, and .79 with the Arithmetic item. As was previously noted in Chapter 3, the Basic Scales were slightly less stable over time than the occupational scales; the longer length attributed as the reason (Campbell et al., 1967). However, it was found that the most reliable basic scale over a 22 year period was the Six Item Basic Mathematics Scale. It was concluded that short scales, if their content is homogeneous, can be as reliable as longer scales. Finally, it was observed that the author's scale was heavily weighted on the items which composed the SVIB Mathematics Basic Scale.

Concerning the comparison between the SVIB Engineering Scale, McCampbell's General Engineering Scale, and the Engineering Persistence Scale, all three scales appeared to be weighted in a similar manner as indicated by the percentage of directional overlap. This was to be expected as the SVIB Engineering Scale was developed using employed engineers and the middle third of a "men-in-general" group as the high and low criterion groups. McCampbell's General Engineering Scale was developed from 500 blanks obtained from seven engineering specialty groups. However, the Engineering Persistence Scale was considerably longer than the SVIB Engineering Scale. McCampbell's General Engineering Scale was developed from 500 blanks obtained from seven engineering specialty groups. The Engineering Persistence Scale had a significantly greater estimate of internal consistency than did either of the other two scales, which was explained in part by its length and by the fact that the cross-validation sample used to obtain the reliability estimate was more homogeneous being drawn from the same engineering group used in developing the Engineering Persistence Scale. Similar to the Engineering Persistence Scale, both of these scales appeared to be related significantly to the criterion measure, "stay" in engineering, on a preliminary cross-validation. McCampbell's scale contributed a very small proportion to the discrimination of the two groups when combined with twelve other variates in a Discriminant Function analysis program. This result was unusual, since Haddock (1968) was able to differentiate 1966 engineering students who had continued in the program for three semesters from those students who had withdrawn from engineering during this period. The SVIB Engineering Scale appeared to contribute significantly more to the discrimination of the two criterion groups using the discriminant function analysis program. Perhaps another statistical procedure would have yielded different results. However, the discriminant function analysis program was considered to be appropriate as the data were composed of continuous variable and a dichotomous criterion.

However, the results indicated that it was possible to differentiate between those students who continued in an engineering program for four semesters and those students who either withdrew or transferred out of engineering on the basis of 13 academic ability, achievement, and interest measures. The SVIB Mathematics Basic Scale appeared to make the most significant contribution to the discrimination of the "stay" and "leave" engineering criterion groups in combination with High School Rank, the Basic Science Scale, and the SVIB Engineering Scale.

In reviewing the literature on the relationship between interests and academic achievement Berdie (1960) noted that the relationship was so slight that it was of little practical use in making predictions concerning academic achievement. Mahew (1965) noted that high school rank when combined with certain scholastic ability measures has resulted in correlations between .37 and .83 with freshman grade point averages. Fishman and Pasanella (1960) indicated that when more than these two measures were utilized, the gains in correlation with freshman grades were very slight.

The results of the present study indicated that it was possible to develop an Academic Achievement Interest Scale which was significantly related to the cross-validation criterion measure, second semester graduation index. This scale in combination with high school rank, the SAT-M scores, the SAT-V scores, and the SVIB Academic Achievement Scale correlated .54 with the criterion measure. Using high school rank alone, the correlation with second semester graduation index was .44, which meant that high school rank was predicting over 19 per cent of the variance as noted in Table 25. When high school rank was combined with the

Table 25

Summary of the Contribution of Each of Five Academic Achievement, Ability, and Interest Measures to the Multiple Correlation with the Criterion Measure[1]

Step Number	Variable Entered	Multiple R	R Square	Increase in R Square
1	High School Rank (3)	.44	.19	.19
2	Academic Achievement Interest Scale (1)	.51	.26	.07
3	Scholastic Aptitude Test-Mathematics Section (5)	.53	.28	.02
4	Scholastic Aptitude Test-Verbal Section (4)	.54	.29	.006
5	SVIB Academic Achievement Scale (2)	.54	.29	.003

[1]1. Academic Achievement Interest Scale
2. SVIB Academic Achievement Interest Scale
3. High School Rank
4. Scholastic Aptitude Test-Verbal Section
5. Scholastic Aptitude Test-Mathematics Section

The optimal solution for predicting second semester graduation index was a combination of High School Rank, the academic Achievement Interest Scale, and the SAT-M Scores, which correlated .53 with the criterion. However, the greatest decrease in the multiple correlation with the criterion occurred when both the High School Rank and the author's AAIS Scale were deleted. The multiple $\underline{R}$ dropped from .54 to .48 when the author's scale was omitted and from .54 to .46 when High School Rank was deleted. Thus, these two variables made the most significant contribution to predicting the variance of the criterion measure.

Those students who were more academically successful appeared to be more interested in the physical and social sciences and in academic employment, in contrast to the interests of students who were less academically successful. The more successful students expressed an academic interest in the scientific, theoretical, and philosophical subjects in contrast to the less academically successful students who expressed a disinterest for these subjects. This result was interpreted as a reflection of their poorer performance in this area. The academically successful student preferred activities which offered opportunity for promotion, supervisory responsibilities, and positions of prestige. This group also appeared to be desirous of independence in their work and preferred few close friends. In contrast the less academically successful group had a preference for more diverse activities which ranged from sketching pictures of wild animals to playing the piano. This group also had a stronger preference for certain types of people than the more academically successful group, who appeared to be more introverted and conservative in their views concerning political groups. Perhaps, this group may become more socially oriented upon graduation as reflected by Lebold's (1968) retest of the interests of engineering graduates. The interests of engineering graduates tended to become more socially oriented upon graduation from an engineering program.

In general, the profiles of these two criterion groups on the SVIB Basic Scales appeared to confirm the results of the item analysis.

In comparing the Academic Achievement Interest Scale with the SVIB Academic Achievement Scale, both scales appeared to be similar in terms of their discriminant weights, however, the author's scale was considerably longer which was thought to account in part for its higher reliability coefficient. Despite the high percentage of directional overlap between the two scales, the intercorrelation between the two scales was moderate. Although the difference of .08 in correlation with the criterion was small, the Academic Achievement Interest

Scale added considerably more to the prediction of the criterion than did the SVIB Academic Achievement Scale when both scales were combined in a multiple correlation analysis. It was thought that the difference in samples used in constructing these two scales may have contributed to the difference between these two measures and their relationship with the criterion measure. The author's scale was developed from the same sample pool utilized in obtaining an internal consistency reliability estimate. Also the achievement interest pattern was thought to reflect the academic interests of freshman engineering students at this particular institution. Whereas the SVIB Academic Achievement Scale was constructed with a more heterogeneous group and, perhaps, is more descriptive of a general academic achievement pattern.

As previously mentioned, Strong (1943), Pierson (1947), and Sadler (1950) have found the SVIB inventoried interests to be more related to academic persistence than academic achievement. The question is raised as to whether or not these two scales are similarly measuring persistence in an engineering program. While both scales had similar correlations with their respective criterion measures upon cross-validation, similar reliability coefficients, and a high percentage of directional overlap, the correlation between the two scales was moderate ($r = .29$).

In terms of content, the Engineering Persistence group had a greater preference for occupations related to engineering sciences and technology, whereas, the Academic Achievement group had a greater preference for academic professions. Both groups had a preference for school subjects which related to mathematics. The Persistence group had a stronger preference for the social sciences, whereas, the "stay" in engineering group had a greater preference for subjects related to engineering and technology. The Persistence group more strongly endorsed mechanical activities, whereas the academic achievement group preferred activities with responsibility, business activities, and activities involving change. Both groups did not have a strong endorsement for various types of people. In terms of a preference for activities both groups were interested in improving machines, the salary received for work, and certain prestigeous positions.

In general, the Academic Achievement group appeared to be more theoretical and social science oriented in their interests as compared with the Persistence group which was interested in engineering related subjects and mechanical activities. Both groups did not endorse strongly certain types of people and both groups appeared to be similar in their preference of certain activities. In comparing the mean standard scores for each group on each scale, the "stay" group scored higher than did the "leave" group on the Academic Achievement Interest Scale. Similarly the "high" academic group scored higher on the Engineering Persistence Scale than did the "low" academic group. These results presented in Table 26 tend to reflect the percentage of overlap between the two scales.

While both the "stay" criterion group and "high" criterion group had similar scores on the Academic Achievement Interest Scale, their scores on the Engineering Persistence Scale were considerably different. It was concluded that persistence in the engineering program could not be explained by academic success alone.

In conclusion, it was possible to develop and cross-validate an Academic Achievement Interest Scale which did contribute significantly to the prediction of the criterion measure, second semester graduation index. The development of these two Engineering Interest Scales did appear to support the use of item analysis to develop interest scales which could be utilized in predicting continuance and academic success in a particular curriculum.

Table 26

Profile of the Cross-Validation Sample Groups of 1967 Freshman Engineering Students on Both the Engineering Persistence Interest Scale and the Academic Achievement Interest Scale

	Criterion Groups			
Scale	"Stay" Group	"Leave" Group	"High" Group	"Low" Group
	Mean Std. Score	Mean Std. Score	Mean Std. Score	Mean Std. Score
Eng. Persistence Interest Scale	25.08	13.52	22.48	20.19
Academic Achievement Interest Scale	14.93	11.78	14.49	10.03

CHAPTER 5

SUMMARY AND CONCLUSIONS

This study was conducted to determine if two Engineering Interest Scales could be developed which would differentiate the interests among certain groups of engineering students at Purdue University using item analysis as the statistical technique.

1194 item alternatives of the Strong Vocational Interest Blank for Men (SVIB) were used in developing these two interest scales. The purposes of this study were: 1) to determine if an interest scale could be developed and cross-validated which would differentiate the interests of students who continued in an engineering program for four semesters with a 4.00 or above graduation index from the interests of those students who either withdrew or transferred out of engineering during this period with a 4.00 or above graduation index; 2) to determine if an interest scale could be developed and cross-validated which would differentiate the interests of students who were academically successful with a second semester graduation index of 4.40 or higher from the interests of those students who were less academically successful with a second semester graduation index of below 4.40; 3) to compare the two scales developed in this study with the SVIB Engineering Scale, McCampbell's Revised General Engineering Scale, and the SVIB Academic Achievement Scale; 4) to compare the profiles of the criterion groups on the SVIB Basic Scales to determine the content of the two scales developed in this study; and 5) to report an estimate of reliability for the scales developed.

The data consisted of the SVIB item responses from a total group of 507 engineering students who completed the SVIB (Form T399) as freshmen in 1966. In constructing the Engineering Persistence Scale, the sample was divided into two groups (231 engineering students who had continued in engineering for four semesters and 90 students who had either transferred from, or withdrawn from the engineering program during the same period). In developing the Academic Achievement Interest Scale, the sample was also divided into two groups (235 engineering students who had completed two semesters in the engineering program with at least a 4.40 graduation index after the second semester and 251 engineering students who had completed two semesters in the engineering program with a second semester graduation index of below 4.40).

Item weights of ± 1 were assigned to item alternatives depending on their ability to discriminate the four criterion groups at the .10 level of significance. Using item analysis two engineering interest scales were developed. The Engineering Persistence Scale consisted of 177 significant items with 131 positive weights and 152 negative weights. This scale correlated .26 with the criterion upon preliminary cross-validation with a sample of 205 freshman engineering students who had entered Purdue University in 1967. When this scale was combined with 12 other academic ability, achievement and interest measures in a discriminant function analysis program to determine if this combination of variates could differentiate the interests of those students who continued in engineering for four semesters from the interests of those students who left during this period, it was found that such a combination significantly discriminated these two groups. This combination of 13 academic achievement, ability and interest measures was able to differentiate those students who would continue in an engineering program from those who would leave the program during a four semester period with 72 per cent accuracy, which was significantly better than chance. The author's scale did not contribute significantly to this discrimination. The combination of four variates, the Mathematics Basic Scale, High School Rank, Science Basic

Scale, and the SVIB Engineering Scale, appeared to make the largest contribution to the discrimination of these two groups. The Mathematics Basic Scale had the highest discriminant function analysis coefficient. The items which composed this scale were heavily weighted on the author's Engineering Persistence Scale.

Those students who were academically successful and continued in engineering for four semesters appeared to be interested in occupations involving electrical work, science, technology, and detailed work. Academically, these students were interested in engineering science subjects, mathematics, and technology. This group preferred activities involving mechanical work. In respect to their personal abilities and characteristics, this group considered themselves to be inventive, well-organized, and efficient. In contrast, those students who left engineering program during this four semester period preferred occupations involving sales and social personal contact. This group had a strong endorsement for the humanities and social sciences and preferred more social and personal contact activities in conjunction with an interest for teaching and sales related activities. These students expressed interests in a vareity of people and social organizations. In general, these interest patterns appeared to be reflected on the SVIB Basic Scales.

The SVIB General Engineering Scale was shorter than was the author's scale. This measure correlated .26 with the criterion measure upon preliminary cross-validation and contributed more significantly to the discrimination of the two criterion groups than the author's scale in the discriminant function analysis. The SVIB Engineering Scale correlated .67 with the author's interest scale and the percentage of directional overlap between the two scales was significant. The SVIB General Engineering Scale was not found to be as reliable as the author's scale, which was attributed to the fact that the sample used in determining the reliability estimate was from the same sample pool used in developing the Engineering Persistence Scale.

McCampbell's Revised General Engineering Scale was longer than the Engineering Persistence Scale with 268 positive and 294 negative weights. This scale also had a high correlation with the criterion upon preliminary cross-validation. Similar to the author's scale, it did not appear to contribute to the discrimination of the two criterion groups upon further cross-validation. This interest scale correlated .64 with the Engineering Persistence Scale and had a directional overlap of 56 per cent with the author's interest scale. McCampbell's scale was not found to be as reliable as the author's scale with this particular sample which was explained in the same manner as the lower reliability estimate for the SVIB Engineering Scale.

The Academic Achievement Interest Scale consisted of 118 significant items with 91 positive weights and 82 negative weights. This scale correlated .27 with the criterion measure, second semester graduation index, upon preliminary cross-validation. The author's scale and four other academic achievement, ability, and interest measures significantly related to the criterion measure, were combined in a stepwise regression analysis program to determine if singly or in combination they contributed to predicting the variance of the criterion measure. These measures also were combined in this manner to determine the optimal solution to predicting the variance of the criterion measure. A combination of High School Rank, the author's Academic Achievement Interest Scale, and the Scholastic Aptitude Test-Mathematics section provided the optimal solution correlating .53 with the criterion measure The combination of High School Rank and the Academic Achievement Interest Scale correlated .51 with the criterion. High School Rank was contributing approximately 19 per cent to the prediction of the criterion variance and the author's scale was contributing 7 per cent to the prediction of the criterion measure. The author's scale also had a reported reliability of .90 using the Kuder Richardson Formula 21.

Those students who were more academically successful liked occupations which involved the physical and social sciences as well as positions of an academic and political nature. They appeared to be interested in academic subjects which involved mathematical theory, the physical and social sciences. This group preferred activities which involved assuming responsibility and supervision, the possibility of discovery, and prestigeous activities. This group appeared to be rather introverted, preferring few friends and the opportunity for mental activity. The "high" academic group appeared to be self-confident, efficient, and well organized in their work. In contrast, the less academically successful group expressed less interest in the occupational preferences of the more academically successful students. Also this group appeared to be less interested in the academic subjects which the "high" criterion group had endorsed. This was considered to be a reflection of their poorer performance in these subject areas. The activities of the less successful students appeared to be quite diverse. This group had a strong endorsement for different types of people and described themselves as being able to make decisions quickly, and to be more socially extroverted in their relationships with others.

In comparison, the SVIB Academic Achievement Scale was shorter than the author's scale, being composed of 55 items with 57 positive and 65 negative weights. This scale correlated .19 with the criterion measure in the preliminary cross-validation, but did not contribute significantly to the multiple correlation with the criterion measure. The correlation between the two scales was moderate with a 79 per cent directional overlap. The SVIB Academic Achievement Scale was less reliable than the author's scale with a .67 reliability coefficient. Again, this was attributed in part to homogeneity of the samples used in developing and cross-validating the author's AAIS scale.

A comparison of the author's Engineering Persistence Scale with the Academic Achievement Interest Scale indicated that the Engineering Persistence Scale was longer, having 177 items with 131 positive and 152 negative weights. This scale was slightly more reliable than the Academic Achievement Interest Scale. While there was a 63 per cent overlap between the scales, the correlation between them was moderate. While there was a considerable degree of overlap, it was noted that the Engineering Persistence Scale was longer than the Academic Achievement Interest Scale. Also, the "stay" criterion group scored considerably higher on the Engineering Persistence Scale than did the "High" academic criterion group. It was concluded that persistence in an engineering program was attributed to a different interest pattern than the academic achievement interest pattern.

If one were to generalize concerning the difference in interest between these two groups, the engineering students who persevered in the engineering curriculum for four semesters appeared to be more interested in science as applied to engineering and technical and mechanical activities which also related to engineering. The more academically successful engineering students appeared to have an interest in scientific occupations as well as academic positions. Their academic interests were similar to the "Persistence" group except that this group appeared to be more theoretical and interested in the social sciences.

Implications for Counseling

As previously mentioned, the first four semesters in an engineering program are a critical period for the engineering student. It is during this period that the loss of students in terms of transferral and withdrawal is the greatest.

The author's Academic Achievement Interest Scale, in combination with high school rank, appeared to add both a statistical and practical contribution to the prediction of second semester graduation index for a sample of freshman engineering students at Purdue University.

It was felt that such a scale would benefit the academic counselor and freshman engineering student in further defining the student's engineering interests. This scale would assist the counselor to go beyond the statement "Your interests appear to be similar to the interests of men involved in engineering." It would appear that a definition of how similar the student's interests were to the interests of those students who were or were not academically successful over a two semester period would be more relevant to the student in his decision as to whether or not to pursue an engineering curriculum during this early period of his college career.

While the author's Engineering Persistence Scale did not appear to add considerably to the differentiation of the "stay" and "leave" criterion groups, it was noted that a combination of 13 academic ability, achievement, and interest measures appeared to differentiate these two groups significantly better than chance. The inclusion of an interest measure was thought to be beneficial to both academic counselors and students in assisting the student to decide whether or not to pursue an engineering program at Purdue University.

Suggestions for Further Research

In view of the preliminary cross-validation result, further research in the refinement and validation of the Engineering Persistence Scale appears to be warranted. As was noted in Chapter One, both of the scales developed in the present study are restricted in terms of generalizability to the particular samples of freshmen engineering students at Purdue University. Both of the author's scales were noted to possess an unusually high estimate of reliability as determined by the Kuder Richardson Formula 21. This unusually high estimate was attributed in part to the fact that the estimate of reliability for both scales was derived from the sampling pool used in the development of the two scales. Cross-validation of the author's Academic Achievement Interest Scale both with other freshman classes at Purdue University and at other institutions would be helpful in further determining the scale's reliability and validity.

A follow-up study to determine whether or not the interests of the more academically successful engineering students remained stable over a four year period would also be useful in determining the degree of maturity represented by this academic interest pattern at this time.

Finally, it was thought that the development of such scales for other curricula would be useful to both students and academic counselors in assisting the student to decide whether or not to pursue a particular curriculum.

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APPENDIX A

APPENDIX A

Table A1

Scoring Weights for the Engineering Persistence Scale, The SVIB Engineer Scale, and McCampbell's General Engineering Scale

Item	Engineering Persistence Scale			SVIB Engineer Scale			McCampbell's General Engineering Scale		
	L	I	D	L	I	D	L	I	D
1				-1					-1
2	-1		1	-1			-1		
3	1		-1					-1	-3
4									-1
5									-1
6	1		-1					-1	-2
7	-1	1	1	-1	1	1			
8				-1	-1	1			
9				-1		1			-1
10	1		-1	1		-1		-1	-2
11	-1							-1	
12									-1
13									-3
14								-1	-2
15							-1		
16	1		-1						
17			-1					-1	-2
18							-1		
19		1	-1						-2
20									
21							-2	-1	
22	1		-1						
23	1		-1	1		-1			-1

Table A1 (cont'd)

Item	L	I	D	L	I	D	L	I	D
24	1		-1	1	-1	-1		-1	-3
25				-1		1			-1
26				-1		1			-1
27									-3
28									-1
29				-1	-1	1			-1
30	1		-1	1		-1			-1
31	-1	1		-1		1			-1
32	1		-1	1	-1	-1		-1	-2
33									
34			-1					-1	-1
35								-1	-1
36									
37									
38									
39			-1						
40				-1		1			-1
41									
42			1	-1		1			
43	-1								
44									
45	1		-1					-2	-3
46									
47				-1		1			
48									
49	1		-1						-1
50	1								
51				-1		1			-1
52							-1		
53		-1						-1	
54	-1	-1	1	-1	-1	1	-1	-1	

Table A1 (cont'd)

Item	L	I	D	L	I	D	L	I	D
55	1		-1						-1
56			-1	1		-1			-2
57									
58	-1			1		-1			-1
59									
60									
61	1			1		-1		-1	-1
62	-1								
63				-1	-1	1			
64									
65							-1		
66				-1		1			-1
67				-1	-1	1			-2
68	-1	1							
69				-1		1			-1
70	-1		1	-1		1		-1	
71									
72	-1			-1		1			-1
73									-1
74							-1	-2	
75		1							
76									-1
77	-1		1	-1	-1	1			
78	-1			-1	-1	1			
79				-1	-1	1			
80	-1			-1	-1	1			
81		-1	1				-1		
82				-1		1			-3
83	1		-1	1		-1		-1	-1
84									
85							-1	-1	

Table A1 (cont'd)

Item	L	I	D	L	I	D	L	I	D
86				-1		1			-2
87		1	-1						
88	1								-1
89				-1		1	-1	-1	
90									
91	1		-1						
92									-1
93									-1
94	1		-1						-2
95		-1	1					-1	-1
96	-1								
97									
98	1		-1						-1
99							-1		
100	-1	1							
101	1	-1		1		-1		-3	-4
102							-1		
103								-1	-1
104									
105							-1		
106							-1		
107	1	-1	-1	1	-1	-1		-2	-4
108	1		-1	1	-1	-1		-1	
109							-1		
110	-1		1	-1		1	-1		
111							-1		
112	-1	1					-1		
113							-1		
114			-1	1	-1	-1			
115	1	-1	-1	1	-1	-1		-2	-4
116							-2		

Table A1 (cont'd)

Item	L	I	D	L	I	D	L	I	D
117							-1		
118							-1		
119		1					-2		
120	1	-1		1	-1	-1		-3	-2
121								-1	-1
122	1		-1	1	-1	-1		-1	-1
123							-1		
124									
125							-1		
126	-1	1					-2		
127			1				-1		
128	1		-1	1	-1	-1		-3	-2
129	-1						-2		
130							-2		
131				-1	1	1			
132	1		-1	1	-1	-1		-1	-2
133	-1			-1		1	-2		
134		-1	1				-1		
135									
136		1	-1				-1		
137								-1	
138									
139							-1		
140									
141									
142									
143			1				-1	-1	
144			-1						-1
145			1						-1
146									
147							-2		

Table A1 (cont'd)

Item	L	I	D	L	I	D	L	I	D
148	1		-1					-1	-2
149									
150	1	-1							
151									
152		1							
153			-1	-1		1			-1
154				-1		1		-1	-1
155								-1	-2
156									
157									
158	-1								
159			1						-2
160	-1								
161									
162	-1		1						
163							-1		
164	-1	1							
165									
166									
167		1	-1						
168	-1	1							
169									
170	-1	1	-1						
171				-1	1	1			
172		1					-1		
173			1						
174									
175	-1	1							
176									
177							-4		
178									

Table A1 (cont'd)

Item	L	I	D	L	I	D	L	I	D
179							-2		
180	1		-1				-2	-1	-1
181									
182									
183	-1								
184	-1	1		-1		1	-1		
185	1	-1	-1					-1	-2
186	1		-1						-2
187	1							-1	-2
188	1		-1					-1	-3
189			-1					-1	-2
190	1		-1	1		-1			-2
191			1				-1		
192	-1						-1		
193	1								
194							-2		
195							-1		
196	-1		1						-1
197	-1		1				-1		
198	-1		1						
199	-1			-1		1			-2
200				-1		1			
201	-1		1	-1		1			-1
202	-1	1							
203	-1			-1	1	1			-1
204									-2
205									-1
206									-1
207									
208									
209	-1						-1		

Table A1 (cont'd)

Item	L	I	D	L	I	D	L	I	D
210	1								-1
211									-1
212	1		-1					-1	-1
213									
214		-1							
215				1		-1			-1
216			-1						
217									
218	-1	1							
219							-1		
220				-1		1	-1		
221		1							-1
222			-1						
223				1		-1	-1		
224			-1				-2		
225		1						-1	-4
226									-1
227			-1						-1
228		1	-1				-1		
229									
230							-1		
231	-1	1							
232	-1	1							
233									
234							-1		
235							-1		
236							-1		
237									
238									
239	-1	1							
240							-1		

Table A1 (cont'd)

Item	L	I	D	L	I	D	L	I	D
241									-1
242							-1		
243									-1
244									
245							-1		
246		-1	1				-1		
247			-1				-2		
248									-1
249									
250		1	-1						-1
251									
252			1						
253									
254	-1								
255	-1	1							-2
256							-1		
257									
258	-1								
259		1							
260									
261									
262									-3
263									-3
264	1	-1							-3
265			-1						-1
266	-1								-1
267									
268	-1								-1
269									-1
270									-1
271	-1	1						-1	

Table A1 (cont'd)

Item	L	I	D	L	I	D	L	I	D
272		-1	1						-1
273									-1
274	-1			-1	-1	1			
275			1						
276									
277									
278									
279									
280							-2		
281	1		-1	1		-1		-1	-3
282			-1				-1		
283	1	-1	-1	1	-1	-1		-2	-2
284				1	1	-1	-1		-1
285			-1						-1
286							-1		
287	-1						-2		
288	-1			-1		1	-2	-1	
289	-1			-1	1	1	-1		-1
290	-1			-1		1	-2		
291									-2
292			-1				-2		
293									-1
294									
295								-1	
296									
297								-1	
298		-1	1				-1		
299									
300							-1		
301									-1
302									

Table A1 (cont'd)

Item	L	I	D	L	I	D	L	I	D
303	1	-1	-1					-3	-1
304	1							-2	-1
305									
306							-1		
307		1							
308	-1						-1		
309	-1	1					-1		
310							-3		
311									-1
312									
313									
314				1	-1	-1			
315			-1				-1		
316		1	-1					-1	
317	-1	1					-1		
318									
319		-1						-1	
320							-1		
321									
322				-1		1			-1
323							-2		
324				-1		1			-1
325									
326			1						
327									-2
328	1		-1				-1		
329							-1		
330									-1
331	1		-1	1		-1			-2
332	-1								
333							-1		-1

Table A1 (cont'd)

Item	L	I	D	L	I	D	L	I	D
334	-1		1						-1
335									-1
336							-1		
337	-1								
338	1			1		-1			-2
339									-1
340									
341							-1		
342							-2		
343									-4
344								-1	-1
345	-1		1				-1		
346	-1	-1	1						
347	1								-3
348				1		-1	-1		-1
349							-1		
350									-1
351									-1
352									
353							-1		
354		-1	1						
355			-1	1		-1			
356									
357									
358							-1		
359									
360									
361			1						
362									
363									
364									

Table A1 (cont'd)

Item	L	I	D	L	I	D	L	I	D
365									
366									
367									
368	1		-1	1		-1			-3
369								-1	-1
370									
371	-1	1	1						
372									
373	1		-1				-1		
374	-1						-1		
375									
376			-1					-1	
377									
378	1	-1						-1	
379								-1	-1
380							-1		
381								-1	
382									
383									
384									
385							-1		
386	-1		1						
387									
388	-1								-1
389							-1		
390									
391									
392	-1	-1	1				-1	-1	
393	1						-1		
394			1						
395							-1		

Table A1 (cont'd)

Item	L	I	D	L	I	D	L	I	D
396									
397	1								
398									
399									-1

Table A2

Scoring Weights for Both the Academic Achievement Interest Scale and the SVIB Academic Achievement Interest Scale

Item	Academic Achievement Interest Scale			SVIB Academic Achievement Interest Scale		
	L	I	D	L	I	D
1		-1	1			
2				-1		1
3						
4						
5						
6						
7						
8	1					
9				1		-1
10						
11				-1		1
12	-1	1				
13				-1		1
14						
15						
16						
17				-1	1	1
18				-1		1
19						
20						
21						
22						
23	1		-1	1		-1
24						
25						
26			-1			
27	1		-1	1	-1	-1

Table A2 (cont'd)

Item	L	I	D	L	I	D
28			-1			
29						
30						
31						
32						
33	1					
34						
35				1		-1
36						
37						
38						
39						
40						
41						
42						
43	-1					
44						
45						
46						
47	1		-1			
48						
49						
50						
51						
52						
53				1		-1
54						
55						
56				-1		1
57	1	-1				
58						

Table A2 (cont'd)

Item	L	I	D	L	I	D
59						
60						
61						
62						
63						
64	1					
65						
66				1		-1
67			1	1		-1
68			1			
69		-1		1		-1
70						
71				1		-1
72		1	-1			
73						
74						
75						
76						
77		-1	1			
78						
79						
80						
81				-1		1
82	1		-1	1		-1
83	1			1		-1
84						
85						
86						
87						
88						
89	1					

Table A2 (cont'd)

Item	L	I	D	L	I	D
90				-1		1
91						
92						
93						
94						
95			1			
96						
97	-1		1			
98			-1			
99						
100						
101				-1	-1	-1
102	-1		1			
103				1	-1	-1
104		-1	1			
105						
106						
107	1	-1	-1	1		-1
108	1		-1	1	-1	-1
109						
110						
111						
112				1		-1
113						
114			-1			
115				1	-1	-1
116						
117						
118				1		-1
119			-1			
120				1	-1	-1

Table A2 (cont'd)

Item	L	I	D	L	I	D
121						
122						
123	-1		1			
124						
125						
126	1					
127					1	
128				1	-1	-1
129	1		-1			
130				1		-1
131						
132						
133	1					
134			1			
135			1			
136				1		-1
137						
138						
139				-1	1	1
140	-1					
141						
142				1		-1
143		-1	1	-1		1
144						
145						
146						
147						
148	1	-1				
149						
150						
151	-1		1			

Table A2 (cont'd)

Item	L	I	D	L	I	D
152						
153	-1	1				
154	-1	1				
155						
156						
157						
158						
159			1			
160						
161						
162						
163						
164						
165	1					
166						
167				1		-1
168	-1					
169						
170	-1	1				
171						
172				1		-1
173						
174						
175						
176						
177						
178						
179						
180			1	-1		1
181			1			
182						

Table A2 (cont'd)

Item	L	I	D	L	I	D
183	-1		1			
184						
185						
186						
187			1	-1		1
188						
189						
190				-1		1
191						
192		-1		1	-1	-1
193						
194						
195						
196		-1				
197						
198						
199				-1		1
200						
201	-1					
202						
203				1		-1
204						
205						
206						
207	1					
208						
209						
210	-1		1			
211						
212				1	-1	-1
213						

Table A2 (cont'd)

Item	L	I	D	L	I	D
214		-1				
215						
216						
217						
218						
219						
220						
221						
222						
223						
224		1	-1			
225	1	-1				
226	1					
227						
228						
229						
230						
231		-1	1			
232			-1			
233	-1		1			
234						
235						
236	1					
237		1				
238						
239						
240	1		-1	1		-1
241						
242		-1				
243				1		-1
244	-1					

Table A2 (cont'd)

Item	L	I	D	L	I	D
245						
246						
247						
248						
249	-1	1	-1			
250						
251						
252						
253	-1					
254						
255						
256						
257						
258	-1					
259	-1	1				
260						
261		1				
262						
263						
264						
265	-1	1				
266	-1					
267						
268						
269		-1				
270						
271						
272						
273			1			
274						
275			1			

Table A2 (cont'd)

Item	L	I	D	L	I	D
276						
277						
278						
279						
280						
281		-1				
282				-1		1
283	1					
284						
285	-1					
286						
287						
288						
289				1		-1
290						
291	-1	1				
292						
293	1					
294						
295	1	-1		1	-1	-1
296						
297						
298						
299						
300			-1			
301						
302		-1	1			
303						
304						
305						
306						

Table A2 (cont'd)

Item	L	I	D	L	I	D
307	-1					
308	1	-1				
309						
310						
311		1	-1			
312						
313			-1			
314						
315						
316	1					
317	-1		1			
318			1			
319						
320						
321						
322						
323			1			
324	-1		1			
325						
326						
327						
328						
329	1	-1				
330						
331	1					
332						
333						
334						
335						
336						
337	-1	1				
338	1					

Table A2 (cont'd)

Item	L	I	D	L	I	D
339						
340			1			
341						
342			1			
343						
344						
345		-1	1	-1		1
346		-1				
347	1	-1		1		-1
348						
349						
350						
351						
352						
353				1		-1
354						
355	1		-1			
356						
357						
358		-1	1			
359						
360						
361						
362	-1		1			
363	-1					
364						
365	-1		1			
366						
367						
368						
369	1					

Table A2 (cont'd)

Item	L	I	D	L	I	D
370						
371						
372	1		-1			
373	1		-1			
374						
375						
376						
377						
378	1		-1	1	-1	-1
379						
380		-1		1		-1
381						
382						
383						
384						
385						
386	-1		1			
387						
388						
389						
390			-1			
391			1			
392						
393						
394						
395		-1	1			
396						
397						
398	1					
399						

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