A STUDY OF SELECTED ACADEMIC AND INTEREST VARIABLES IN RELATION TO ACHIEVEMENT IN A COLLEGE OF ENGINEERING

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TABLE OF CONTENTS

Chapter Page

LIST OF TABLES

Table | Page

CHAPTER I

INTRODUCTION

The nature of this problem stems from a question frequently asked by many who are concerned with engineering education at Oklahoma State University. What are the characteristics of students who are successful in engineering? To date, there is no complete agreement as to what qualifications are necessary for success in the engineering curriculum. Although there are many standardized instruments available for assessing various forms of human behavior, very little is known concerning the relationship of these measures to successfully fulfilling the requirements for graduation in the College of Engineering at Oklahoma State University. As stated by Boe (10, p. 377):

> . . . it may be easier today to rule out candidates on the basis of characteristics which are rather clearly causes of failure than to select in a positive fashion those for whom success is assured.

It seems reasonable to assume that administrators, instructors and counselors could be more effective in their work with students if projections could be made from the available information on students concerning their chances of succeeding in the study of engineering. Therefore, it seems obvious that an effort should be made to discover the combination of traits necessary to complete successfully the engineering program at Oklahoma State University. This study was undertaken with that goal in mind.

Setting of the Study

The faculty of the College of Engineering, Oklahoma State University, has recommended the establishment of a professional program for the education of potential engineers. The program will consist of a two-year preprofessional curriculum followed by a three-year professional program. Not all students will be permitted to enter the professional program. Consequently, there should be some rationale for admission or rejection of candidates to the professional program after two years of pre-engineering course work.

At the present time, the primary requisite for a student's acceptance into the professional program, after two years of preprofessional work, is a grade point average of 2.5 or higher. Consequently, this requirement could be viewed as somewhat arbitrary. It would, therefore, be advantageous to determine if there is a rationale for setting an arbitrary grade point average of 2.5 or above as a requirement for entrance into the program or if there are factors other than a specific grade point that are more indicative of success in upper division engineering work.

Statement of the Problem

The problem of this study was to determine the relationship of selected academic and interest variables to success in engineering. The Oklahoma State University College of Engineering, as well as many other colleges and universities, is particularly interested in the problems of admitting and guiding students who enroll in the engineering program. Problems that originate in connection with admitting and advising students in OSU's College of Engineering arise as a result of the following:

1. All students who enter Oklahoma State University are eligible to enter the College of Engineering.

2. All students who complete their sophomore year in engineering are subject to evaluation before they are admitted to upper division status or their junior year.

3. At the present time, there is no rationale other than arbitrary standards for admitting or rejecting students for entrance into the upper division engineering program.

Therefore, this study was designed to determine what factors available in the record of the student are most predictive of success in the study of engineering.

Justification of the Study

At Oklahoma State University, as well as at other large state-supported universities:

> . . . the requirements for admission, out of necessity, are left at a relatively low level. It, therefore, becomes the responsibility of the Division of Engineering to establish meaningful and realistic admission policies for the professional college. The primary objective in establishing guidelines for a selective admissions program would be to select and attract students who are judged to have the capacity for success in the study and practice of engineering. A corollary would be reduced rate of attrition for those students whose chances for success, for one reason or another, are better in a different field of study. (37)

High attrition rates are of great concern to those involved in engineering education in the College of Engineering at OSU as well as engineering educators throughout the nation. High attrition rates, coupled with the predictions by the Engineering Manpower Commission of the Engineer's Joint Council's forecast of shortages in our technically trained manpower pool, has brought authoritative comment from a number of deans of engineering throughout the nation:

1. Large numbers of students who are well qualified for engineering are dropping out.

2. High attrition rates cause student disillusionment which reacts against engineering and is one of the principal causes of the declining freshman enrollments. In other words, 'Why take engineering if the odds are stacked against you?'

3. There are effective ways of reducing student attrition if we would face up to the problem. (15)

Students deserve and have a right to the best information that can be obtained concerning their chances of being successful in engineering. Astin and Holland (5) reported that for purposes of predicting success, universities should, "...abandon our efforts to construct sophisticated inventories, (about the student) and instead, concentrate on securing more elaborate records of past achievement." Better advisement procedures which give students more information about their chances of success should be developed, so that students will be in a better position to judge for themselves if the odds for successful completion of the program are actually stacked against them.

The odds seem stacked against quite a number of engineering students if recent records are accurate. The Engineering Manpower Commission reported that the national dropout average for baccalaureate degree engineering programs is approximately fifty percent (18). For one reason or another, one out of every two students who entered colleges of engineering were unsuccessful.

Numerous studies have been made in the area of engineering education relative to the dropout. Griffin and Barrow (24) reported that a student with above average intelligence and a strong background in science and mathematics can generally succeed in an engineering program.

In an effort to alleviate some of the problems concerning high attrition rates, it is hoped that this data will provide informational guidelines to be used by the admission's committee in the College of Engineering for the selection and retention of students in the professional school. By providing information that increases the student's knowledge concerning the probability of his chances for success in engineering, he can either choose to continue in engineering or various alternate routes can be made available to the student to aid him in his quest for future academic success.

The following applications of the prediction factors are suggested to improve and extend the guidance work of the College of Engineering at Oklahoma State University:

1. The predictions could be used as part of a technique for determining the admission of students to the professional school status in the College of Engineering.

2. An index of probable success could be given to every student at the end of his second year of work. This might serve as a form of motivation for the better students. Also, on the basis of this information, some students might choose to transfer to other colleges on campus, after counseling, early enough to avoid a loss of time and money in their quest for academic success.

Limitations of the Study

This study was limited to those students who were classified as sophomores in the College of Engineering at the conclusion of the Spring Semester, 1966-67. Students were excluded from this study if they were classified as a transfer student, international student, or if they failed to have on record any one or a combination of the following test scores: (1) American College Test scores (ACT), (2) Cooperative Algebra Test scores (CAT), (3) Nelson-Denny Reading Test scores (NDRT), or (4) Kuder Preference Record scores (KPR).

The assumption was made that all students enrolled in engineering were exposed to comparable conditions. Although it is recognized that teacher grading criteria, quality of instruction and teacher-student relationships are of great importance, they will be treated as random variables in this study.

Definition of Terms

Success. Success is defined as graduation with a Bachelor of Science Degree in Engineering.

GPA. GPA is the acronym for grade point average. College grade point averages referred to in this report were determined by dividing the total number of grade points earned by the number of hours attempted. The points earned were determined on the basis of four points for each hour of A, three points for each hour of B, two points for each hour of C, one point for each hour of D, and zero points for each hour of F. High school grade point averages were determined by utilizing the above system with averages computed on the basis of grades earned in the total number of units attempted in the tenth, eleventh, and twelfth grades.

Procedure

Chapter I contains a definition of the problem and presents pertinent information concerning the background of the study. Chapter II contains a review of the related literature. Chapter III contains a description of the subject population, procedures, instruments, hypotheses to be tested and methods of analysis to be utilized. In Chapter IV the statistical results are presented and in Chapter V, a summary of the study along with conclusions and recommendations are presented.

CHAPTER II

A REVIEW OF RELATED LITERATURE

In this chapter a selected number of studies which have a relationship to the thesis of this investigation are discussed and summarized. In order to approach this review in a systematic fashion, the studies have been classified as follows: (1) studies related to ability and achievement and (2) studies related to interests and achievement. While most of the studies are primarily concerned with attempts that have been made to predict academic success in terms of grade point averages, few investigations have given emphasis to long-range predictions and even fewer have investigated success as defined in this study -- graduation with a Bachelor of Science in Engineering.

Research concerning engineering academic achievement is abundant, but as yet there has been little agreement as to what method best predicts engineering success with a high degree of reliability, although it is recognized that a great deal can be done to produce answers which are something more than mere opinion or guesswork.

As D. L. Adler (3) expresses it, "The problem of selecting the most promising candidates and eliminating the unfit early in the training continues to receive primary attention in engineering literature."

Studies Related to Ability and Achievement

In a study conducted at the State University of Iowa, attempts were made to select promising candidates for engineering by using the Iowa Qualifying Examination Battery as a means of predicting success in engineering. Adler concluded that the combination of the Mathematics Aptitude and English Training Tests, sub-tests of the Iowa Qualifying Battery, would yield as high predictions as the more elaborate battery. Of the original ninety-nine students studied, he found the twenty-six who graduated to be a group of definitely superior ability. No students who scored below the thirty percentile on the sub-tests were graduated from the College of Engineering. In summary, Adler (3) stated:

> . . . in the interest of sound educational guidance, the college of engineering may well consider methods of reducing its rate of scholastic mortality and directing the efforts of the unfit student into channels which promise greater personal and social growth.

Over thirty years ago, Dean R. T. Sackett (49) made the following observation concerning engineering advisement:

> The need for better selection and guidance should be emphasized again . . . too many students fail to continue because they did not have sufficient information on which to make an intelligent choice. Some of the reasons given would be ludicrous if they were not so tragic.

Berdie and his associates at the University of Minnesota have made a continuing effort to study the validities of tests used for counseling and selecting prospective engineering students. Swanson and Berdie (54) have reported a recent study which has significance for this investigation. Correlations were reported from a sample of 620 freshman engineering students between first quarter grade point averages and the following selected predictors: high school grade point averages, .39; score on the Minnesota Scholastic Aptitude Test, .34; score on the

Cooperative English Test, .37; score on the Institute of Technology Mathematics Test, .63; Composite score on the American College Testing Program, .44; Verbal score on the College Entrance Examination Board (CEEB), .41; and the Mathematics score on the CEEB, .42. It is interesting to note that Swanson and Berdie found that selected multiple correlations were only slightly higher than the independent correlations for the Institute of Technology Mathematics score and the ACT Composite score.

Baker (6), using as predictors the Purdue Physical Science-Mathematics Operations, Purdue English-Reading, ACE-Arithmetic, Purdue English-Errors, and the Purdue Physical Science-Problem Analysis, found a multiple correlation of .77 with first semester grades.

Stinson (51) studied three groups of Oklahoma State University engineering enrollees which consisted of the following: Group I was defined as those who successfully completed the program and received a Bachelor of Science in Engineering; Group II was defined as students who transferred to some other four-year program, graduating with a Bachelor's degree; and Group III was defined as those students who dropped out of college. One of her basic objectives was to determine if the three groups differed significantly in academic ability as measured by the following: the Total Score on the American Council on Education Psychological Examination, the scores on the Cooperative Algebra Test, and the scores on an English test developed at Oklahoma State University. She reported that Oklahoma State University engineering graduates scored significantly higher than non-engineering graduates on all tests except English Placement and Verbal Comprehension. Engineering graduates scored significantly higher than the drop out group on all tests of academic ability. Stinson concluded that successful engineering students must possess certain abstract abilities such as general reasoning ability to work effectively with mathematical concepts.

Boe (10) gave emphasis in his study to academic achievement in engineering in relation to four predictors: the American Council on Educational Psychological Examination (ACE), the Cooperative English Test, a locally developed Mathematics Placement Test, and the high school grade point average. Using a sample of 116 junior engineering students, his results yielded a multiple R of .54 when all indices were utilized for predicting the grade point average at the end of the junior year. The ACE combined with English yielded an R of .43 and the ACE combined with the mathematics test yielded an R of .44.

Jones (35) compared the effectiveness of the Pre-Engineering Ability Test (PEAT) and the American College Testing Program (ACT) in predicting first semester grade point averages in selected engineering courses, and reported the following results: the r between the ACT Composite and grade point average was .64, while the r as compared to PEAT and grade point average was .61.

Bowers (11), in his investigation concerning the effectiveness of predicting grade point averages from tests used in the counseling program at Oklahoma State University, compared two groups of first semester engineering freshmen. Group I consisted of 243 students. The following correlations with grade point averages were found: American Council on Education Psychological Examination, .42; Pre-Engineering Ability Test, .58; the Minnesota Paper Form Board Test, .26; and Cooperative Algebra

Test .58. Group II consisted of 492 students. The correlations were as follows: .50, .60, .17, and .55. All r's were significant at the .05 level of confidence for Groups I and II.

Ritter (46) conducted a study at Marquette University in which he concerned himself with the relationship between high school rank, American Council on Education Psychological Examination (ACE) raw score ranks, and grade point average at the end of six quarters. A correlation of .70 was found between ACE raw score rank and grade point average, but he found no relationship between high school rank and success.

McClanahan and Morgan (41), at Colorado Agricultural and Mechanical College (Colorado State University), conducted a study concerning the predictive value for engineering freshmen of tests administered to all incoming freshmen. Results obtained indicated a multiple R of .848 between first year grade point average and the following tests: (1) the American Council on Education Cooperative English Test, (2) Nelson-Denny Reading Test, (3) Iowa Placement Examination Chemistry Aptitude, (4) ACE Test and (5) high school rank. With the omission of high school rank, they found a multiple R of .848, and when only the English and chemistry tests were used, the multiple R was found to be .814. Basing a regression equation on the two tests, a standard error of estimate was yielded of .45. A follow-up study indicated that the greatest discrepancies between predicted and actual grade point average occurred at extreme grade levels.

Drake and Thomas (16) made use of the Pre-Engineering Inventory and the ACE Test in an attempt to predict grade point averages in the College of Engineering. Expectancy tables were developed which indicated the probability of a student earning a specific grade point average which was dependent upon his quartile placement on the Pre-Engineering Inventory and the ACE. The authors recommended that these data might be used for admission of borderline cases to the College of Engineering, but recommended that extreme caution should be used in using this data alone for elimination of students from the study of engineering.

In a study of freshmen engineering students at Marquette University, Mallory (40) found that aptitudes measured by the Minnesota Paper Form Board Test and the American Council on Education Test to be the best predictors of success in engineering in terms of grade point average for retention purposes.

Berdie (9) found significant correlations between first quarter grades and the Numerical Ability Test scores from the Differential Aptitude Test in a study conducted at the University of Minnesota of beginning engineering freshmen.

French (21) reported the results of a validity study that he conducted using the Scholastic Aptitude Test, verbal and mathematical; CEEB English Composition Test; high school record; and a group of recently developed aptitude tests. He compared the validities of these indices for predicting freshman grade point averages with their ability to predict four-year averages and graduation versus non-graduation. The following findings were reported:

1. Tests that are valid for predicting freshman grades are equally valid for predicting cumulative grades.

2. High school grades correlated .46 with the freshman grade point average as well as with the accumulative grade point average; high

school grades predict an overall average for the freshman year better than they predict grades in a specific area.

3. SAT-V correlated with freshman average .44 and with the accumulative average .43.

4. None of the indices had an appreciable validity for predicting graduation.

Pattishall and Banghart (44), Brown (12), Freehill (20), and Johnson (34), in their studies, revealed that students who dropped out of college had significantly lower test scores in reading than students who successfully continued their university educational program.

Hills, Bush and Klock (30) conducted an investigation in the Georgia University system to determine the ability of the Scholastic Aptitude Test scores, Verbal and Mathematics, and high school averages as predictors of accumulative sophomore and senior accumulative grade point averages. A total of 3,303 students from sixteen colleges were represented in this study. The authors, using the above predictors, found a multiple correlation of .58 for sophomore accumulative grade point averages and a multiple correlation of .65 for senior accumulative grade point averages.

Iffert (33) conducted a study concerning the attrition rates of men attending twenty colleges and universities. His findings indicate that attrition could have been reduced 17.3 percent if admission to these colleges had been limited to the upper twenty percent of the high school graduating class. Iffert concluded that the student's standing in his high school graduating class was a much better indicator of the probability of graduating from college than the student's scores on placement tests.

Studies Related to Interest and Achievement

Interest in one's course of study would appear to be of paramount importance to the student enrolled in an engineering curriculum. Why students choose a particular curriculum is a matter of conjuncture, but authorities in the field of vocational guidance have made several comments which seem to be appropriate for this investigation. According to Holland (32), Roe (47), and Super (52), students who choose a particular field of study, in most cases, have unique interests which lead them to their selected vocational choice. Holland (31) believes that the person making a vocational choice goes through a process of searching for situations that will satisfy his needs. Roe (48) traced vocational choice back to the individual's early experiences in relation to his attitudes and abilities.

It seems reasonable to assume that some measure of interest is essential in attempting to adequately predict success in an engineering program. However, very few investigators have concerned themselves with the predictive power of existing interest tests.

Berdie (8) conducted a study at the University of Minnesota to determine if vocational interests tests could be used to predict an engineering student's satisfaction with the curriculum and achievement. Students were divided into four groups on the basis of scores on the _Strong Vocational Interest Blank_: (1) primary interest in engineering, (2) secondary interest in engineering, (3) tertiary interest patterns in engineering, and (4) no interest in engineering. Although no significant difference existed among the groups on the basis of grades, they differed significantly on the basis of curriculum satisfaction. The group composed of students that had no interest in engineering was less satisfied with the curriculum than the other three groups that indicated interest patterns in engineering.

Barnett (7), in his follow-up study of veterans being guided into engineering as a result of counseling by the New York YMCA Vocational Service Center, used the Kuder Preference Record to investigate interest patterns of students persisting in engineering school versus those who dropped out. He found significant differences (at the .05 level of probability) on the following four scales: (1) computational--higher for the successful, (2) scientific--higher for the successful, (3) persuasive--higher for the dropouts, and (4) clerical--higher for the successful.

Stinson (51), using the Kuder Preference Record, reported that engineering graduates scored significantly higher on the scientific scale than did engineering dropouts. She also reported that students who were successful in engineering scored significantly lower on the clerical scale than did non-engineering graduates and dropouts. Speer (50), in his comparisons of engineering freshmen and liberal arts freshmen, found significant differences in interest patterns on the KPR for the two groups.

Bowers (11), studying the relationship between scores on the ten scales of the Kuder Preference Record and first semester grade point averages, reported that all of the correlations were extremely low with the exception of the following areas: (1) the Computational which yielded a correlation of .21, (2) the Outdoor which yielded a correlation of .20, and (3) the Scientific which yielded a correlation of .14. The lowest correlation yielded was between the Persuasive scale and first semester grade point average.

Summary

From the review of the literature, one can only conclude that the intellective and interest factors that contribute to academic success are many and complex.

Several studies have indicated that the intellectual characteristics of a student make a critical contribution to success in any academic program. But it is also apparent that academic variables alone do not account for all the variance in predicting success; other variables such as interest have been attributed to some portion of the variance. However, research concerning interest variables suggest few significant findings and these findings are contradictory dependent on which study one reviews. Although there is no major agreement, the scales on the Kuder Preference Record that appear to distinguish engineering students from students with other majors are the Scientific and Computational scales, and to some extent the Mechanical scale.

From the review of the literature, there are several postulates that emerge which provide this study with a tenable guide. The postulates are as follows:

1. The correlation of a variable with a predictor has a tendency to vary from institution to institution.

2. Combinations of several variables have a tendency to produce higher correlations than the correlation of a single predictor.

3. Grade point averages appear to and should make excellent predictors of academic success since this variable makes use of past samples of academic work to forecast future academic work.

4. A need exists for studying both academic and interest variables when studying factors that have a relationship to successfully completing any academic program.

CHAPTER III

SUBJECTS, INSTRUMENTS, AND PROCEDURES

This chapter will consider the subject population, the methods employed in collection of the data, the predictive indices, the hypotheses to be tested and the method of analysis to be utilized in this investigation.

Subjects

The subjects utilized in this study were selected from a population of 392 students classified as sophomores and enrolled in the College of Engineering, Oklahoma State University, in the spring semester, 1966-67. After exclusion of students transferring into the College of Engineering with more than eight hours of previous college work, international students, and students who failed to have on record the ACT, KPR, NDRT, or the CAT, the subjects utilized in this study consisted of 196 students. The list of students who successfully completed their degree in engineering was obtained from the Official Commencement Program, published by the Registrar's Office, Oklahoma State University.

The subjects of this investigation were grouped into two categories: (1) students who completed the requirements for a Bachelor of Science in Engineering (N=103), and (2) students who were unsuccessful or failed to complete the requirements for a Bachelor of Science in Engineering (N=93).

Collection of the Data

The data used in this study included the following test scores, grade point averages, and ratings: ACT standard scores in English, mathematics, social studies, natural science and the composite score of the four areas; Cooperative Algebra Test, Form Z; Nelson-Denny Reading Test; Kuder Preference Record; grade point averages in mathematics, chemistry, physics, social science and humanities at the end of the individual's sophomore year in the College of Engineering; and the total grade point average at the end of the individual's sophomore year in the College of Engineering.

The data was gathered from several different sources. A list of the subjects was obtained from the Office of the Dean of Engineering. American College Test scores in English, mathematics, social studies and natural science and a score of the composite of the four areas was obtained from the Office of the Registrar. Cooperative Algebra Test scores, Nelson-Denny Reading scores and Kuder Preference Record scores were obtained from the Oklahoma State University Testing Bureau, the Office of the Registrar and student records on file in the Office of the Dean of Engineering. Total grade point averages and grade point averages in mathematics, chemistry, physics, social science and humanities were obtained from the subject's files in the Office of the Director of Student Services, College of Engineering or were obtained from the Office of the Registrar.

The subjects of this study completed the ACT before admission to Oklahoma State University. The CAT, NDRT, and the KPR were completed during the pre-orientation clinics conducted at Oklahoma State University.

Predictors and Dependent Variables

In this study, the predictors or independent variables are defined as the variables from which predictions are being made and the criterions or dependent variables are the theoretical scores that are being predicted. As Popham (45) expresses it:

> In making predictions regarding an individual's theoretical score on one measure from his score on an initial measure, we usually refer to the variable from which we are making the prediction as the independent variable or predictor variable. The variable that is predicted is called the dependent variable or the criterion variable.

The predictive indices utilized in the study are as follows: (1) ACT scores, (2) CAT, (3) NDRT Comprehension and Total Scores, (4) KPR scores, (5) High School GPA, and (6) College GPA computed through the sophomore year as follows: (a) accumulative GPA, (b) mathematics GPA, (c) physics GPA, (d) chemistry GPA, (e) social science GPA, and (f) humanities GPA.

The dependent or criterion variables to which predictions will be made include the following: (1) upper division grade point average, (2) accumulative grade point average, and (3) successful completion of the engineering program or graduation.

In the following pages, the predictors or independent variables will be discussed and the dependent or criterion variables will be defined.

Predictors

The American College Testing Battery (ACT)

This study will utilize all individual ACT scores as well as the composite score which is the mean of the four individual sub-tests.

The individual scores representing the scholastic aptitude in English, mathematics, social studies and natural science are described by the publisher as reflections of educational development and academic potential, since it tests not only factual knowledge, but also tests reasoning ability, critical thinking and problem solving skills, as well as the understanding of basic concepts and the ability to formulate and test hypotheses (1, p. 3). Administered under the direction of the American College Testing Program, Inc. (55) the ACT is given five times each year at testing centers throughout the United States and Canada to those students in their senior year of high school who are planning to attend an institution of higher learning. The scores are reported to three institutions designated by the student as those institutions he is considering attending. Norms for college-bound high school seniors are used in determining the scores which are reported to the colleges.

The Cooperative Algebra Test, Form Z

The Cooperative Algebra Test was developed by the Educational Testing Service to measure a student's comprehension of the basic concepts, techniques, and unifying principles of elementary algebra (13). According to the publisher's catalog, the development of the Cooperative achievement tests follow currently accepted practices with respect to curricular validation, preliminary tryout, item analysis, and so on (13). Multiple choice items are used throughout the form, with the items arranged from least difficult to most difficult.

Emphasis is given to the ability to apply mathematical ideas to new situations and to reason with insight while factual recall and computations are minimized. Bowers (11) found an r of .58 between scores on a different form of the CAT and grade point average in engineering school.

The Nelson-Denny Reading Test (NDRT)

The NDRT was designed for use in grades nine through sixteen, and norms have been established for each grade level. It yields scores in vocabulary, comprehension, total and reading rate. The NDRT is a thirty minute test which contains a 100-item vocabulary section and a thirty-six-item reading comprehension section of the traditional multiple choice types. The comprehension and vocabulary sections are combined in arriving at a total score.

After examining several different factors related to academic achievement, Garrett (23) found the NDRT demonstrated an r of .67 with academic performance. Crites (13, Buros p. 53) indicates that the NDRT is very reliable and suggests that there is evidence of its validity for a number of purposes, one of them being prediction of academic success.

Reviewers in the Sixth Mental Measurements Yearbook (13) are critical of the NDRT reading rate scale for the following reasons: first, the reading rate sentences are poorly written and are too complex; second, the word count at the end of each sentence is not accurate in some cases; third, the respondent is requested to mark his own rate score at the end of one minute; consequently, there is no assurance that the rate is marked correctly and the one-minute reading period is regarded as insufficient reading time to establish a reading rate score. As a result of the above criticisms, the rate score will not be included in this study.

Kuder Preference Record (KPR)

The Kuder Preference Record-Vocational Form CH (KPR) is an instrument used to measure an individual's interest in ten major categories. Forced choice items, arranged in triads, are used, with the respondent asked to select the item he likes most and the one he likes least. Containing 168 items, the instrument is self-administering, and assesses the following ten categories: Outdoor, Mechanical, Computative, Scientific, Persuasive, Artistic, Literary, Musical, Social Service and Clerical (37). The following is a description of the KPR scales:

Outdoor: Indicates a preference for work outside the majority of the time, usually concerned with animals and growing things.

Mechanical: Indicates a preference for work with machines and tools.

Computative: Indicates a preference for working with numbers.

Scientific: Indicates a preference for discovering new knowledge and solving problems.

Persuasive: Indicates a perference for meeting and dealing with people and offering projects or things to sell.

Artistic: Indicates a preference for doing creative work with one's hands.

Musical: Indicates a preference for attending concerts, playing instruments, singing, etc.

Social Service: Indicates a preference for working with people in a helping relationship.

Clerical: Indicates a preference for office work that requires precision and accuracy.

The construction of the KPR uses ipsative scores which Anastasi (4) defines as follows:

> . . . the strength of each need is expressed, not in absolute terms, but in relation to the strength of the individual's other needs. The frame of reference in ipsative scoring is the individual rather than the normative sample.

Layton (Buros, 13, p. 132), in his discussion of the ipsative form indicates that if the scores are high on one scale, others must be low, and one can infer the individual's relative preference for one or more of the areas.

The authors of the KPR manual (35) suggest that the best use of this measure would be the development of group profiles for each college so that norms could be developed for comparative purposes between an individual student's interests and those of his peers.

Several studies indicate that the scales of the KPR show reliabilities that are acceptable. Anastasi (4) reports the reliabilities as determined by the Kuder-Richardson Technique, clusters around .90 for the KPR scales and are stable over periods of one year or more.

Super and Crites (53), in a summary of the Kuder reliability data, report the following:

> For Form C the Kuder-Richardson reliability coefficients, which are conservative estimates, range from .84 to .90 (100 girls); from .85 to .93 (100 boys); from .87 to .90 (100 women); and from .85 to .92 (100 men).

In this study an attempt will be made to determine if interests, as measured by the KPR, have a significant predictive relationship to success in engineering.

High School Grade Point Average

The high school grade point average has been found to be one of the better predictors of academic success in college (2, 28, 29, 30). However, very few of the studies, as can be recalled from the review of the literature, have made predictions beyond the first year of college utilizing this predictor. Therefore, it would seem worthwhile to investigate the use of this variable as a predictor of success in college.

College Grade Point Average

Many prediction studies make use of this index as a variable, and it would seem logical to use this variable as a predictor of success since it will make use of a sample of university work for future predictions of further university work (21, 27, 43). Since the decision to admit or reject students for the professional program will be made after the student completes his second year in engineering, all subjects' grade point averages were computed through the sophomore year for the following: (1) accumulative average, (2) mathematics, (3) physics, (4) chemistry, (5) social science, and (6) humanities. The university grading system of A = four points, B = three points, C = two points, D = one point, and F = zero points, was used in computing all averages.

Dependent Variables

Three dependent variables will be analyzed in this study. Although the major thrust of this study will be to attempt to determine what factors in the record of the student are most indicative of success as defined by graduation, upper division grade point average and overall grade point average will also be examined.

Dependent variable number one is defined as upper division grade point average.

Dependent variable number two is defined as accumulative grade point average for all college work.

Dependent variable number three is defined as successful completion of the engineering program or graduation. Those students who withdrew from the program were labeled as unsuccessful. Success, defined in this manner, constitutes a dichotomy to be predicted.

Hypotheses to be Tested

Hypothesis I: No significant predictive relationship exists between upper division grade point average and the following predictors: (1) Sophomore GPA, (2) Mathematics GPA, (3) Chemistry GPA, (4) Physics GPA, (5) Social Science GPA, (6) Humanities GPA, (7) High School GPA, (8) CAT, (9) NDRT Vocabulary, (10) NDRT Comprehension, (11) NDRT Total, (12) ACT English, (13) ACT Mathematics, (14) ACT Social Science, (15) ACT Natural Science, (16) ACT Composite, (17) KPR Outdoor, (18) KPR Mechanical, (19) KPR Computational, (20) KPR Scientific, (21) KPR Persuasive, (22) KPR Artistic, (23) KPR Literary, (24) KPR Musical, (25) KPR Social Service, and (26) KPR Clerical.

Hypothesis II: No significant predictive relationship exists between accumulative grade point average and the following predictors: (1) Sophomore GPA, (2) Mathematics GPA, (3) Chemistry GPA, (4) Physics GPA, (5) Social Science GPA, (6) Humanities GPA, (7) High School GPA, (8) CAT, (9) NDRT Vocabulary, (10) NDRT Comprehension, (11) NDRT Total, (12) ACT English, (13) ACT Mathematics, (14) ACT Social Science, (15) ACT Natural Science, (16) ACT Composite, (17) KPR Outdoor, (18) KPR Mechanical, (19) KPR Computational, (20) KPR Scientific, (21) KPR Persuasive, (22) KPR Artistic, (23) KPR Literary, (24) KPR Musical, (25) KPR Social Service, and (26) KPR Clerical.

Hypothesis III: No significant predictive relationships exist between success in engineering and the following predictors: (1) Sophomore GPA, (2) Mathematics GPA, (3) Chemistry GPA, (4) Physics GPA, (5) Social Science GPA, (6) Humanities GPA, (7) High School GPA, (8) CAT, (9) NDRT Vocabulary, (10) NDRT Comprehension, (11) NDRT Total, (12) ACT English, (13) ACT Mathematics, (14) ACT Social Science, (15) ACT Natural Science, (16) ACT Composite, (17) KPR Outdoor, (18) KPR Mechanical, (19) KPR Computational, (20) KPR Scientific, (21) KPR Persuasive, (22) KPR Artistic, (23) KPR Literary, (24) KPR Musical, (25) KPR Social Service, and (26) KPR Clerical.

Method of Analysis

For dependent variable one, upper division grade point average, and dependent variable two, accumulative grade point average, analysis began with the computation of zero-order correlation coefficients between each predictive index and every other index, and between dependent variables and each index. The population utilized for the analysis of dependent variables one and two consisted of 103 students who had successfully completed the engineering program.

A step-wise regression analysis was used in further analyzing the data for dependent variables one and two. By this method, partial correlation coefficients are derived between each variable and the dependent variables. This program first computes the Pearson product moment correlation coefficients between the twenty-six predictors and between each predictor and the criterion variables. These coefficients are then printed out in a correlation matrix for further study. The program also computes and prints the mean and standard deviation for each variable under study.

In order to determine the effect of each predictor with respect to its predictive power when compared to all other predictors, a beta weight for each predictor is computed. The larger the beta weight for a predictor, the more that predictor is contributing to the predictive efficiency of the total regression equation. The next step was to compute a regression coefficient for each predictor. The purpose of the coefficient is to "temper" the predictor with which it is associated so that predictor will make the proper contribution to the regression equation when all predictors are taken into consideration. Since the dependent variable may have a different mean than the predictors, the "a" coefficient must be computed. This coefficient (sometimes called the dependent variable intercept) makes the adjustment for this difference. The computer then prints out both the regression coefficients and the "a" coefficient.

For the final analysis, the computer considers each predictor one at a time, then selects and retains only those predictors making a significant contribution (at the .01 level of confidence) to the regression equation. Before a predictor is added to the regression equation, the computer performs an analysis of variance to determine if the predictor is contributing anything to the total efficiency of the regression equation. If no significant contribution is being made, the computer rejects the predictor considered and utilizes only those predictors in the regression equation that are making a significant contribution. To check the efficiency of the regression equation, a multiple correlation coefficient is computed and printed out by the computer. After all coefficients needed for prediction have been computed and printed out, the regression equation is:

$$Y_1 = a + b_1X_1 + b_2X_2 + b_3X_3$$

where: Y_1 = predicted score on dependent variable

a = intercept or "a" coefficient

b_1 = regression coefficient for predictor number one

X_1 = score on predictor number one

b_2 = regression coefficient for predictor number two

X_2 = score on predictor number two

The equation for the multiple correlation coefficient is:

$$R = \sqrt{B_1r_1 + B_2r_2 + B_3r_3}$$

where: R = multiple correlation coefficient

B_1 = Beta weight for predictor number one

r_1 = Pearson product moment between predictor number one and dependent variable.

In reference to dependent variable number three which utilized the data for all 196 students in the sample, it was determined that engineering student success could be defined as completion of the program or graduation. Those who withdrew from their program were labeled unsuccessful. Success defined in this manner constitutes a dichotomy to be predicted. The decision was made to develop a computer program that would compute a multiple correlation and regression equation to the dichotomy.

Since the point-biserial correlation coefficient correlates a continuous variable with a dichotomy and is a product moment, it can be used in a multiple correlation and regression just as if it were a Pearson product.

As was mentioned before, this program calls for a step-wise regression. This means, with this particular program, the computer starts with the predictor that has the largest correlation with the dependent variable. Then each of the remaining predictors is added to the regression equation one at a time. As each predictor is added, the computer performs an analysis of variance to determine if that added predictor contributes anything to the total efficiency of the regression equation. Any contribution significant at the .01 level will be considered a significant contribution. If the added predictor makes a statistically significant contribution, the computer accepts it as part of the multiple correlation. If the added predictor is determined not to be making a significant contribution, the computer rejects that predictor from the multiple correlation. This means the computer is programmed to make the decision as to which predictors should be included in the regression equation. The status of each predictor is printed out. This procedure was followed with the same step-wise regression program as mentioned in the preceding pages. The computer performs the same operation as outlined when it computes and prints out means, standard deviations, regression coefficients and "a" coefficients; however, this time the dependent variable is a dichotomy. The regression equation is:

$$Y_D = a + b_1X_1 + b_2X_2$$

where: a = "a" coefficient

b_1 = regression coefficient for predictor number one

X_1 = score on predictor number one

Y_D = predicted classification in dichotomy

In this equation since the value of one has been assigned to successful students, when Y_D equals .50 or more, the student is predicted to be successful. A multiple R to the dichotomy is computed to determine the efficiency of the regression equation. As is expected of the step-wise program, each predictor is examined one at a time to determine if it should be rejected or accepted into the total regression equation. By the use of these equations, the criterion of success can be predicted from known indices.

The predictive accuracy of the multiple regression equations was tested by randomly selecting twenty-five subjects that fulfilled the requirements for graduation in January, 1971, and then proceeding in the following manner. The data from these subjects were substituted into the appropriate equations, and the resulting predictions concerning the three dependent variables were compared with known results.

A discussion of the analysis, along with the results, will be presented in Chapter IV.

CHAPTER IV

PRESENTATION OF THE DATA AND ANALYSIS OF RESULTS

The current chapter is concerned with the presentation and analysis of the results of this investigation. The correlations and intercorrelations between the predictor variables and the three criterion variables will be presented. These include the correlations derived between the values of Sophomore GPA, Mathematics GPA, Chemistry GPA, Physics GPA, Social Science GPA, Humanities GPA, High School GPA, CAT, NDRT scores, ACT scores, KPR scores and three dependent variables -- Upper Division GPA, Accumulative GPA, and success versus nonsuccess.

Multiple correlations were next developed on a step-wise build-up between the indices in combinations and each dependent variable to determine what predictor variables were making significant contributions to predicting each dependent variable. Regression equations for purposes of predicting each of the three dependent variables will be presented in tabular form for each dependent variable respectively.

The regression technique selected is referred to as a step-wise multiple linear regression. This analysis was preformed on the IBM 7040 computer at the Oklahoma State University Statistical Laboratory. The computer was programmed for three dependent variables and twenty-six predictor variables.

With the step-wise technique, intermediate results are used to give useful statistical information at each step in the calculation. A number of intermediate regression equations are obtained by adding one variable at a time, thus giving the intermediate equations:

a. $Y = A + b_1X_1$

b. $Y = A + b_1X_1 + b_2X_2$

c. $Y = A + b_1X_1 + b_2X_2 + b_3X_3$, etc.

The coefficients for each of these intermediate equations and the reliability of each coefficient are obtained step-by-step. The values and reliability may vary with each subsequent equation. The coefficients represent optimum values when the equation is fitted by the specific variables included in the equation. For the purposes of the present research, the variables included in the reported regression equation for each dependent variable were limited to those that contributed to additional variance reduction and increased the predictive efficiency of the regression equation. The equations were tested for their predictive value by presenting the known results along with the predicted results for all subjects in relation to all dependent variables where applicable. For example, data concerning all 196 subjects were utilized for predicting success. However, only those students who graduated with a Bachelor of Science in Engineering (N=103) were utilized for predicting upper division GPA and accumulative GPA. To determine if the predictors were applicable to subjects other than the population under investigation, the prediction equations were tested by applying them to a randomly selected group of twenty-five students who fulfilled all requirements for the Bachelor of Science in Engineering in January, 1971. Actual results will be presented along with predicted results.

The final analysis of data was concerned with determining if there is a rationale for setting a requirement of a 2.500 grade point average or above after two years of preprofessional work as the primary requisite for admission to the professional program.

In order to present the data in a systematic manner, data for each dependent variable will be presented under separate headings in the following manner:

1. Section number one will be concerned with dependent variable number one -- upper division grade point averages.

2. Section number two will be concerned with dependent variable number two -- accumulative grade point average.

3. Section number three will be concerned with dependent variable number three -- success versus nonsuccess. The hypotheses under consideration will be presented only in sections one through three since the hypotheses pertain only to these sections.

4. Section number four will be concerned with the presentation of the data concerning the rationale believed to be pertinent when only the sophomore GPA is utilized as an index of success in relation to admission to the professional program.

Analysis of Data and Presentation of Information Related to Hypothesis I

Table I reveals that six of the predictors yielded significant coefficients of correlation with upper division grade point average as follows: (1) Sophomore GPA (r=.61), (2) Mathematics GPA (r=.51), (3) Chemistry GPA (r=.23), (4) Physics GPA (r=.42), (5) Social Science (r=.38) and (6) Humanities GPA (r=.20). Four of the predictors, Sophomore GPA, Mathematics GPA, Physics GPA, and Social Science GPA, yielded correlations significant beyond the .001 level.

TABLE I

STATISTICALLY SIGNIFICANT CORRELATION COEFFICIENTS WITH DEPENDENT VARIABLE NUMBER ONE -- UPPER DIVISION GRADE POINT AVERAGE (N=103)

Predictor	Mean	SD	Correlation Coefficient
Sophomore GPA	2.784	0.501	0.61***
Mathematics GPA	2.789	0.763	0.51***
Chemistry GPA	3.176	0.694	0.23*
Physics GPA	2.383	0.846	0.42***
Social Science GPA	2.867	0.784	0.38***
Humanities GPA	2.516	0.922	0.20*

***Significant at the .001 level of confidence.
* Significant at the .05 level of confidence.
The Pearson r value for significance at the .05 level with over 100 degrees of freedom is .1946.
The Pearson r value for significance at the .01 level with 100 or more degrees of freedom is .2540.
The Pearson r value for significance at the .001 level with over 100 degrees of freedom is .3211.

The intercorrelations as well as the correlations for dependent variables one and two are presented in Appendix A (see Table XVI). Intercorrelations for the six significant predictors ranged from .21 to .79 with the highest intercorrelations yielded between Sophomore GPA and Mathematics GPA. As would be expected, lowest intercorrelations were yielded between Physics GPA and Humanities GPA (.21), Chemistry GPA and Humanities GPA (.26), Chemistry GPA and Social Science GPA (.29), and Mathematics GPA and Humanities GPA (.29). The intercorrelations for Mathematics GPA, Physics GPA, and Chemistry GPA ranged from .38 for Chemistry GPA and Mathematics GPA to .63 for Physics GPA and Mathematics GPA which suggests that these traits are closely related to each other.

Inferences that might be drawn from the intercorrelations of the predictors and correlations with the criterion -- upper division GPA -- suggest that past academic performance is indicative of future academic performance.

Predictors that yielded low coefficients of correlations with the dependent variable include the NDRT Vocabulary (r=.03), ACT English (r=.04), ACT Composite (r=.04), KPR Outdoor (r=.03), KPR Computational (r=.03), KPR Artistic (r=.001), KPR Literary (r=.03), and KPR Social Service (r=.05). Negative correlations were yielded for KPR Musical (r=-.12) and KPR Persuasive (r=-.12) with the criterion.

After examining the relationships of the predictive indices to upper division grade point average, the next step in the analysis was to combine the variables in an effort to develop a multiple correlation which might provide more precise predictions than any one of the predictive indices.

In determining the multiple correlations and the resulting weights, a step-wise procedure was followed as indicated on pages 33 and 34. Briefly, when all predictors were taken into consideration, the computer selected and retained only those predictors making a significant contribution to the regression equation (at the .01 level of confidence). An analysis of variance was performed to determine if the predictor under consideration would add anything to the total predictive efficiency. If not, the predictor was rejected and the next predictor was entered with the above procedure followed until all variables were entered. The results are shown in Table II, page 39.

As Table II reveals, the following variables were entered into the regression equation: (1) Sophomore GPA, (2) Chemistry GPA, (3) NDRT Comprehension, (4) KPR Musical, (5) KPR Outdoor, and (6) KPR Artistic. The multiple R was increased from the first step, where only one variable was considered, from 0.606 to 0.645 by considering all six predictor variables. Since the multiple R was found to be 0.645, this implies that about forty-two percent of the variability in the criterion was accounted for by the six predictors combined in the following regression equation:

$$Y = 0.85680\ X_1 - 0.13912\ X_2 - 0.00846\ X_3 - 0.01090\ X_4 - 0.00529\ X_5 + 0.00723\ X_6 + 1.39008$$

where:

X_1 = Sophomore GPA

X_2 = Chemistry GPA

X_3 = NDRT Comprehension

X_4 = KPR Musical

X_5 = KPR Outdoor

X_6 = KPR Artistic

The values of 0.85680, -0.13912, -0.00846, -0.001090, -0.00529, +0.00723 are the weights by which the values of Sophomore GPA, Chemistry GPA, NDRT Comprehension, KPR Musical, KPR Outdoor and KPR Artistic, respectively, are multiplied. The products of these multiplications and

TABLE II

RESULTS OF STEPS 1, 2, 3, 4, 5 AND 6 FOR ENTERING A VARIABLE INTO THE REGRESSION EQUATION IN A STEP-WISE FASHION FOR DEPENDENT VARIABLE NUMBER ONE -- UPPER DIVISION GRADE POINT AVERAGE (N=103)

Entering Variable	F	Standard Error of the Estimate	Constant	Variables in Regression Equation	Coefficient of Variables in Regression Equation	Standard Error of Coefficient	Multiple Correlation Coefficient
Sophomore GPA	58.570**	0.433	0.93844	Sophomore GPA	0.65461	0.08554	0.606
Chemistry GPA	31.791**	0.430	1.07374	Sophomore GPA	0.76567	0.10306	0.619
				Chemistry GPA	-0.13996	0.07440	
NDRT Comp.	22.698**	0.423	1.38546	Sophomore GPA	0.81224	0.10530	0.629
				Chemistry GPA	-0.15245	0.07395	
				NDRT Comp.	-0.00816	0.00460	
KPR Musical	17.657**	0.427	1.44581	Sophomore GPA	0.80859	0.10485	0.633
				Chemistry GPA	-0.15104	0.07365	
				NDRT Comp.	-0.00744	0.00461	
				KPR Musical	-0.00822	0.00595	
KPR Outdoor	14.643**	0.419	1.61892	Sophomore GPA	0.83340	0.10589	0.638
				Chemistry GPA	-0.14154	0.07359	
				NDRT Comp.	-0.00894	0.00471	
				KPR Musical	-0.00997	0.00606	
				KPR Outdoor	-0.00454	0.00327	
KPR Artistic	13.288**	0.444	1.39008	Sophomore GPA	0.85680	0.10614	0.645
				Chemistry GPA	-0.13912	0.07305	
				NDRT Comp.	-0.00846	0.00469	
				KPR Musical	-0.01090	0.00604	
				KPR Outdoor	-0.00529	0.00328	
				KPR Artistic	-0.00723	0.00459	

**Significant at the .01 level of confidence.

the constant (1.39008) are summed. The summation of these values results in the predicted upper division GPA. The equations were developed and the results are presented in Appendix A (see Table XVII).

The standard error of estimate associated with the multiple regression equation was presented in Table II, page 39. For all six predictors, this value is 0.444 which indicates that sixty-eight times out of one hundred, the obtained upper division GPA will be in the interval of the predicted range plus or minus 0.444 grade points. Ninety-five times out of one hundred the obtained upper division GPA will be in the interval of the predicted range plus or minus two standard errors of the estimate and ninety-nine times out of one hundred the obtained upper division GPA will be in the interval of the predicted range plus or minus three standard errors.

In actuality, a summary of Table XVII (Appendix A) indicates that seventy-one percent of the predictions were within one standard error of the estimate, ninety-five percent of the predictions were within two standard errors of the estimate, and less than four percent of the predictions were greater than two standard errors of the estimate from the prediction.

Testing the Regression Equation

The predictive value of the regression equation was next tested by use of data from subjects who were not members of the population utilized in the study. Twenty-five students were chosen on a random basis from a population of students who had fulfilled all requirements for the Bachelor of Science in Engineering in January, 1971. Since all predictive indices were not available for the students selected, it was determined that two of the predictors -- Sophomore GPA and Chemistry GPA -- could be utilized almost as effectively as utilizing all six predictors. Sophomore GPA and Chemistry GPA produced a multiple R of 0.619 which is only 0.026 less than the 0.645 multiple R produced by all six predictors (Table II). The results are presented in Table III.

TABLE III

ACTUAL AND PREDICTED UPPER DIVISION GRADE POINT AVERAGES
FOR ENGINEERING GRADUATES, JANUARY, 1971
(N=25)

Student Number	Actual	Prediction	Deviation
1	2.430	3.066	0.636
2	2.750	2.903	0.153
3	3.212	2.962	0.250
4	3.425	3.081	0.344
5	2.639	2.529	0.110
10	2.814	2.676	0.138
11	2.962	2.696	0.266
12	3.184	2.947	0.137
13	2.884	2.746	0.138
14	2.795	3.045	0.250
15	3.048	3.027	0.021
16	2.900	2.678	0.222
17	2.191	2.483	0.292
18	2.107	2.324	0.217
19	3.567	3.187	0.380
21	3.483	3.239	0.244
22	3.000	2.760	0.240
23	2.840	2.460	0.380
24	2.217	2.750	0.533
26	2.783	2.521	0.262
27	3.153	2.879	0.274
28	3.481	3.174	0.307
29	2.194	2.771	0.577
30	3.189	2.834	0.355
31	2.153	2.423	0.270

As Table II, page 39, indicates, the standard error of the estimate associated with the predictors, Sophomore GPA and Chemistry GPA, is .430, and the following results are obtained in relation to the predicted upper division GPA, when compared to the actual upper division GPA. Ninety-six percent of the predicted upper division GPA's fell within one standard error of the estimate, plus or minus, and only four percent (one case) fell within an area greater than one standard error of the estimate.

Summary

Hypothesis I: No significant predictive relationship exists between upper division grade point average and the following predictors: (1) Sophomore GPA, (2) Mathematics GPA, (3) Chemistry GPA, (4) Physics GPA, (5) Social Science GPA, (6) Humanities GPA, (7) High School GPA, (8) CAT, (9) NDRT Vocabulary, (10) NDRT Comprehension, (11) NDRT Total, (12) ACT English, (13) ACT Mathematics, (14) ACT Social Science, (15) ACT Natural Science, (16) ACT Composite, (17) KPR Outdoor, (18) KPR Mechanical, (19) KPR Computational, (20) KPR Scientific, (21) KPR Persuasive, (22) KPR Artistic, (23) KPR Literary, (24) KPR Musical, (25) KPR Social Service, and (26) KPR Clerical.

Since analysis of the data reveals that six of the predictors yielded significant predictive relationships that could be utilized for prediction to upper division grade point average, the null hypothesis is rejected for the following: (1) Sophomore GPA, (2) Chemistry GPA, (3) NDRT Comprehension, (4) KPR Musical, (5) KPR Outdoor, and (6) KPR Artistic. The null hypothesis is accepted for the following predictors: (1) Mathematics GPA, (2) Physics GPA, (3) Social Science GPA, (4) Humanities GPA, (5) High School GPA, (6) CAT, (7) NDRT Vocabulary, (8) NDRT Total, (9) ACT English, (10) ACT Mathematics, (11) ACT Social Science, (12) ACT Natural Science, (13) ACT Composite, (14) KPR Mechanical, (15) KPR Computational, (16) KPR Scientific, (17) KPR Persuasive, (18) KPR Literary, (19) KPR Social Service, and (20) KPR Clerical.

Although the regression equation developed appears to be capable of making consistent predictions, the standard error of estimate for the population studied, as well as the population utilized for testing the predictive efficiency of the equation, is too large to be meaningful. Therefore, it appears that the regression equation developed for predicting upper division grade point average will have little utility for the selection of students for the professional program.

Analysis of Data Related to Hypothesis II

Table IV, page 44, reveals that thirteen of the predictors yielded significant coefficients of correlations with accumulative grade point average as follows: (1) Sophomore GPA (r=.89), (2) Mathematics GPA (r=.71), (3) Chemistry GPA, (r=.46), (4) Physics GPA (r=.65), (5) Social Science GPA (r=.23), (6) Humanities GPA (r=.37), (7) High School GPA (r=.23), (8) CAT (r=.23), (9) NDRT Vocabulary (r=.20), (10) NDRT Total (r=.20), (11) ACT Mathematics (r=.20), (12) KPR Persuasive (r=.24), and (13) KPR Social Service (r=.45). Seven of the predictors, Sophomore GPA, Mathematics GPA, Chemistry GPA, Physics GPA, Social Science GPA, Humanities GPA, and KPR Social Service, yielded coefficients of correlations significant beyond the .001 level of confidence.

As Appendix A (see Table XVI) indicates, predictors that yielded low coefficients with the dependent variable include the KPR Mechanical (r=-.02), KPR Literary (r=.04), KPR Computational (r=.07), and KPR Musical (r=-.09).

TABLE IV

STATISTICALLY SIGNIFICANT CORRELATION COEFFICIENTS WITH DEPENDENT VARIABLE NUMBER TWO -- ACCUMULATIVE GRADE POINT AVERAGE AT GRADUATION (N=103)

Predictor	Mean	SD	Correlation Coefficient
Sophomore GPA	2.784	0.50	0.89***
Mathematics GPA	2.789	0.76	0.71***
Chemistry GPA	3.176	0.694	0.46***
Physics GPA	2.383	0.846	0.65***
Social Science GPA	2.867	0.784	0.54***
Humanities GPA	2.516	0.922	0.37***
High School GPA	3.358	0.445	0.23*
CAT	46.466	8.137	0.23*
NDRT Vocabulary	42.252	10.428	0.20*
NDRT Total	91.572	17.994	0.20*
ACT Mathematics	28.398	3.916	0.20*
KPR Persuasive	53.699	8.983	-0.24*
KPR Social Service	32.582	11.469	0.45***

***Significant at the .001 level of confidence.
* Significant at the .05 level of confidence.

The highest correlation yielded between the predictors and the criterion was Sophomore GPA (r=.89). Consequently, the intercorrelations are revealing since Sophomore GPA, as Appendix A (see Table XVI) indicates, intercorrelates with the following predictors: Mathematics

GPA (.79), Chemistry GPA (.58), Physics GPA (.62), and Humanities GPA (.44). Since all are contributing to the Sophomore GPA, the intercorrelations are congruent with expected results. The NDRT Total, CAT, NDRT Vocabulary, ACT Mathematics, and KPR Persuasive intercorrelate with Sophomore GPA from .21 to .29. None of the intercorrelations are particularly informative, since no particular prominent patterns of intercorrelations are apparent. For example, although the KPR Persuasive intercorrelates with Sophomore GPA -.29, it also shows a negative relationship to the criterion since it yields an r of -.24. The difference of .05 could be attributed to just chance variation.

The next step performed in the analysis of the data concerned the development of a multiple regression equation in an effort to combine several variables for purposes of making more precise predictions of the accumulative GPA.

The same procedure was followed as was described earlier in this chapter concerning the development of the multiple regression equation. In brief, when all predictors were taken into consideration, the computer selected and retained only predictors that would make a significant contribution to the regression equation. The results are shown in Table V, page 46. In this case only one predictor was utilized. Since no other predictors were capable of making a significant contribution to increase the predictive efficiency of the regression equation, only Sophomore GPA was utilized.

The predictor, Sophomore GPA, produced a correlation coefficient of .886 with the dependent variable which implies that about seventy-eight percent of the variability in the criterion was accounted for by Sophomore GPA in the following regression equation:

TABLE V

RESULTS OF ENTERING A VARIABLE INTO THE REGRESSION EQUATION FOR DEPENDENT VARIABLE NUMBER TWO -- ACCUMULATIVE GRADE POINT AVERAGE (N=103)

Entering Variable	F	Standard Error of the Estimate	Constant	Coefficient of Variable in Regression Equation	Standard Error of Coefficient	Correlation Coefficient
Sophomore GPA	367.353**	0.222	0.43885	0.83982	0.03482	0.886

**Significant at the .01 level of confidence.

$$Y = 0.83982X + 0.43885$$

where:

X = Sophomore GPA

The value of 0.83982 is multiplied by the actual Sophomore GPA and the product is added to the constant 0.43885. The summation of these values results in the predicted accumulative GPA. The equation was developed and the results are presented in Appendix A (see Table XVIII).

As is reported in Table V, page 46, the standard error of the estimate associated with the regression equation is 0.222. This means that sixty-eight times out of a hundred, the obtained accumulative GPA will be in the interval of the predicted range plus or minus 0.222 grade points; ninety-five times out of one hundred the obtained accumulative GPA will be in the interval of the predicted range plus or minus two standard errors of the estimate; and ninety-nine times out of one hundred the obtained accumulative GPA will be in the interval of the predicted range plus or minus three standard errors.

In actuality, a summary of Appendix A (see Table XVIII) indicates that about sixty-seven percent of the predictions were within one standard error of the estimate, ninety-six percent of the predictions were within two standard errors of the estimate, and one hundred percent of the predictions were within three standard errors of the estimate.

Testing the Regression Equation

The predictive value of the regression equation was tested by use of the data from subjects that were not members of the population utilized in the study. The regression equation was applied to the randomly selected engineering graduating seniors of January, 1971, and the results are presented in Table VI.

TABLE VI

ACTUAL AND PREDICTED ACCUMULATIVE GRADE POINT AVERAGES FOR ENGINEERING GRADUATES, JANUARY, 1971 (N=25)

Subject Number	Actual Accumulative Average	Predicted Accumulative Average	Deviation
1	2.758	3.256	0.498
2	2.834	3.065	0.211
3	3.124	3.134	0.010
4	3.112	3.436	0.324
5	2.789	2.987	0.198
10	2.780	2.933	0.153
11	2.836	2.823	-0.013
12	3.057	3.034	-0.023
13	2.920	3.046	0.126
14	3.083	3.396	0.313
15	3.153	3.374	0.221
16	2.791	2.802	0.011
17	2.181	2.330	0.149
18	2.060	2.227	0.167
19	3.550	3.595	0.040
21	3.582	3.725	0.143
22	2.987	3.094	0.107
23	2.638	2.547	-0.091
24	2.481	2.969	0.488
26	2.621	2.619	-0.002
27	2.964	2.875	-0.089
28	3.496	3.582	0.086
29	2.445	2.911	0.466
30	2.910	2.658	-0.252
31	2.223	2.505	0.282

As was stated earlier, the standard error of the estimate associated with the prediction, Sophomore GPA, is .222. The following results are observed for the predicted accumulative GPA when compared to the actual GPA. Seventy-two percent of the predicted accumulative GPA's fell within one standard error of the estimate (plus or minus), ninety-two percent of the predicted accumulative GPA's fell within two standard errors of the estimate (plus or minus), and one hundred percent of the predicted accumulative GPA's fell within three standard errors of the estimate.

Summary

Hypothesis II: No significant predictive relationship exists between accumulative grade point average and the following predictors: (1) Sophomore GPA, (2) Mathematics GPA, (3) Chemistry GPA, (4) Physics GPA, (5) Social Science GPA, (6) Humanities GPA, (7) High School GPA, (8) CAT, (9) NDRT Vocabulary, (10) NDRT Comprehension, (11) NDRT Total, (12) ACT English, (13) ACT Mathematics, (14) ACT Social Science, (15) ACT Natural Science, (16) ACT Composite, (17) KPR Outdoor, (18) KPR Mechanical, (19) KPR Computational, (20) KPR Scientific, (21) KPR Persuasive, (22) KPR Artistic, (23) KPR Literary, (24) KPR Musical, (25) KPR Social Service, and (26) KPR Clerical.

Since analysis of the data reveals that one of the predictors yielded a significant predictive relationship that could be utilized for prediction to accumulative GPA, the null hypothesis is rejected for Sophomore GPA, but it is accepted for all other predictors listed above.

The regression equation developed appears to be capable of making quite accurate predictions for the population studied and it appears to continue to be accurate for the group randomly selected for testing its predictive efficiency. The standard error of the estimate associated with this predictor is relatively small. Therefore, it is a meaningful prediction. It would seem that the regression equation developed for predicting accumulative GPA would have great utility for the selection of students for the professional program in Engineering.

Analysis of Data Related to Hypothesis III

From an inspection of Table VII, page 51, it is apparent that twelve of the predictors yielded significant coefficients of correlations with success. The predictors were as follows: Mathematics GPA, Sophomore GPA, Physics GPA, Chemistry GPA, High School GPA, Humanities GPA, Social Science GPA, CAT, ACT Natural Science, ACT Mathematics, ACT Composite, and ACT Social Science.

The Sophomore GPA has the largest relationship with successful completion of the engineering program (r=.55). The second highest r was obtained by the Mathematics GPA (r=.52), followed by the Physics GPA (r=.51), Chemistry GPA (r=.49), Social Science GPA (r=.37), High School GPA (r=.36), and Humanities GPA (r=.34). All of the predictors listed above indicate that past academic performance is indicative of future academic performance since all predictors listed above are grade point averages and were significant beyond the .001 level of confidence.

The intercorrelations of these seven predictors (Appendix B, Table XIX) range from 0.35 to .77 which suggests that some of the predictors are apparently measuring the same or very closely related factors. Since all predictors significant at the .001 level are grade point averages, these observed relationships appear to be congruent with expected results.

TABLE VII

STATISTICALLY SIGNIFICANT CORRELATION COEFFICIENTS WITH DEPENDENT VARIABLE NUMBER THREE -- SUCCESS VERSUS NON-SUCCESS (N=196)

Factor	Mean	SD	Correlation Coefficient
Mathematics GPA	2.30	0.93	0.52***
Sophomore GPA	2.41	0.68	0.55***
Physics GPA	1.85	1.05	0.51***
Chemistry GPA	2.74	0.92	0.49***
Social Science GPA	2.53	0.95	0.37***
High School GPA	3.16	0.56	0.36***
Humanities GPA	2.17	1.06	0.34***
CAT	44.30	9.68	0.25*
ACT Natural Science	25.53	4.33	0.24*
ACT Mathematics	27.39	4.35	0.24*
ACT Composite	24.58	3.54	0.23*
ACT Social Science	24.26	4.71	0.21*

***Significant not less than the .001 level of confidence.
* Significant not less than the .05 level of confidence.

The factors associated with achievement and ability yielded significance at the .05 level of confidence. The CAT, a measure of understanding of basic algebra, yielded an r of .250 with the criterion followed closely by the ACT Natural Science (r=.24), the ACT Mathematics (.24), the ACT Composite (.23), and the ACT Social Science (.23).

The next step in the analysis of the data was to perform a stepwise multiple regression analysis in order that weights for the variables most highly correlated with the criterion could be selected for utilization in a multiple regression equation. The four variables selected were those that resulted in an increase in the amount of variance accounted for when these variables were entered into the regression equation in a step-wise fashion. Table VIII, page 53, summarizes the results for entering four variables into the regression equation in a step-wise fashion. The first variable to enter the regression equation was Sophomore GPA followed by Physics GPA, Chemistry GPA, and the KPR Persuasive. When the remaining variables were entered one by one into the regression equation, none resulted in a reduction of variance that would contribute to the predictive efficiency of the regression equation.

The multiple regression equation for predicting to success was found to be as follows:

$$Y_D = 0.20967X_1 + 0.12345X_2 + 0.10668X_3 + 0.00253X_4 - 0.73479$$

where:

X_1 is the Sophomore GPA

X_2 is the Physics GPA

X_3 is the Chemistry GPA

X_4 is the KPR Persuasive score

The multiple R was found to be .63 which implies that approximately forty percent of the variability was accounted for by the four predictors combined in the regression equation.

As was indicated in Chapter III, page 32, since a value of one was assigned to successful students, when Y_D equals .50 or more, the student was predicted to be successful. The equations were developed and the results are presented in Appendix B (see Table XX). Tables IX and X summarize the results of incorrect predictions. Table IX, page 54, indicates that fifteen students were predicted to graduate but failed

TABLE VIII

RESULTS OF STEPS 1, 2, 3, AND 4 FOR ENTERING A VARIABLE INTO THE REGRESSION EQUATION IN A STEP-WISE FASHION FOR DEPENDENT VARIABLE NUMBER THREE -- SUCCESS (N=196)

Entering Variable		Standard Error of Estimate	Constant	Variables in Regression Equation	Coefficient of Variables in Regression Equation	Standard Error of Coefficient	Multiple Correlation Coefficient
Sophomore GPA	95.356**	0.411	-0.49128	Sophomore GPA	0.42180	0.04314	.57
Physics GPA	56.522**	0.400	-0.40060	Sophomore GPA	0.28419	0.05746	.60
				Physics GPA	0.13006	0.03725	
Chemistry GPA	40.851**	0.394	-0.47627	Sophomore GPA	0.21116	0.06355	.61
				Physics GPA	0.11506	0.03722	
				Chemistry GPA	0.10168	0.04030	
KPR Persuasive	33.333**	0.391	-0.73479	Sophomore GPA	0.20967	0.06299	.63
				Physics GPA	0.12345	0.03679	
				Chemistry GPA	0.10668	0.03973	
				KPR Persuasive	0.00668	0.00253	

**Significant at the .01 level of confidence.

and Table X, page 55, indicates that nineteen students were predicted to fail but graduated. Total results indicate that the regression equation made the correct prediction about eighty-three percent of the time.

TABLE IX

STUDENTS PREDICTED TO GRADUATE BUT FAILED
(N=15)

Student Number	Actual	Prediction	Deviation
109	0.00000	0.77971	-0.77971
139	0.00000	0.54070	-0.54070
140	0.00000	0.51341	-0.51341
145	0.00000	1.00000	-1.00000
149	0.00000	0.51772	-0.51772
151	0.00000	0.53356	-0.53356
161	0.00000	0.83541	-0.83541
167	0.00000	0.54947	-0.54947
168	0.00000	0.58473	-0.58473
175	0.00000	0.52228	-0.52528
180	0.00000	0.66545	-0.66545
185	0.00000	0.67135	-0.67135
187	0.00000	0.98845	-0.98845
193	0.00000	0.58321	-0.58321
195	0.00000	1.00000	-1.00000

The predictive value of the regression equation was tested by applying the data to the twenty-five randomly selected subjects described earlier in this chapter. As Table XI, page 56, reveals, the regression equation made the correct prediction eighty-three percent of the time. Twelve percent of the time, incorrect predictions were made.

TABLE X

STUDENTS PREDICTED TO FAIL BUT GRADUATED
(N=19)

Student Number	Actual	Prediction	Deviation
2	1.0000	0.46699	0.53301
10	1.0000	0.34768	0.65232
14	1.0000	0.47763	0.52237
17	1.0000	0.45972	0.54028
33	1.0000	0.34451	0.65549
34	1.0000	0.38369	0.61631
37	1.0000	0.29749	0.70251
39	1.0000	0.34709	0.65291
41	1.0000	0.40957	0.59043
50	1.0000	0.34062	0.65938
54	1.0000	0.49894	0.50106
55	1.0000	0.40899	0.59101
57	1.0000	0.36318	0.63682
70	1.0000	0.40782	0.59218
74	1.0000	0.43460	0.56540
75	1.0000	0.44013	0.55987
95	1.0000	0.33331	0.66669
96	1.0000	0.42722	0.57278
98	1.0000	0.26212	0.73788

Summary

Hypothesis III: No significant predictive relationships exist between success in engineering and the following predictors: (1) Sophomore GPA, (2) Mathematics GPA, (3) Chemistry GPA, (4) Physics GPA, (5) Social Science GPA, (6) Humanities GPA, (7) High School GPA, (8) _CAT_, (9) _NDRT_ Vocabulary, (10) _NDRT_ Comprehension, (11) _NDRT_ Total, (12) _ACT_ English, (13) _ACT_ Mathematics, (14) _ACT_ Social Science, (15) _ACT_ Natural Science, (16) _ACT_ Composite, (17) _KPR_ Outdoor, (18) _KPR_

Mechanical, (19) KPR Computational, (20) KPR Scientific, (21) KPR Persuasive, (22) KPR Artistic, (23) KPR Literary, (24) KPR Musical, (25) KPR Social Service, and (26) KPR Clerical.

TABLE XI

ACTUAL AND PREDICTED RESULTS TO THE DICHOTOMY OF SUCCESS VERSUS NONSUCCESS FOR A RANDOM SAMPLE OF JANUARY, 1971 ENGINEERING GRADUATES UTILIZING SOPHOMORE GPA, PHYSICS GPA, AND CHEMISTRY GPA AS PREDICTORS

Student Number	Actual	Prediction	Deviation
1	1.000	0.782	-0.218
2	1.000	0.796	-0.304
3	1.000	0.697	-0.303
4	1.000	0.956	-0.044
5	1.000	0.776	-0.304
10	1.000	0.694	-0.306
11	1.000	0.568	-0.432
12	1.000	0.737	-0.263
13	1.000	0.836	-0.164
14	1.000	1.000	0.000
15	1.000	0.971	-0.029
16	1.000	0.619	-0.381
17	1.000	0.308	-0.692
18	1.000	0.323	-0.677
19	1.000	1.000	0.000
21	1.000	1.000	0.000
22	1.000	0.732	-0.268
23	1.000	0.554	-0.446
24	1.000	0.767	-0.233
26	1.000	0.575	-0.425
27	1.000	0.707	-0.293
28	1.000	1.000	0.000
29	1.000	0.645	-0.355
30	1.000	0.439	-0.561
31	1.000	0.548	-0.452

Since analysis of the data reveals that four of the predictors yielded significant predictive relationships that could be utilized for predicting to success, the null hypothesis was rejected for the following predictors: (1) Sophomore GPA, (2) Physics GPA, (3) Chemistry GPA, and (4) KPR Persuasive. The null hypothesis was accepted for the following predictors: (1) Mathematics GPA, (2) Social Science GPA, (3) Humanities GPA, (4) High School GPA, (5) CAT, (6) NDRT Vocabulary, (7) NDRT Comprehension, (8) NDRT Total, (9) ACT English, (10) ACT Mathematics, (11) ACT Social Science, (12) ACT Natural Science, (13) ACT Composite, (14) KPR Outdoor, (15) KPR Mechanical, (16) KPR Computational, (17) KPR Scientific, (18) KPR Artistic, (19) KPR Literary, (20) KPR Musical, (21) KPR Social Service, and (22) KPR Clerical.

The regression equation developed for predicting successful completion of the program appears to be quite accurate. For the initial population of students (N=196) studied, correct predictions were made eighty-three percent of the time. For the population selected to test the predictive efficiency of the regression equation, correct predictions were made eighty-eight percent of the time. For selection of students to the professional program, the regression equation appears to have great utilization.

Overall Grade Point Average at the Conclusion of the Sophomore Year as a Predictor

As was reported on page two in Chapter I, the primary requisite for a student's acceptance into the professional program, after two years of preprofessional work, is a grade point average of 2.500 or higher.

Consequently, this section is primarily concerned with the rationale for this decision.

As was indicated by the prediction to the dichotomy of success versus nonsuccess, 196 students were either predicted to be successful or predicted to be unsuccessful. Since a value of one was assigned to the successful students and a value of zero was assigned to unsuccessful students, a value of .50 or more resulted in the student being predicted to be successful. Thus, the problem becomes one of determining what sophomore grade point average would be required to obtain a value of .50 or above. Consequently, the Sophomore GPA was utilized as the only predictor and the following results were obtained as shown in Table XII.

TABLE XII

RESULTS OF ENTERING THE PREDICTOR -- SOPHOMORE GPA INTO THE REGRESSION EQUATION FOR PREDICTING SUCCESS VERSUS NONSUCCESS

Predictor	F	Regression Coefficient	Intercept	Standard Error of Regression Coefficient	Correlation Coefficient
Sophomore GPA	95.356***	0.42128	0.49128	0.04314	.574

***Significant at the .001 level of confidence.

As Table XII reveals, when only Sophomore GPA is utilized as a predictor to the dichotomy of success versus nonsuccess, the regression equation was found to be as follows:

$Y_D = 0.42128\ X + 0.49128$ where:

X = the Sophomore GPA.

As a result of the above, the following equation might be utilized to determine what grade point average would be required to obtain a value of 0.5: $rgX + a = y$ when

rg = the regression coefficient (0.42128)

X = the sophomore grade point average

a = the constant (-0.49128)

y = the predicted or critical cutting point (0.5).

Thus the equation becomes:

$$(0.42128 \times X) + (-0.49128) = .5$$

$$(0.42128 \times X) = .5 - (-0.49128)$$

$$X = \frac{0.99128}{0.42128}$$

$$X = 2.35.$$

Therefore, for a student to be predicted to be successful based solely on the sophomore grade point average, a grade point average of not less than 2.35 is required in order for the student to have a fifty-fifty chance of completing the program.

The results of utilizing only Sophomore GPA are presented in Appendix C (see Table XXI). Tables XIII and XIV summarize inaccurate predictions. Seventeen students were predicted to fail (see Table XIII) but graduated and seventeen students were predicted to graduate but failed (see Table XIV). Utilizing only Sophomore GPA as a predictor, the results reflect accurate predictions which were made approximately eighty-three percent of the time.

TABLE XIII

STUDENTS PREDICTED TO FAIL BUT GRADUATED UTILIZING ONLY SOPHOMORE GPA AS A PREDICTOR (N=17)

Student Number	Actual	Prediction	Deviation
10	1.00000	0.32264	0.67736
33	1.00000	0.30283	0.69717
34	1.00000	0.35128	0.64872
37	1.00000	0.27503	0.72497
50	1.00000	0.37913	0.62807
54	1.00000	0.35802	0.64198
55	1.00000	0.41532	0.58468
57	1.00000	0.37698	0.62302
59	1.00000	0.48272	0.51728
66	1.00000	0.47051	0.52949
70	1.00000	0.40714	0.53286
74	1.00000	0.48020	0.51980
90	1.00000	0.33738	0.66262
95	1.00000	0.37066	0.62934
96	1.00000	0.39847	0.60153
98	1.00000	0.48272	0.51728
101	1.00000	0.46461	0.53539

TABLE XIV

STUDENTS PREDICTED TO GRADUATE BUT FAILED UTILIZING ONLY SOPHOMORE GPA AS A PREDICTOR (N=17)

Student Number	Actual	Prediction	Deviation
109	0.00000	0.82228	-0.82228
121	0.00000	0.99922	-0.99922
134	0.00000	0.50920	-0.50926
142	0.00000	1.00000	-1.00000
145	0.00000	0.89474	-0.89474
156	0.00000	0.61543	-0.61543
161	0.00000	0.82313	-0.82313
171	0.00000	0.50547	-0.50547
180	0.00000	0.71991	-0.71991
185	0.00000	0.74518	-0.74518
186	0.00000	0.63186	-0.63186
187	0.00000	0.98658	-0.98658
188	0.00000	0.78731	-0.78731
190	0.00000	0.51980	-0.51980
192	0.00000	0.54718	-0.54718
193	0.00000	0.76583	-0.76583
195	0.00000	1.00000	-1.00000

Summary

As was stated in Chapter I, one of the primary requisites for entering the professional engineering program, after two years of pre-professional work, is a grade point average of 2.5 or higher. Based on the findings in this section, it would appear that a more desirable cutting sophomore grade point average would be a 2.350, which is the grade point average associated with a .50 prediction to the dichotomy of success versus nonsuccess. Since eighty-three percent of the forecasts made were accurate when the regression equation was utilized for predictive purposes, it would seem to be more practical to utilize a 2.350 sophomore grade point average as a cutting point for selecting students for the professional engineering program instead of a sophomore grade point average of 2.500.

As Table XV reveals, eighty-three percent of the successful students who had a prediction of .50 or more completed the engineering program and eighty-two percent of the unsuccessful students with less than a .50 failed to complete the engineering program.

TABLE XV

PERCENTAGES OF SUCCESSES AND FAILURES ABOVE AND BELOW A PREDICTION OF .50 TO THE DICHOTOMY OF SUCCESS VERSUS NONSUCCESS UTILIZING SOPHOMORE GPA AS A PREDICTOR

	N Above .50	Percentage	N Below .50	Percent
Students that completed B.S. in Engineering	86	83	17	18
Students who failed to complete B.S. in Engineering	17	17	76	82
Total	103	100	93	100

Discussion

In reference to the review of the literature, the findings of this study, in general, are not congruent with studies that have been done at other institutions. For example, Barnett (7) and Stinson (51) reported that scores on the KPR Scientific scale were significantly higher for students who persisted in engineering than for those who dropped out. However, no significant predictive relationships were found in this study associated with the KPR Scientific scale.

Bowers (11) lowest correlation, in his study of the relationships between scores on the KPR and first semester GPA in engineering, was between the criterion and the KPR Persuasive score. In this study, the KPR Persuasive, although a negative correlation, was one of the significant predictors of success. ACT scores appear to be fairly good predictors of first semester or even first year grades in college (54, 35), as does the CAT (11). However, neither of these measures appeared as a significant predictor of the three dependent variables predicted in this study.

Although the NDRT was a significant predictor for upper division GPA in this study, it failed to make a significant contribution to predicting accumulative GPA or success. It is interesting to note that McClanahan and Morgan (41) found the NDRT to be a significant predictor for forecasting first semester engineering grade point averages.

Since the best single predictor of success in this study was Sophomore GPA, one might conclude that the best predictor of success in any academic program is past performance in an academic program. Stinson (51) concluded that successful engineering students must possess certain abstract abilities such as general reasoning ability to work effectively with mathematical concepts. This statement appears to be congruent with the findings of this investigation since about thirty-eight of the first sixty hours taken during the first two years of engineering are directly or indirectly related to mathematical concepts. These thirty-eight hours, of course, are making a significant contribution to the computation of the Sophomore GPA, which is the most outstanding predictor of the three dependent variables investigated in this study. In conclusion, it would appear that the findings of this study might be unique for the College of Engineering, Oklahoma State University, just as similar findings of studies conducted by other investigators appear to be unique for the institution where the research was conducted.

In Chapter V the summary and conclusions will be presented along with the recommendations concerning the utilization of this data.

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

The purposes of this chapter are to summarize this investigation, to report the conclusions drawn from this study, and to make recommendations on the basis of this study's findings.

Summary

The major problem under investigation in this study was to determine the predictive relationship of selected academic and interest variables to success in engineering. The groups of predictor variables utilized for making statements of prediction to successful completion of the engineering program were Sophomore GPA, Mathematics GPA, Chemistry GPA, Physics GPA, Social Science GPA, Humanities GPA, High School GPA, NDRT Scores, ACT Scores, and KPR Scores. Two other dependent variables were also examined. Statements of prediction were developed for upper division GPA and accumulative GPA utilizing the predictors listed above.

Various approaches, as is revealed by the review of the literature, have been taken in attempts to identify factors that are associated with success in any program. The most frequent approach appears to be determining if there were significant intellectual and interest differences between students who were successful in a given curriculum and those who dropped out of college. Another approach has been the study of intellectual variables only, such as scores on achievement or aptitude measures, and grade point average, which have resulted in the identification of some of the characteristics of persisting students. Correlational studies have constituted another approach but the correlation of a variable with a predictor have tended to vary from institution to institution.

Although prediction studies cited tend, in general, to attempt to identify success with a specific grade point average, the fact remains that a student is successful if he graduates no matter what his grade point average may be. Consequently, the primary approach in this investigation was to develop statements of prediction to success as defined by graduation with a Bachelor of Science in Engineering. Other variables predicted were upper division GPA and accumulative GPA. Interest in development of statements of predictions to these variables arose as a result of the establishment of a professional program for the education of engineers. The program will consist of a two-year preprofessional curriculum followed by a three-year professional program. The decision was made not to admit all students to the three-year professional program, with the primary requisite for a student's acceptance being a grade point average of 2.500 or higher at the conclusion of the student's two years of preprofessional work. Consequently, the decision was made to attempt to determine if there was a rationale for setting an arbitrary grade point average of 2.500 or above as a requirement for entrance into the professional program or if there were factors available from the record of the student other than a specific grade point average that are more indicative of successful completion of the engineering program.

The subjects utilized in this study were selected from a population of 392 students classified as sophomores and enrolled in the College of Engineering, Oklahoma State University, in the spring semester, 1966-67. After exclusion of students transferring into the College of Engineering with more than eight hours of previous college work (N=128), international students (N=41), and students who failed to have on record the ACT, KPR, NDRT, or the CAT (N=27), the subjects utilized in this investigation consisted of 196 students (103 students who had completed the requirements for graduation and 93 students who had failed to complete the requirements for a Bachelor of Science in Engineering).

Using a step-wise procedure, multiple correlations were developed between the predictor variables, in selected combinations, and the three dependent variables. Raw score weights for multiple regression equations were derived for the three dependent variables under study. The regression equation for upper division GPA was $Y = 0.85680\ X_1 - 0.13912\ X_2 - 0.00846\ X_3 - 0.01090\ X_4 - 0.00529\ X_5 + 0.00723\ X_6 + 1.39008$. Approximately forty-two percent of the criterion variance was accounted for by the following predictors: (1) Sophomore GPA, (2) Chemistry GPA, (3) NDRT Comprehension, (4) KPR Musical, (5) KPR Outdoor, and (6) KPR Artistic. The standard error of the estimate associated with the six predictors was 0.444. Consequently, the prediction to upper division GPA would seem to have little value for selecting students for the professional engineering program since the predictions are not precise enough to be meaningful.

The regression equation for prediction to accumulative GPA was $Y = 0.83982\ X + 0.43885$. Approximately seventy-eight percent of the criterion variance was accounted for by the predictor -- Sophomore GPA.

The standard error of the estimate associated with the predictor -- Sophomore GPA -- was 0.222. Consequently, it would appear that predictions within acceptable limits could be made utilizing this prediction equation for the selection of students for the professional engineering program.

The multiple regression equation for prediction to successful completion of the engineering program was $Y_D = 0.20967\ X_1 + 0.12345\ X_2 + 0.10668\ X_3 + 0.00253\ X_4 - 0.73479$. Approximately forty percent of the criterion variance was accounted for by utilizing the following four predictors in the regression equation: (1) Sophomore GPA, (2) Physics GPA, (3) Chemistry GPA, and (4) KPR Persuasive.

The predictive efficiency of the regression equations were tested by applying the data to the population studied and also to twenty-five randomly selected students who fulfilled the requirements for the Bachelor of Science in Engineering in January, 1971.

For the dependent variable, upper division grade point average, results indicate that seventy-one percent of the predictions for the population studied were within one standard error of estimate (.444), plus or minus, ninety-five percent of the predictions were within two standard errors of the estimate, plus or minus, and less than four percent of the predictions were greater than two standard errors of the estimate, plus or minus, from the prediction. For the twenty-five randomly selected students who were not members of the population utilized in this investigation, ninety-six percent of the predicted upper division GPA's fell within one standard error of the estimate, plus or minus, and only four percent (one case) fell within an area greater than one standard error of the estimate.

As a result, the null hypothesis of no significant predictive relationships between upper division GPA and the predictors -- Sophomore GPA, Chemistry GPA, NDRT Comprehension, KPR Musical, KPR Outdoor, and KPR Artistic -- was rejected.

For the dependent variable, accumulative GPA, results indicate that sixty-seven percent of the predictions for the population studied were within one standard error of the estimate (.222), plus or minus, ninety-six percent of the predictions were within two standard errors of the estimate, and all predictions were within three standard errors of the estimate. For the twenty-five randomly selected students utilized for testing the regression equation, seventy-two percent of the predicted accumulative GPA's fell within one standard error of the estimate, plus or minus, ninety-two percent of the predicted accumulative GPA's fell within two standard errors of the estimate, plus or minus, and all predicted accumulative GPA's fell within three standard errors of the estimate, plus or minus. As a result, the null hypothesis of no significant predictive relationship between accumulative GPA and the predictor -- Sophomore GPA -- was rejected.

For the dependent variable, success, results indicate that correct predictions were made eighty-three percent of the time for the initial population (N=196). For the population selected to test the predictive efficiency of the regression equation, correct predictions were made eighty-eight percent of the time.

As a result of these findings, the null hypothesis of no significant predictive relationships between success and the following predictors -- Sophomore GPA, Physics GPA, Chemistry GPA, and KPR Persuasive -- was rejected.

In reference to the rationale for utilizing a cutting GPA of 2.5 or above at the conclusion of the sophomore year for the admission of a student into the professional program, the following results are reported. When the Sophomore GPA was utilized as the only predictor of success, the following regression equation was developed: $Y_D = 0.42128 X + 0.49128$. Based on this equation, as is shown on page 59, the grade point average determined to be associated with a prediction of .5 was 2.35. Therefore, for a student to be predicted to be successful based solely on Sophomore GPA, a grade point average of not less than 2.35 would appear to be the most appropriate point for accepting or rejecting students for the professional engineering program. Utilizing only Sophomore GPA as a predictor of success, correct predictions were made eighty-three percent of the time.

Conclusions

Within the limits and findings of this study, the following conclusions are suggested:

1. Upper division GPA cannot be predicted with the degree of accuracy necessary for the selection of students for the professional engineering program utilizing the twenty-six predictors and the population selected, since the standard error of the estimate for the significant predictors was 0.444. Predictions simply do not fall within acceptable limits.

2. Accumulative GPA can be predicted within acceptable limits since the standard error of estimate associated with the predictor, Sophomore GPA, was 0.222. Therefore, it would appear that utilization

of the regression equation associated with predicting accumulative GPA might be a point for consideration in selecting students for the professional engineering program.

3. Predictions to the dichotomy of success versus nonsuccess would seem to be the best method of selecting students for the professional engineering program, since correct predictions were made eighty-three percent of the time utilizing the regression equation developed for that purpose.

4. If only one variable is to be used for determining admission to the professional engineering program, Sophomore GPA is the most consistent predictor, whether predictions are being made to upper division GPA, accumulative GPA, or to successful completion of the engineering program.

5. If a specific Sophomore GPA is to be set for admission to the professional engineering program, it would appear that the Sophomore GPA should be lowered from 2.500 to 2.350 since this is the Sophomore GPA associated with a prediction of .50 to the dichotomy of success versus nonsuccess.

Recommendations

The results of this study indicate that the most predictive index in the record of the student is Sophomore GPA, whether one is predicting upper division GPA, accumulative GPA, or successful completion of the Engineering program. Therefore, it would appear that Sophomore GPA could be utilized as a factor for selecting students for the professional engineering program. It is also recognized that no one method of selecting students for any academic program is completely satisfactory. As Table XIV reveals, seventeen students were predicted to graduate in engineering, but failed. Table XIII also indicates that seventeen students were predicted to fail but graduated. Although the predictions were well above chance level (eighty-three percent were correctly predicted), admission or rejection of a student for any academic program utilizing a solely statistical method leaves much to be desired. The human element needs to remain an integral part of the selection process. Therefore, the following recommendations are made.

The admission's officer for the professional engineering program should consider admitting all students with a predicted score to success of .50 or more, whether he chooses to utilize the regression equation using four predictors or simply the Sophomore GPA as a predictor. However, reasonably accurate predictions to the dichotomy of success versus nonsuccess can be made utilizing only Sophomore GPA as a predictor, and it offers the simplicity of working with only one predictor. No matter which of the two systems might be employed, it would seem logical to utilize the system chosen to select or reject students for the professional engineering program in the following manner. Any student that falls in a predicted range of .30 to .49 to the dichotomy of success versus nonsuccess should be called in for an interview with the admission's officer before the decision is made to accept or reject him for the professional engineering program. The rationale for this recommendation is based on the following Tables. As Table X, page 55, reveals, only two students with a predicted score of less than .30 completed the engineering program. Table XIII indicates that only one student with a predicted score below .30 graduated with a Bachelor of Science in Engineering. Whereas, predictions summarized in Table X were derived from utilizing four predictors, predictions summarized in Table XIII were derived by utilizing only Sophomore GPA as a predictor. Indications are that students who fall below a prediction of .30 have little chance of completing the engineering program. Therefore, after the admission's officer discusses with the student his possibilities for graduation in reference to his predicted score, if the student determines he would prefer to transfer to another college on campus, the admission's officer could either transfer him to another college on campus or refer him to the appropriate agency for vocational counseling if the student is not ready to make a choice concerning a major. By providing alternatives to the student, his chances of making an appropriate educational decision are increased. In order to facilitate the implementation of the selection process for a student's admission to the professional engineering program, the following system might be utilized. For example, the regression equation, utilizing the Sophomore GPA as a predictor of success, could be routinely programmed so that print outs could be utilized for identifying the student's predicted score to the dichotomy of success versus nonsuccess. With the extensive computer system available, this task would not be difficult. By identifying the marginal students (students with a predicted score of less than .50) before they are permitted to enroll in upper division engineering courses, it is possible, after academic counseling, that a number of students might be transferred to another curriculum where they might experience success. It is also possible that the admission's officer and the academic counselors might be able to offer suggestions for the improvement of the individual's academic performance if he remains in engineering.

While it is recognized that this study does not offer a panacea that cures all ills for the admission or rejection of any student for the professional engineering program, it is a better system than simply making an educated guess about a student's chances for success. It has at least, established guidelines that might be considered for identifying marginal students. With the aid of academic and personal counseling, these marginal students might experience success either in engineering or another curriculum. By identifying the marginal student, which the regression equation developed for success appears to do, it becomes a valuable tool not only for the College of Engineering admission's officer, but for the individual student it serves.

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APPENDIXES

APPENDIX A

DATA RELATED TO DEPENDENT VARIABLE ONE -- UPPER DIVISION GPA AND DEPENDENT VARIABLE TWO -- ACCUMULATIVE GPA

TABLE XVI

THE INTERCORRELATION MATRIX OF THE SCORES FOR TWENTY-SIX PREDICTORS AND THE TWO DEPENDENT VARIABLES - UPPER DIVISION GPA AND ACCUMULATIVE GPA (N=103)

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1.	Sophomore GPA		79	58	74	62	44	24	25	21	24	25	24	29	23	18
2.	Mathematics GPA			35	63	49	29	14	21	17	16	18	14	29	19	12
3.	Chemistry GPA				38	29	26	31	23	02	06	04	04	20	06	06
4.	Physics GPA					33	21	14	36	18	09	15	19	40	22	19
5.	Social Science GPA						37	14	-04	32	29	33	23	05	37	20
6.	Humanities GPA							31	02	26	35	34	28	18	23	24
7.	High School GPA								28	11	15	15	17	24	10	18
8.	CAT									33	18	29	31	65	27	20
9.	NDRT Vocabulary										63	91	49	27	52	42
10.	NDRT Comprehension											89	56	31	61	42
11.	NDRT Total												58	33	62	46
12.	ACT English													42	56	50
13.	ACT Mathematics														38	26
14.	ACT Social Science															60
15.	ACT Natural Science															
16.	ACT Composite															
17.	KPR Outdoor															
18.	KPR Mechanical															
19.	KPR Computational															
20.	KPR Scientific															
21.	KPR Persuasive															
22.	KPR Artistic															
23.	KPR Literary															
24.	KPR Musical															
25.	KPR Social Service															
26.	KPR Clerical															
I.	Upper Division GPA															
II.	Accumulative GPA															

TABLE XVI, Continued

		16	17	18	19	20	21	22	23	24	25	26	I	II
1.	Sophomore GPA	25	20	04	08	19	-29	-17	05	01	01	18	61	89
2.	Mathematics GPA	17	11	-01	18	21	-31	-16	11	04	-06	22	51	71
3.	Chemistry GPA	12	20	-03	06	11	-29	-10	04	01	17	06	23	46
4.	Physics GPA	26	12	09	11	13	-15	-13	-01	-05	01	12	42	65
5.	Social Science GPA	23	12	-01	-09	26	-08	-19	18	-01	-06	-01	38	54
6.	Humanities GPA	23	06	-05	-05	10	-22	-13	15	04	00	06	20	37
7.	High School GPA	23	01	01	01	21	-18	-21	12	-01	05	10	12	23
8.	CAT	44	-12	-10	11	11	-01	-12	06	10	00	-01	16	23
9.	NDRT Vocabulary	48	-19	-17	-14	04	-01	-05	44	13	-28	-10	13	20
10.	NDRT Comprehension	57	-19	-14	06	05	-06	-13	42	11	-31	09	03	16
11.	NDRT Total	57	-20	-17	-05	04	-04	-10	48	13	-33	-01	09	20
12.	ACT English	79	-22	02	-03	-01	-05	-15	18	05	-17	14	04	18
13.	ACT Mathematics	63	-23	07	10	12	-02	-23	09	05	-05	03	08	20
14.	ACT Social Science	76	-14	-06	-04	21	10	-23	34	-18	-11	-02	68	17
15.	ACT Natural Science	70	-05	04	-05	17	-03	-04	15	-09	-24	06	08	16
16.	ACT Composite		-17	03	-04	13	01	-21	20	-02	-20	09	04	18
17.	KPR Outdoor			30	-24	19	-45	11	-14	-22	12	-31	06	16
18.	KPR Mechanical				-15	20	-33	02	-37	-23	-13	-06	03	02
19.	KPR Computational					12	05	-35	-14	-04	-02	57	03	07
20.	KPR Scientific						-25	-39	-13	-31	10	-14	06	14
21.	KPR Persuasive							-23	05	-07	07	-05	-12	-24
22.	KPR Artistic								-14	06	-22	-07	00	12
23.	KPR Literary									13	-25	-14	03	04
24.	KPR Musical										-26	00	-12	-09
25.	KPR Social Service											-33	05	45
26.	KPR Clerical												07	13
I.	Upper Division GPA													85
II.	Accumulative GPA													

(All decimals omitted)

TABLE XVII

ACTUAL AND PREDICTED UPPER DIVISION GRADE POINT AVERAGE FOR ENGINEERING GRADUATES (N=103)

Subject Number	Actual Upper Division GPA	Predicted Upper Division GPA	Deviation
1	3.58000	3.34693	0.23307
2	3.46500	2.55149	0.91351
3	3.95700	3.42732	0.52968
4	2.04600	2.52840	-0.48240
5	2.89300	2.89401	-0.00101
6	3.69500	3.49072	0.20428
7	2.50000	2.83211	-0.33211
8	3.03900	2.54173	0.49727
9	3.58000	3.06925	0.51075
10	2.08300	2.06750	0.01550
11	3.67700	3.52597	0.15103
12	2.96900	2.43784	0.53116
13	3.20500	3.01435	0.19065
14	3.19600	2.58092	0.61508
15	3.18300	2.93674	0.24626
16	2.63200	2.59338	0.03862
17	2.43200	2.55912	-0.12712
18	3.43000	3.34436	0.08564
19	3.64600	2.94772	0.69828
20	3.41400	2.92651	0.48749
21	2.86100	3.05574	-0.19474
22	3.41300	3.07130	0.34170
23	2.33800	2.53474	-0.19674
24	1.95800	2.69286	-0.73486
25	3.82800	3.39257	0.43543
26	3.82800	3.21052	0.61748
27	2.15900	3.45255	-1.29356
28	2.30000	2.47787	-0.17788
29	2.65700	2.82990	-0.17290
30	2.27100	2.66588	-0.39488
31	3.27600	2.58208	0.69392
32	2.74000	2.59594	0.14406
33	2.18100	1.97518	0.20582
34	2.22500	2.45992	-0.23492
35	1.95100	3.06942	-1.11842
36	3.27700	3.03403	0.24297
37	2.07600	2.14410	-0.06810
38	3.44100	3.25313	0.18787
39	2.60600	2.53401	0.07199
40	2.71600	2.77469	-0.05869

TABLE XVII, Continued

Subject Number	Actual Upper Division GPA	Predicted Upper Division GPA	Deviation
41	2.46500	2.46865	-0.00365
42	2.81100	2.82606	-0.01506
43	2.88600	2.63572	0.25028
44	2.45500	2.75148	-0.29648
45	2.17700	2.23399	-0.05699
46	2.95500	2.85361	0.10139
47	3.19000	2.83268	0.35732
48	2.12300	2.65428	-0.53128
49	2.64100	3.23144	-0.59044
50	2.56900	2.39706	0.17194
51	3.02500	3.16389	-0.13889
52	2.20500	2.51131	-0.30631
53	2.60000	2.74247	-0.14247
54	2.00900	2.15363	-0.14463
55	2.88700	2.28851	0.59849
56	2.75200	2.98055	-0.22855
57	2.29400	2.40595	-0.11195
58	2.74000	2.84209	-0.10209
59	2.48300	2.27969	0.20331
60	2.18000	2.40580	-0.22580
61	2.35100	2.74687	-0.39587
62	2.35600	2.47732	-0.12132
63	3.20800	2.97272	0.23528
64	3.08500	2.97146	0.11354
65	3.14900	2.87802	0.27098
66	2.86800	2.56917	0.29883
67	2.34800	2.65465	-0.30665
68	2.89700	3.43280	-0.53580
69	2.25000	2.59859	-0.34859
70	3.24600	2.35288	0.89312
71	2.28000	2.76908	-0.48908
72	2.08100	2.55716	-0.47616
73	2.54700	2.61344	-0.06644
74	2.34700	2.51614	-0.16914
75	3.10900	2.61138	0.49762
76	2.52900	2.46850	0.06049
77	3.57300	3.37004	0.20296
78	3.24100	3.18378	0.05722
79	2.60800	2.85775	-0.24975
80	1.84300	2.56054	-0.71754
81	2.51300	2.98637	-0.47337
82	1.79400	2.59073	-0.79673
83	2.95200	2.54042	0.41158
84	2.25200	2.73707	-0.48507

TABLE XVII, Continued

Subject Number	Actual Upper Division GPA	Predicted Upper Division GPA	Deviation
85	2.03800	2.35952	-0.32152
86	3.88400	3.21073	0.67327
87	3.45100	3.44038	0.01062
88	3.65300	3.13631	0.51669
89	2.68600	2.58974	0.09626
90	2.23100	2.19855	0.03245
91	3.15300	2.96518	0.18782
92	2.05700	2.67647	-0.61947
93	3.10000	2.80721	0.29278
94	2.50600	2.59502	-0.08902
95	2.18700	2.37074	-0.18374
96	2.58200	2.41278	0.16922
97	3.04900	2.98340	0.06560
98	2.14900	2.44852	-0.29952
99	3.55100	3.66219	-0.11119
100	2.83300	2.69730	0.13570
101	2.49400	2.23056	0.26344
102	2.80000	2.61314	0.18686
103	2.42400	2.92856	-0.50456

TABLE XVIII

ACTUAL AND PREDICTED ACCUMULATIVE GRADE POINT AVERAGE FOR ENGINEERING GRADUATES (N=103)

Subject Number	Actual Upper Division GPA	Predicted Upper Division GPA	Deviation
1	3.42100	3.18255	0.23845
2	2.96100	2.42587	0.53513
3	3.94900	3.74943	0.19957
4	2.37500	2.69882	-0.32382
5	2.97000	3.01291	-0.04291
6	3.67600	3.50924	0.16676
7	2.76300	2.97092	-0.20792
8	2.93600	2.80295	0.13305
9	3.64300	3.54704	0.09596
10	2.00000	2.06139	-0.06139
11	3.80300	3.73348	0.06952
12	2.75100	2.56444	0.18656
13	3.19700	3.11453	0.08247
14	2.77800	2.41496	0.36304
15	3.18300	3.11285	0.07015
16	2.71200	2.79455	-0.08255
17	2.47100	2.55101	-0.08001
18	3.52600	3.47985	0.04615
19	3.34000	2.99527	0.34473
20	3.17900	2.89197	0.28703
21	2.89300	2.89449	-0.00149
22	3.48900	3.44122	0.04778
23	2.39700	2.50062	-0.10362
24	2.29700	2.68622	-0.38922
25	3.63100	3.30433	0.32667
26	2.47000	2.79036	-0.32036
27	3.67600	3.59743	0.07857
28	2.35200	2.48130	-0.12930
29	2.63300	2.62491	0.00809
30	2.43800	2.69126	-0.25326
31	3.00600	2.52917	0.47683
32	2.60000	2.47794	0.12206
33	2.07200	2.02192	0.05008
34	2.13600	2.11850	0.01750
35	2.75700	3.02803	-0.27103
36	3.22000	3.08345	0.13655
37	1.97300	1.96649	0.00651
38	3.53900	3.37151	0.16749
39	2.59200	2.59972	-0.00072
40	2.70100	2.69126	0.00974

TABLE XVIII, Continued

Subject Number	Actual Upper Division GPA	Predicted Upper Division GPA	Deviation
41	2.48700	2.55017	-0.06317
42	2.79800	2.77440	0.02360
43	2.81800	2.72989	0.08811
44	2.46300	2.51741	-0.05441
45	2.26800	2.43595	-0.16795
46	2.86500	2.74165	0.12335
47	3.01900	2.80211	0.21689
48	2.42200	2.81555	-0.39355
49	3.06600	3.34380	-0.27780
50	2.34200	2.15965	0.18235
51	3.07000	3.00619	0.06381
52	2.27200	2.42251	-0.15051
53	2.85000	3.01543	-0.16543
54	2.04700	2.13194	-0.08494
55	2.57500	2.24615	0.32885
56	2.74800	2.73997	0.00803
57	2.18800	2.16973	0.01827
58	2.84300	2.93145	-0.08845
59	2.41100	2.38052	0.03048
60	2.26600	2.41915	-0.15315
61	2.60800	2.93229	-0.32429
62	2.58600	2.87770	-0.29170
63	3.08900	2.87518	0.21382
64	3.04600	2.95832	0.08768
65	2.87100	2.51741	0.35359
66	2.63200	2.35617	0.27583
67	2.39600	2.50566	-0.10966
68	3.13800	3.39839	-0.26039
69	2.50000	2.77944	-0.27944
70	2.84100	2.34945	0.49155
71	2.49300	2.80547	-0.31247
72	2.29300	2.61567	-0.32267
73	2.54700	2.57704	-0.03004
74	2.33100	2.37548	-0.04448
75	2.79100	2.47794	0.31306
76	2.51000	2.52329	-0.01329
77	3.62400	3.54620	0.07780
78	3.36500	3.41014	-0.04514
79	2.87000	3.17499	-0.30499
80	2.11900	2.58292	-0.46392
81	2.55000	2.61651	-0.06651
82	2.22800	2.75760	-0.52960
83	2.79700	2.61651	0.18049
84	2.51200	2.85754	-0.34554

TABLE XVIII, Continued

Subject Number	Actual Upper Division GPA	Predicted Upper Division GPA	Deviation
85	2.40500	2.72317	-0.31817
86	3.83900	3.61674	0.22226
87	3.48300	3.39671	0.08629
88	3.47400	3.16828	0.30572
89	2.57000	2.46451	0.10549
90	2.12500	2.09078	0.03422
91	3.21700	3.21027	0.00673
92	2.26000	2.59972	-0.33972
93	2.86600	2.59216	0.27384
94	2.60600	2.73493	-0.12893
95	2.12400	2.15713	-0.03313
96	2.37500	2.21256	0.16244
97	3.11000	3.11789	-0.00789
98	2.20600	2.38052	-0.17452
99	3.67500	3.64697	0.02802
100	2.83800	2.82899	0.00901
101	2.39400	2.34441	0.04959
102	2.84000	2.57620	0.26380
103	2.62400	2.89449	-0.27049

APPENDIX B

DATA RELATED TO DEPENDENT VARIABLE

NUMBER THREE -- SUCCESS

TABLE XIX

THE INTERCORRELATIONAL MATRIX OF THE SCORES FOR TWENTY-SIX PREDICTORS AND SUCCESS
(N=196)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. Sophomore GPA		77	64	68	68	52	40	33	25	31	31	22	39	28	29
2. Mathematics GPA			57	65	51	45	38	39	22	31	29	22	43	25	27
3. Chemistry GPA				53	47	40	47	41	18	19	20	18	37	23	26
4. Physics GPA					40	40	34	37	20	17	21	19	39	23	33
5. Social Science GPA						47	34	13	33	31	35	29	20	37	26
6. Humanities GPA							35	23	38	46	46	37	35	38	41
7. High School GPA								31	22	27	27	25	37	27	29
8. CAT									28	25	30	37	71	29	30
9. NDRT Vocabulary										65	91	56	34	57	53
10. NDRT Comprehension											91	58	36	60	48
11. NDRT Total												63	39	64	55
12. ACT English													48	61	56
13. ACT Mathematics														46	41
14. ACT Social Science															67
15. ACT Natural Science															
16. ACT Composite															
17. KPR Outdoor															
18. KPR Mechanical															
19. KPR Computational															
20. KPR Scientific															
21. KPR Persuasive															
22. KPR Artistic															
23. KPR Literary															
24. KPR Musical															
25. KPR Social Service															
26. KPR Clerical															
I. Upper Division GPA															
II. Accumulative GPA															
III. Success-Nonsuccess															

TABLE XIX, Continued

		16	17	18	19	20	21	22	23	24	25	26	I	II	III
1.	Sophomore GPA	36	06	08	-04	19	-10	-18	04	-03	05	-02	64	67	55
2.	Mathematics GPA	33	-05	-02	14	20	-07	-20	07	01	06	06	61	63	52
3.	Chemistry GPA	31	08	03	-00	23	-11	-18	-01	00	16	-04	51	55	49
4.	Physics GPA	32	11	11	-04	25	-14	-17	-03	03	09	-09	58	61	51
5.	Social Science GPA	33	07	-02	-07	21	02	-23	16	-10	04	-01	42	44	37
6.	Humanities GPA	44	-09	-06	01	14	-04	-13	16	-04	06	00	37	39	34
7.	High School GPA	37	-03	00	04	19	03	-17	03	-00	-03	03	36	38	36
8.	CAT	51	-07	-06	15	20	01	-13	-02	07	02	-03	25	26	25
9.	NDRT Vocabulary	59	-11	-04	-08	08	-02	-11	39	09	-18	-10	17	18	14
10.	NDRT Comprehension	61	-13	-12	07	07	-02	-11	40	04	-22	03	18	20	17
11.	NDRT Total	66	-13	-09	-01	08	-02	-12	44	07	-22	-04	19	21	17
12.	ACT English	81	-14	08	02	06	-01	-13	21	01	-16	01	13	15	12
13.	ACT Mathematics	71	-16	06	08	12	06	-13	08	02	-04	01	25	27	24
14.	ACT Social Science	83	-09	01	01	18	09	-19	29	-09	-12	-02	21	22	21
15.	ACT Natural Science	78	-07	08	-07	13	-01	-03	21	02	-17	06	22	24	24
16.	ACT Composite		-13	06	00	14	05	-15	22	00	-16	-01	22	25	23
17.	KPR Outdoor			29	-24	18	-50	06	-14	-17	14	-36	00	02	00
18.	KPR Mechanical				-23	16	-35	05	-26	-17	-16	-14	07	07	06
19.	KPR Computational					10	10	-25	05	-04	-05	47	-06	-05	-07
20.	KPR Scientific						-23	-36	-11	29	02	-12	12	13	11
21.	KPR Persuasive							-18	-03	-02	04	10	03	02	07
22.	KPR Artistic								-22	-04	-18	-04	-18	-20	-18
23.	KPR Literary									13	-24	-04	00	00	-01
24.	KPR Musical										-29	-01	02	03	05
25.	KPR Social Service											-34	08	07	06
I.	Upper Division GPA												-08	-07	-10
II.	Accumulative GPA													99	95
III.	Success-Nonsuccess														95

TABLE XX

PREDICTION TO THE DICHOTOMY OF
SUCCESS VERSUS NONSUCCESS
(N=196)

Subject Number	Actual	Prediction	Deviation
1	1.00000	0.90949	0.09051
2	1.00000	0.46699	0.53301
3	1.00000	1.00000	0.00000
4	1.00000	0.81873	0.18127
5	1.00000	0.75523	0.24477
6	1.00000	1.00000	0.00000
7	1.00000	0.80161	0.19839
8	1.00000	0.74133	0.25867
9	1.00000	1.00000	0.00000
10	1.00000	0.34768	0.65232
11	1.00000	1.00000	0.00000
12	1.00000	0.69004	0.30996
13	1.00000	0.82410	0.17590
14	1.00000	0.47763	0.52237
15	1.00000	1.00000	0.00000
16	1.00000	0.88273	0.11727
17	1.00000	0.45972	0.54028
18	1.00000	1.00000	0.00000
19	1.00000	0.70746	0.29254
20	1.00000	0.74046	0.25954
21	1.00000	0.73575	0.26425
22	1.00000	0.98245	0.01755
23	1.00000	0.73097	0.26903
24	1.00000	0.64919	0.35081
25	1.00000	0.99992	0.00008
26	1.00000	0.72177	0.27823
27	1.00000	1.00000	0.00000
28	1.00000	0.61765	0.38235
29	1.00000	0.65860	0.34140
30	1.00000	0.55816	0.44184
31	1.00000	0.66969	0.33031
32	1.00000	0.43322	0.56678
33	1.00000	0.34451	0.65549
34	1.00000	0.38369	0.61631
35	1.00000	0.89606	0.10394
36	1.00000	0.88961	0.11039
37	1.00000	0.29749	0.70251
38	1.00000	0.98158	0.01842
39	1.00000	0.34709	0.65291
40	1.00000	0.82511	0.17489

TABLE XX, Continued

Subject Number	Actual	Prediction	Deviation
41	1.00000	0.40957	0.59043
42	1.00000	0.50225	0.49775
43	1.00000	0.55116	0.44884
44	1.00000	0.63006	0.36994
45	1.00000	0.56125	0.43875
46	1.00000	0.85797	0.14203
47	1.00000	0.97318	0.02682
48	1.00000	0.93633	0.06367
49	1.00000	0.96311	0.03689
50	1.00000	0.34062	0.65938
51	1.00000	0.85051	0.14949
52	1.00000	0.69517	0.30483
53	1.00000	0.79619	0.20381
54	1.00000	0.49894	0.50106
55	1.00000	0.40899	0.59101
56	1.00000	0.72765	0.27235
57	1.00000	0.36318	0.63682
58	1.00000	0.72153	0.27847
59	1.00000	0.55409	0.44591
60	1.00000	0.56713	0.43287
61	1.00000	0.82538	0.17462
62	1.00000	0.73642	0.26358
63	1.00000	0.69435	0.30565
64	1.00000	0.70843	0.29157
65	1.00000	0.61353	0.38647
66	1.00000	0.71179	0.28821
67	1.00000	0.67718	0.32282
68	1.00000	0.73459	0.26541
69	1.00000	0.61699	0.38301
70	1.00000	0.40782	0.59218
71	1.00000	0.81036	0.18964
72	1.00000	0.79955	0.20045
73	1.00000	0.74337	0.25663
74	1.00000	0.43460	0.56540
75	1.00000	0.44013	0.55987
76	1.00000	0.75668	0.24332
77	1.00000	0.90174	0.09862
78	1.00000	0.95781	0.04219
79	1.00000	0.73556	0.26444
80	1.00000	0.81834	0.18166
81	1.00000	0.55140	0.44860
82	1.00000	0.75832	0.24168
83	1.00000	0.83488	0.16512
84	1.00000	0.80648	0.19352

TABLE XX, Continued

Student Number	Actual	Prediction	Deviation
85	1.00000	0.70634	0.29366
86	1.00000	1.00000	0.00000
87	1.00000	1.00000	0.00000
88	1.00000	0.90411	0.09589
89	1.00000	0.61040	0.38960
90	1.00000	0.61212	0.38788
91	1.00000	1.00000	0.00000
92	1.00000	0.65571	0.34429
93	1.00000	0.57023	0.42977
94	1.00000	0.57915	0.42085
95	1.00000	0.33331	0.66669
96	1.00000	0.42722	0.57278
97	1.00000	0.88485	0.11515
98	1.00000	0.26212	0.73788
99	1.00000	1.00000	0.00000
100	1.00000	0.62268	0.37732
101	1.00000	0.55516	0.44484
102	1.00000	0.68143	0.31857
103	1.00000	0.85275	0.14725
104	0.00000	0.23475	-0.23475
105	0.00000	0.08873	-0.08873
106	0.00000	0.00527	-0.00527
107	0.00000	0.31975	-0.31975
108	0.00000	0.23059	-0.23059
109	0.00000	0.77971	-0.77971
110	0.00000	0.37796	-0.37796
111	0.00000	0.16716	-0.16716
112	0.00000	0.07342	-0.07342
113	0.00000	0.34618	-0.34618
114	0.00000	-0.04157	-0.04157
115	0.00000	0.11541	-0.11541
116	0.00000	0.29404	-0.29404
117	0.00000	0.01214	-0.01214
118	0.00000	0.39846	-0.39846
119	0.00000	0.28015	-0.28015
120	0.00000	0.02814	-0.02814
121	0.00000	1.00000	-1.00000
122	0.00000	0.48706	-0.48706
123	0.00000	0.03188	-0.03188
124	0.00000	0.30873	-0.30873
125	0.00000	0.04587	-0.04587
126	0.00000	0.33342	-0.33342
127	0.00000	0.40013	-0.40013
128	0.00000	0.09639	-0.09639

TABLE XX, Continued

Subject Number	Actual	Prediction	Deviation
129	0.00000	0.41400	-0.41400
130	0.00000	0.39709	-0.39709
131	0.00000	0.10176	-0.10176
132	0.00000	0.01151	-0.01151
133	0.00000	0.17613	-0.17613
134	0.00000	0.42720	-0.42720
135	0.00000	0.11400	-0.11400
136	0.00000	0.25480	-0.25480
137	0.00000	0.22531	-0.22531
138	0.00000	0.34677	-0.34677
139	0.00000	0.54070	-0.54070
140	0.00000	0.51341	-0.51341
141	0.00000	0.21492	-0.21492
142	0.00000	0.38814	-0.38814
143	0.00000	0.44230	-0.44230
144	0.00000	0.32992	-0.32992
145	0.00000	0.00000	-1.00000
146	0.00000	0.34673	-0.34673
147	0.00000	0.00066	-0.00066
148	0.00000	0.06091	-0.06091
149	0.00000	0.51772	-0.51772
150	0.00000	0.03048	-0.03048
151	0.00000	0.53356	-0.53356
152	0.00000	0.14990	-0.14990
153	0.00000	0.13374	-0.13374
154	0.00000	0.13431	-0.13431
155	0.00000	0.34053	-0.34053
156	0.00000	0.45999	-0.45999
157	0.00000	0.21716	-0.21716
158	0.00000	0.21413	-0.21413
159	0.00000	0.02459	-0.02459
160	0.00000	0.11140	-0.11140
161	0.00000	0.83541	-0.83541
162	0.00000	0.06145	-0.06145
163	0.00000	0.38757	-0.38757
164	0.00000	0.23706	-0.23706
165	0.00000	0.17410	-0.17410
166	0.00000	0.49128	-0.49128
167	0.00000	0.54947	-0.54947
168	0.00000	0.58473	-0.58473
169	0.00000	0.06263	-0.06263
170	0.00000	0.18154	-0.18154
171	0.00000	0.49906	-0.49906
172	0.00000	0.13077	-0.13077

TABLE XX, Continued

Subject Number	Actual	Prediction	Deviation
173	0.00000	0.45653	-0.45653
174	0.00000	0.40124	-0.40124
175	0.00000	0.52528	-0.52528
176	0.00000	0.48454	-0.48454
177	0.00000	0.43965	-0.43965
178	0.00000	0.24557	-0.24557
179	0.00000	0.09994	-0.09994
180	0.00000	0.66545	-0.66545
181	0.00000	0.30739	-0.30739
182	0.00000	0.30593	-0.30593
183	0.00000	0.37013	-0.37013
184	0.00000	0.48401	-0.48401
185	0.00000	0.67135	-0.67135
186	0.00000	0.21154	-0.21154
187	0.00000	0.98845	-0.98845
188	0.00000	0.28891	-0.28891
189	0.00000	0.28794	-0.28794
190	0.00000	0.37254	-0.37254
191	0.00000	0.03642	-0.03642
192	0.00000	0.30610	-0.30610
193	0.00000	0.58321	-0.58321
194	0.00000	0.44656	-0.44656
195	0.00000	1.00000	-1.00000
195	0.00000	0.19026	-0.19026

APPENDIX C

SOPHOMORE GPA AS A PREDICTOR OF SUCCESS

TABLE XXI

RESULTS OF PREDICTIONS TO THE DICHOTOMY OF SUCCESS VERSUS NONSUCCESS UTILIZING ONLY SOPHOMORE GPA (N=196)

Subject Number	Actual	Prediction	Deviation
1	1.00000	0.88505	0.11495
2	1.00000	0.50547	0.49453
3	1.00000	1.00000	0.00000
4	1.00000	0.64239	0.35761
5	1.00000	0.79995	0.20005
6	1.00000	1.00000	0.00000
7	1.00000	0.77889	0.22111
8	1.00000	0.69463	0.30537
9	1.00000	1.00000	0.00000
10	1.00000	0.32264	0.67736
11	1.00000	1.00000	0.00000
12	1.00000	0.57498	0.42502
13	1.00000	0.85092	0.14908
14	1.00000	0.50000	0.50000
15	1.00000	0.85008	0.14992
16	1.00000	0.69042	0.30958
17	1.00000	0.56824	0.43176
18	1.00000	1.00000	0.00000
19	1.00000	0.79110	0.20890
20	1.00000	0.73928	0.26072
21	1.00000	0.74055	0.25945
22	1.00000	1.00000	0.00000
23	1.00000	0.54297	0.45703
24	1.00000	0.63607	0.36393
25	1.00000	0.94613	0.05387
26	1.00000	0.68831	0.31169
27	1.00000	1.00000	0.00000
28	1.00000	0.53328	0.46672
29	1.00000	0.60532	0.39468
30	1.00000	0.63860	0.36140
31	1.00000	0.57729	0.44271
32	1.00000	0.53159	0.46841
33	1.00000	0.30283	0.69717
34	1.00000	0.35128	0.64872
35	1.00000	0.80753	0.19247
36	1.00000	0.83534	0.16466
37	1.00000	0.27503	0.72497
38	1.00000	0.97984	0.02016
39	1.00000	0.59268	0.40732
40	1.00000	0.63860	0.36140

TABLE XXI, Continued

Subject Number	Actual	Prediction	Deviation
41	1.00000	0.56782	0.43218
42	1.00000	0.68030	0.31970
43	1.00000	0.65798	0.34202
44	1.00000	0.55139	0.44861
45	1.00000	0.51053	0.48947
46	1.00000	0.66387	0.33613
47	1.00000	0.69421	0.30579
48	1.00000	0.70095	0.29905
49	1.00000	0.96594	0.03406
50	1.00000	0.37193	0.62807
51	1.00000	0.79658	0.20342
52	1.00000	0.50379	0.49621
53	1.00000	0.80121	0.19879
54	1.00000	0.35802	0.64198
55	1.00000	0.41532	0.58468
56	1.00000	0.66303	0.33697
57	1.00000	0.37698	0.62302
58	1.00000	0.75909	0.24091
59	1.00000	0.48272	0.51728
60	1.00000	0.50210	0.49790
61	1.00000	0.75951	0.24049
62	1.00000	0.73212	0.26788
63	1.00000	0.73086	0.26914
64	1.00000	0.77257	0.22743
65	1.00000	0.55139	0.44861
66	1.00000	0.47051	0.52949
67	1.00000	0.54549	0.45451
68	1.00000	0.99332	0.00668
69	1.00000	0.68283	0.31717
70	1.00000	0.46714	0.53286
71	1.00000	0.69589	0.30411
72	1.00000	0.60068	0.39932
73	1.00000	0.58130	0.41870
74	1.00000	0.48020	0.51980
75	1.00000	0.53159	0.46841
76	1.00000	0.55434	0.44566
77	1.00000	1.00000	0.00000
78	1.00000	0.99922	0.00078
79	1.00000	0.88126	0.11874
80	1.00000	0.58425	0.41575
81	1.00000	0.60110	0.39890
82	1.00000	0.67188	0.32812
83	1.00000	0.60110	0.39890
84	1.00000	0.72201	0.27799

TABLE XXI, Continued

Subject Number	Actual	Prediction	Deviation
85	1.00000	0.65461	0.34539
86	1.00000	1.00000	0.00000
87	1.00000	0.99248	0.00752
88	1.00000	0.87789	0.12211
89	1.00000	0.52485	0.47515
90	1.00000	0.33738	0.66262
91	1.00000	0.89895	0.10105
92	1.00000	0.59268	0.40732
93	1.00000	0.58889	0.41111
94	1.00000	0.66050	0.33950
95	1.00000	0.37066	0.62934
96	1.00000	0.39847	0.60153
97	1.00000	0.85261	0.14739
98	1.00000	0.48272	0.51728
99	1.00000	1.00000	0.00000
100	1.00000	0.70769	0.29231
101	1.00000	0.46461	0.53539
102	1.00000	0.58088	0.41912
103	1.00000	0.74055	0.25945
104	0.00000	0.21268	-0.21268
105	0.00000	0.10273	-0.10273
106	0.00000	0.04332	-0.04332
107	0.00000	0.18277	-0.18277
108	0.00000	0.07029	-0.07029
109	0.00000	0.82228	-0.82228
110	0.00000	0.20257	-0.20257
111	0.00000	0.30831	-0.30831
112	0.00000	0.02113	-0.02113
113	0.00000	0.28640	-0.28640
114	0.00000	0.14696	-0.14696
115	0.00000	0.30831	-0.30831
116	0.00000	0.17139	-0.17139
117	0.00000	0.37867	-0.37867
118	0.00000	0.32432	-0.32432
119	0.00000	0.28093	-0.28039
120	0.00000	0.08292	-0.08292
121	0.00000	0.99922	-0.99922
122	0.00000	0.41448	-0.41448
123	0.00000	0.04332	-0.04332
124	0.00000	0.25734	-0.25734
125	0.00000	0.28556	-0.28556
126	0.00000	0.29399	-0.29399
127	0.00000	0.22026	-0.22026
128	0.00000	0.11241	-0.11241

TABLE XXI, Continued

Subject Number	Actual	Prediction	Deviation
129	0.00000	0.33822	-0.33822
130	0.00000	0.25397	-0.25397
131	0.00000	0.13685	-0.13685
132	0.00000	0.11958	-0.11958
133	0.00000	0.15202	-0.15202
134	0.00000	0.50926	-0.50926
135	0.00000	0.18782	-0.18782
136	0.00000	0.31716	-0.31716
137	0.00000	0.48567	-0.48567
138	0.00000	0.31716	-0.31716
139	0.00000	0.41237	-0.41237
140	0.00000	0.47472	-0.47472
141	0.00000	0.01018	-0.01018
142	0.00000	1.00000	-0.00000
143	0.00000	0.46587	-0.46587
144	0.00000	0.31674	-0.31674
145	0.00000	0.89474	-0.89474
146	0.00000	0.34075	-0.34075
147	0.00000	0.00457	-0.00457
148	0.00000	0.17561	-0.17561
149	0.00000	0.39257	-0.39257
150	0.00000	0.10104	-0.10104
151	0.00000	0.42122	-0.42122
152	0.00000	0.26703	-0.26703
153	0.00000	0.11087	-0.11087
154	0.00000	0.22911	-0.22911
155	0.00000	0.49128	-0.49128
156	0.00000	0.61543	-0.61543
157	0.00000	0.15412	-0.15412
158	0.00000	0.09388	-0.09388
159	0.00000	0.20299	-0.20299
160	0.00000	0.06565	-0.06565
161	0.00000	0.82312	-0.82312
162	0.00000	0.35760	-0.37560
163	0.00000	0.32221	-0.32221
164	0.00000	0.37867	-0.67868
165	0.00000	0.29904	-0.29904
166	0.00000	0.41658	-0.41658
167	0.00000	0.43975	-0.43975
168	0.00000	0.48694	-0.48694
169	0.00000	0.24596	-0.24596
170	0.00000	0.26323	-0.26323
171	0.00000	0.50547	-0.50547
172	0.00000	0.45660	-0.45660

TABLE XXI, Continued

Subject Number	Actual	Prediction	Deviation
173	0.00000	0.22616	-0.22616
174	0.00000	0.39973	-0.39973
175	0.00000	0.45829	-0.45829
176	0.00000	0.48020	-0.48020
177	0.00000	0.39341	-0.39341
178	0.00000	0.44607	-0.44607
179	0.00000	0.38077	-0.38077
180	0.00000	0.71991	-0.71991
181	0.00000	0.28219	-0.28219
182	0.00000	0.38667	-0.38667
183	0.00000	0.33064	-0.33064
184	0.00000	0.49620	-0.49620
185	0.00000	0.74518	-0.74518
186	0.00000	0.63186	-0.63186
187	0.00000	0.98658	-0.98658
188	0.00000	0.78731	-0.78731
189	0.00000	0.49705	-0.49705
190	0.00000	0.51980	-0.51980
191	0.00000	0.18782	-0.18782
192	0.00000	0.54718	-0.54718
193	0.00000	0.76583	-0.76583
194	0.00000	0.46124	-0.46124
195	0.00000	1.00000	-0.00000
196	0.00000	0.16381	-0.16381

VITA

Horace Mann, Jr.

Candidate for the Degree of

Doctor of Education

Thesis: A STUDY OF SELECTED ACADEMIC AND INTEREST VARIABLES IN RELATION TO ACHIEVEMENT IN A COLLEGE OF ENGINEERING

Major Field: Student Personnel and Guidance

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