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A Comparison of Minority and Non-Minority Engineering Students on Selected Personality and Program Variables

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Abstract

A Comparison of Minority and Non-Minority Engineering Students on Selected Personality and Program Variables

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The purpose of this study was to investigate whether there are common characteristics associated with 226 Hispanic, African American, and White engineering students who persist at predominantly White colleges and universities. A personality profile of minority and non-minority engineering students was developed. Information regarding factors influencing choice of major, university, study, work and extracurricular involvement, possible reasons for withdrawal from college, awareness and satisfaction with student support services and selected academic courses was also compiled. Components of Minority Engineering Programs (MEPs) which are most used or valued by minority engineering students were identified

Analysis of Variance identified four of the thirty-seven ACL scales that were statistically significantly different between groups. MEP results

indicate that students attending universities with formal MEP's in place are more aware of MEP and other services offered by the university than students attending universities without formal MEP's. Engineering Survey results indicate minorities as deciding on college and college major much earlier than their non-minority counterparts. Minorities were employed more hours per week than non-minorities and spend less time studying outside of class.

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Chapter I

Introduction

Overview

The Task Force on Women, Minorities, and the Handicapped in Science and Technology's, Final Report, (1989), notes that America faces a shortfall of scientists and engineers by the year 2000. By that year, 85% of new entrants to the nation's workforce will be members of minority groups and women. According to the National Science Foundation (1988), engineers made up over half of the 4.6 million scientists and engineers employed in the U.S. in 1986; therefore, engineering is a critical human resource area. The only way to meet this projected shortfall is by utilizing all available talent, especially groups traditionally underrepresented in science and engineering: women, minorities, and people with disabilities. It is time for action that addresses these predicted vacancies.

Total undergraduate engineering enrollments in American universities are down. They are at their lowest level since the 1980-81 school year and reflect a trend of decline. During 1986-87 to 1989-90 school years, total minority engineering enrollment increased

13.7% (4,091 students), while enrollments for all others dropped 10.3% (35,529 students). Minority increases occurred each year since 1986-87, while decreases occurred for all other students (NACME, 1990). Total undergraduate engineering enrollments were at their lowest level in 1986-87 since 1980-81 and are part of a falling trend (NACME, 1988). Efforts to increase minority student retention in engineering schools have had mixed success over the past fifteen years. Success has been realized by an increase in minorities admitted to approved engineering programs in the United States. Enrollment of minorities increased steadily from 1980 to 1985, with a concomitant increase in minority engineering graduates. However, percentages of minority graduates remain far below that of non-minority students and increases in minority graduates beyond 1991 will occur only if the pool of qualified minority precollege students increases and retention of minority engineering students improves.

Underrepresented minorities

Underrepresented minorities are defined in this paper as members of three groups: 1) African Americans or African Americans; 2) Hispanics consisting of

Mexican Americans and Puerto Ricans; and 3) Native Americans. Attempts were made to obtain samples from each group.

Although African Americans comprise 12% of the general population, only two percent of all employed scientists and engineers are African American. In 1988, African Americans earned four percent of the baccalaureate degrees in science and engineering. During that same year only 14 African Americans earned Ph.D.s in engineering (Task Force on Women, Minorities, and the Handicapped, Interim Report, 1988). Most African Americans who earn advanced degrees in science and engineering did undergraduate work at Historically Black Colleges and Universities (HBCU's).

Hispanics are America's fastest growing minority group. They comprise nine percent of America's population, but only two percent of all employed scientists and engineers. Hispanic women earn only one-sixth as many bachelors degrees in engineering as Hispanic men.

Native Americans make up about 0.6% of the U.S. population (approximately 1.4 million), and are 0.5% of all employed scientists and engineers. The Task Force

reports that many Native Americans, including those holding degrees and professional jobs, do not want to be mainstreamed into the general American community. Native Americans typically prefer to maintain their separate tribal identity.

Retention of Minorities

According to Hall (1984), of every 100 Whites who enter first grade, 83 complete high school, 23 complete college, and 8 complete graduate or professional school. By comparison, for every 100 African Americans (African Americans are cited because there is more data on African Americans than other minorities) who enter first grade, 72 complete high school, 12 complete college, and 4 finish graduate or professional school.

Reasons for the shortfall in engineering have been under investigation for decades. Sackett (1940) discusses a paper investigating engineering education written in 1929 stating that 50% of entering freshman engineering students failed to graduate because of deficient scholarship, indefinite interest, or lack of fundamental aptitudes. He suggested that, despite numerous books, articles, and other publications addressing engineering school dropout, the problem was

similar in 1940 to what it was in 1929. At that time, a suggestion was for better counseling as a first step in the selection of students more likely to complete an engineering degree.

Engineering schools nationwide have experienced difficulty in successfully retaining minority students. The population most susceptible to leaving engineering is composed of minority freshmen. Students admitted with deficiencies in mathematics and physical sciences have scholastic handicaps that are often compounded by inadequate motivation and limited or minimal support from the college or university community. The freshman year is most important for student retention and critical to success for engineering students,

Because there is a paucity of research addressing successful programs that recruit and maintain minorities, additional research is needed on outcomes of programs designed specifically to recruit and retain minorities in engineering.

Problem Statement

Minorities remain an underrepresented group in the engineering profession. Unless retention efforts are improved, underrepresented minorities are likely to be

a wasted resource in fulfilling the projected upcoming shortfall of engineers. Despite this need, there are few empirical studies to assist in directing retention efforts. Most studies undertaken focused on cognitive and situational variables and little attention has been given to the role of non-cognitive features such as personality. Personality characteristics play a significant role in selecting and persisting in a major field of study, as indicated by heavy reliance on personality characteristics in the theoretical foundations of interest inventories and career development surveys (Brown, Cross & Selby, 1990). The problem to be investigated in this study is whether minority engineering students possess personality characteristics that can be identified and utilized in the development of a Minority Engineering Program to increase retention of minority engineers.

Research Objectives

The research objectives of this study were to investigate factors influencing choice of major, university, study, work and extracurricular involvement, possible reasons for course difficulty,

and awareness and satisfaction with student support services.

Are there common characteristics associated with Hispanic, African American and Native American engineering students who persist at predominantly White colleges and universities and are they similar or different from White students attending the same colleges and universities? Another purpose of this study was to develop a personality profile of minority engineering students at the selected universities and to determine if these profiles differed significantly from White engineering students attending the same university. Identifying specific personality characteristics of sophomore, junior, and senior minority engineering students may provide information that can contribute to improved methods of retention of a larger percentage of minority engineering students by better targeting of resources for MEP's based on needs and personality of differing minority groups.

There have been few nationwide studies undertaken to determine which components of Minority Engineering Programs (MEPs) are most used or valued by minority engineering students. Identifying those components of

MEPs considered most valuable and useful by students can help focus programs and resources designed to increase retention of minority engineering students. Therefore, an additional purpose of this study was to investigate whether there are Minority Engineering Program characteristics that are perceived as effective in contributing to persistence of minority engineering students at predominantly White colleges and universities.

Research Questions

The present study is an attempt to answer the following questions:

1. What factors, reported by the sample, most influenced choice of major, university, study, vocation; and made up extracurricular involvement?
2. Are there personality differences, on the Adjective Checklist, between African American engineering students attending universities with Minority Engineering Programs and African American engineering students attending universities without Minority Engineering Programs?
3. Are there personality differences, on the Adjective Checklist, between Hispanic engineering students

attending universities with Minority Engineering Programs and Hispanic engineering students attending universities without Minority Engineering Programs?

4. Are there personality differences between White engineering students and African American engineering students at universities with Minority Engineering Programs, and between White engineering students and African American engineering students at universities without Minority Engineering Programs?

5. Are there personality differences between White engineering students and Hispanic engineering students at universities with Minority Engineering Programs, and between White engineering students and Hispanic engineering students at universities without Minority Engineering Programs?

6. Which components of Minority Engineering Programs are most used by minority engineering students?

7. Which components of Minority Engineering Programs are least used by minority engineering students?

Hypotheses

H:1 There will be no personality differences as shown by ACL scores, between minority engineering students

attending universities with MEP's and those attending universities without MEP's.

H:2 There will be no personality differences, as shown by ACL scores, between minority engineering students and non-minority (White) engineering students.

H:3 There will be no differences in personality variables between subcategories of minorities (i.e. between African Americans, Hispanics and Native Americans) enrolled in engineering programs.

H:4 There will be no difference in the value of components/services that an MEP has to offer as rated by Minority engineering students attending colleges/universities having MEPs.

Assumptions and Limitations of the Study

Assumptions:

1) Subjects will accurately respond to the psychological instruments.

2) Personality factors remain stable over time.

Limitations:

1) The psychological instruments to be used in this study are paper-and-pencil tests and involve self-report.

2) There is wide diversity in programs identified as MEPs. Some of these programs are quite comprehensive and others are limited in scope.

3) Subjects were selected by contact persons at the participating university; therefore, subjects in this study may not represent the overall population from which they are drawn.

4) Subjects were volunteers and; therefore, may not represent the overall population from which they were drawn.

Definitions:

ABET: Accreditation Board for Engineering and Technology. The organization primarily responsible for monitoring, evaluating and certifying the quality of engineering and engineering-related education in colleges and universities in the United States.

Minority: Refers to African Americans (African Americans), Hispanics which includes Mexicans and Puerto Ricans, and Native Americans.

Minority Engineering Program: A college or university is considered to have an MEP if it is listed in the National Association of Minority Engineering Program Administrators 1990-91 National Data Book.

Minority Engineering Programs usually offer a majority of the following services:

1) Academic Services
2) Counseling
3) Scholarships
4) Student Center
5) Employment
6) High School Outreach
7) Middle School Outreach

Chapter II

Review of the Literature

General

Retention of students has proven to be a difficult task for many engineering schools. Attrition rates of students majoring in engineering curricula are among the highest of any area of study (Hayden, 1985). This is especially true for minority students in engineering schools (NACME, 1991). Noncognitive (personality) variables which tend to be associated with academic success have been identified as Endurance, Achievement, and Self-Confidence. (Dillard, 1984) This review will cover various academic admission variables, non-cognitive measures, overall problem of attrition, personality studies (general and specific to students and specific to African American students), studies using the ACL, and studies focusing on retention.

Academic Admission Variables

Admission criteria to colleges of engineering vary throughout the United States.

Crisco (1975) investigated whether traditional achievement-proficiency measures were related to academic performance of minority engineering students.

Also examined were relationships of various personality and demographic variables, and the relationship of a cognitive style measure to the academic performance of minority engineering students. His sample population included all freshmen minority students at Marquette University, College of Engineering, from 1971 through 1974, and all majority engineering students who had been enrolled for at least one semester during the same time interval. Predictor variables were high school percentage rank, high school grade point average (GPA), verbal and math sections of the SAT, a Basic Information Questionnaire for demographics, the California Psychological Inventory (CPI), and the Tagatz Information Processing Test (TIPT). From the analysis, Crisco concluded that for the majority group, the degree of relationship between first semester GPA and each achievement-proficiency variable was significant. Individual achievement-proficiency measures were also significant in predicting first semester GPA for Black Americans. Because no significant differences were found between minority subjects using the TIPT and CPI, Crisco combined groups and performed a stepwise multiple regression

analysis. This analysis revealed that high scorers i.e., those who tend to employ more analytic problem solving strategies, perform better academically in engineering than low scorers. He also wrote that such tests are equally applicable for middle class White students and disadvantaged students in predicting college GPA.

Sedlacek and Brooks (1970) conducted a survey to determine criteria for regular admission of freshmen into 97 colleges and universities. Reports from admissions offices of 86 schools questioned indicated that they used either high school average (HSA) or high school rank (HSR) combined with the Scholastic Aptitude Test (SAT) or the American College Test (ACT). A later study of admission practices of 110 colleges by Sedlacek and Webster (1978) revealed the following admission criteria:

1. High School Rank (60%).
2. High School GPA (62%).
3. Standardized Test Scores (SAT-62%, ACT-52%).

Other studies report college admissions offices using rank, GPA, and SAT/ACT scores as admission criteria,

because the data suggests that they are the best predictors of academic success.

Additional studies have focused on the success and retention of engineering students based on entrance requirements. Costello (1977) examined the relationship between entrance requirements and the degree of student success upon graduation. Using a Pearson linear correlation or a multiple correlation, data from 30 graduating seniors in engineering at an urban university were analyzed to determine relationships between SAT-Math and SAT-Verbal scores and graduating GPA. The study found that SAT verbal scores, SAT total scores, and grades in college mathematics were statistically related to graduating GPA. The data analysis also showed that SAT math scores were not related to the graduating GPA.

Non-Cognitive Predictive Measures

A review of existing literature (Brown, Cross & Selby, 1990) reveals a lack of additional predictive measures, such as personality instruments, which may be incorporated into admissions requirements to improve prediction of success in engineering programs. In view of high attrition rates among engineering students

generally, and minority engineering students specifically, such additional testing may identify variables which significantly enhance prediction of academic persistence in engineering.

Young and McAnulty (1981) conducted a study of perceptions of persisting and non-persisting Black and White engineering students. The study revealed: 1) Whites were happier than Blacks at a predominantly White university; 2) Blacks were less likely to resent authority than Whites; 3) there was no significant difference in reported academic skills between Blacks and Whites; and 4) there was no significant difference in reported interest in school work between Blacks and Whites.

One recommendation offered as a result of Young and McAnulty's study was to examine the attitudes of Black engineering students at predominantly Black colleges. It was felt that Black students may express more positive attitudes towards college and exhibit a higher degree of college persistence and ultimate success in engineering without the frustrations of being a minority student at a White college.

Stonewater (1981) described three interrelated strategies to increase minority engineering enrollment and retention. First, "basic skills" and elimination of deficiencies in science and mathematics were considered primary concerns; second, self-esteem and self-concept of minority students were established as critical issues to which the staff had to remain sensitive; and, third, a recruitment program including internal transfer (within the University) of non-engineering students to engineering, as well as high school students, should be initiated.

As a result of this study, minority enrollment reached its highest level; however, attrition was not reduced. The expectation that the curriculum and counseling program would assist minority students in persisting in engineering was not realized; the attrition rate paralleled the rate prior to the study.

The Office of Technology Assessment (1985) sent a questionnaire to 40 recognized experts in the fields of science and engineering. Respondents were asked to present their views on the needs of minorities in science and engineering regarding: 1) causes of and remedies for problems in minority participation in

science and engineering, 2) effectiveness of existing intervention programs to promote such participation, and 3) the need for further research, additional information, and policy actions. Responses were received from 18 individuals. According to those responding, positive factors believed to be principal influences of minorities' decisions to participate and continue in science and engineering careers were: (a) English language competence, (b) early enrollment in math and science courses, (c) continued science and math studies in junior high and high School, (d) basic interest in math and science, (e) intervention programs, (f) encouragement and support from mentors, family, and teachers, (g) role models, (h) positive input from a peer group with high expectations, (i) availability of financial resources, (j) self-discipline, (k) good study habits, (l) challenge, and (m) intellectual gratification.

Negative factors most frequently identified by respondents were: (a) lack of academic preparedness in elementary and secondary school (literacy and necessary science and mathematics courses), (b) lack of role models and mentors and teacher encouragement, (c) lack

of parental support and encouragement, (d) lack of peer support, (e) inadequate career and academic counseling, (f) lack of confidence and perception of self, (g) financial strains, (h) societal emphasis on sports, rock stars, and "quickie" models of success rather than slow and sequential models, (i) loss of interest or motivation, (j) poor study habits, and (k) socioeconomic standing.

Most respondents felt that minority students who were successfully participating in science and engineering should provide more information on their experiences.

Because there is no major study describing how minority graduates succeed in engineering programs. A study of successful minority graduates may help explain the influence of various factors affecting their participation in and completion of science and engineering programs.

Overall Problem Of Attrition

Davis (1965) reported that only 51% of 7400 freshman engineering students he studied were still enrolled as seniors. He also concluded that engineering was the college major showing the greatest

attrition during the college years. This information is important not only to the engineering profession, but to academic institutions that produce engineers. Dropouts from an institution represent a financial loss, and a potential loss of stature.

Marsh (1966) found conflicting results in some descriptive studies of rates and causes of college dropout. He reviewed literature on college dropout rates for the 10 years prior to publication of his article. The literature was divided into three categories: (1) Philosophical and Theoretical, (2) Descriptive, and (3) Predictive. He identified two limitations of earlier prediction studies: (1) the correlations are seldom found to rise above the 0.50 to 0.60 level, and (2) studies do not account for the significant number of students who drop out of school in spite of satisfactory ability and grade-point averages. He suggested that one weakness of existing personality inventories as predictors is their clinical orientation. Because dropouts seemed too similar to returnees in many ways such as background, intentions, and abilities, Marsh felt there may be some underlying structure of personality and pattern of thoughts for

which adequate tests have yet to be developed. He suggested that differences in these rates and causes of dropouts indicate variation among colleges, as well as the likelihood of change from year to year.

Summerskill (1962) suggested that, because attrition rates varied from 12% to 82% among different colleges, local data should be used. His report concluded that only 40% of students at that time graduated on schedule. He estimated that another 20% eventually receive their degree.

Tinto (1985), quoting the National Longitudinal Survey of the High School Class of 1972 (Eckland and Henderson, 1981), indicated that nearly 60 of every 100 first-time entrants to the four-year college sector will leave their first institution of registration without completing a degree program. Of this 60 percent, 29 percent will remain withdrawn from all forms of participation in higher education and 40 percent will transfer to other institutions of higher education. Another 8% to 10% will leave higher education for a brief period of time and later re-enroll at the same or a different institution. These are often referred to as stopouts.

Results of research have not always shown a one-to-one relationship between ability and persistence. For example, Halladay and Andrew (1958) report that 15% of the dropouts from Arkansas colleges were above average on achievement and ability test scores. According to their information, 36% of dropouts had been progressing satisfactorily.

Personality Studies

Beall and Borden (1964) studied the development and personality of engineers. They attempted to analyze the occupational demands of engineering job activities using a scheme of work gratification and personality theory related to physiological need gratification. Their study tended to confirm their postulations that preferences of engineers are for things rather than people, the practical and the objective, collecting facts by careful observation, a need for certainty, and a need for masculine adventure and daring.

Izard (1960) compared profiles on the Edwards Personal Preference Schedule of graduate engineers with Edwards' male norm group, profiles of freshman engineering students and profiles of non-engineering

students. Significantly greater means were observed for engineering graduates on Achievement, Deference, Order, Dominance And Endurance. Mean scores on Order, Endurance and Intraception were significantly different and higher for engineering students.

Korn (1962) compared physical science majors with engineering majors and a comparative group of undeclared majors using the California Psychological Inventory and the Strong Vocational Interest Blank. Engineering majors were found to have higher scores on Sociability, Social Presence, and Communality.

Scott and Sedlacek (1975) using a sample of individuals who had survived academic and self interest selection of two to three years of technical and scientific education found that they could discriminate between physical science, engineering, and other curriculum students using the California Psychological Inventory (CPI) and the Vocational Preference Inventory (VPI). A dimension labeled intellectual-enterprising versus social-conventional differentiates physical scientists from the other two groups. Their findings suggest that physical scientists are more introspective, intellectual, flexible, and sensitive

than are the other two groups, which appear to be more sociable, dominant, and conventional in terms of work and environmental orientations. Implications of their research suggest that counselors give attention to personality as well as interest measures when counseling clients who express interests in both engineering and physical science studies.

Molnar and Delauretis (1973) used aptitude, achievement, non-cognitive data, and first-semester grade point average in predicting long-range educational-vocational decisions of engineering students. Predictor variables used in this study were the seven scale scores from the PIQ, first-semester grade point average, and five precollege variables: high school rank, expressed as a percentile; CEEB Scholastic Aptitude Tests, Math and Verbal; and two CEEB Achievement tests, English and Mathematics. The best predictors consisted of first-semester grade point average, the Overall Engineering Interest scale, and the Industrial Management Interest scale.

Neal and King (1969) compared a multivariate and a configural analysis for classifying engineering students. The purpose of the study was to investigate

the relative efficiency of the two methods. Specifically, they hypothesized that, since measured interest variables play an important part in counseling, these variables should be a good reference point for gauging the desirability of employing one of the two techniques. Subjects consisted of 284 engineering students enrolled at the University of Missouri during the winter semester of 1967-68. Students took the College Interest Inventory and were required to indicate satisfaction with engineering as a future professional commitment on a separate sheet of paper. A multiple-discriminant analysis was performed on the CII results. Results showed that multiple - discriminant analysis can distinguish extremely well between at least three branches of engineering. It is left up to the prospective user to decide if a relatively small overall increase in accuracy over conventional methods is worth the difficulty of establishing local discriminant equations. The authors noted that their study was undertaken with a homogeneous occupational grouping. More diverse groups measured with highly representative scales might return

an increase of fidelity worth the effort involved in construction of discriminant equations.

Southworth and Morningstar (1970) examined the predictive value of Holland's Vocational Preference Inventory (VPI) in determining perseverance in engineering. The instrument was administered to 102 freshman engineering students the summer before they entered the University of Massachusetts. It was also administered to 129 engineering students at the beginning of the senior year. The VPI measures six personality dimensions Realistic, Intellectual, Artistic, Social, Enterprising, and Conventional. Two years after the VPI was administered to the freshmen, the students from this group were divided into three groups: those remaining in engineering, those still in the University but in another major, and those who left the University. A multivariate analysis employing the discriminant function was performed on the freshmen subgroupings and for the senior engineering students. They found that scores on the six scales of the VPI significantly differentiate among the three subgroupings. The difference between persisting engineers and those who left the University was

greatest on the Artistic scale. In this instance, engineering students who persisted in engineering studies did display interest patterns more nearly like those of students with greater experience in the field (the original senior class comparison) and, therefore, more like graduates who are actually working as engineers. The lower Intellectual mean for students who left the University stands in contrast to the high Intellectual mean for the persisters. Students who changed majors scored high on Social and Artistic scales. The authors felt that their study, in addition to supporting certain theoretical formulations, suggested the value of discriminant function analysis as a predictive method.

Robinson (1982) assessed correlations between personality characteristics and sex-stereotyped attitudes of 20 male and 20 female preschool teachers and 20 male engineers. Because gender of the individual has been shown to be less important than personality, it is reasonable to suppose that personality traits override biological gender in terms of teachers' attitudes about appropriate sex roles for boys and girls. This supposition justified further

analysis based on data previously published. Of specific interest to researchers was the relationship between respondents' personality characteristics and their sex stereotyped attitudes as factors overriding the gender of respondents. Based on this conceptualization, it was expected in this analysis that, regardless of sex, those with feminine personalities would hold more feminine sex-role expectations about children's behaviors. Moreover, those with masculine personalities would have masculine sex-role attitudes. Subjects were twenty-five male preschool teachers; twenty male engineers; and twenty female preschool teachers. A demographic face sheet was recorded along with the Adjective Check List (ACL), and the Sex-stereotyped Attitude Checklist (Williams and Bennett, 1975). Rate of returns for materials were: 80% for male teachers; 96% for female teachers; and 59% for male engineers. The researchers found significant positive correlations between the personality of the subjects and their sex-stereotyped attitudes. They felt that the findings underscore a relationship between teachers, gender (or personality) and sex-role expectations they hold for young children.

The more masculine gender held masculine preferred attitudes toward children. The more feminine gender, on the other hand, held feminine-preferred attitudes towards children. Masculine gender preferred that children be tough, courageous, aggressive, independent, assertive, and so on. In contrast, those of feminine gender thought children should be gentle, sensitive, affectionate, soft-hearted and so forth. No differences existed across groups in terms of sex-role behavioral preferences for boys and girls. Personality characteristics of male and female preschool teachers were identical.

Black Personality Studies

Crisco (1975) conducted a study to determine whether traditional achievement-proficiency measures were related to the academic performance of minority engineering students. He also examined the relationship of various personality and demographic variables and the relationship of a cognitive style measure to academic performance of minority engineering students. He included all minority students comprising the total freshmen classes at Marquette University, College of Engineering, from 1971 through 1974 and all

majority engineering students who had been enrolled for at least one semester during the same time interval. Predictor variables were high school percentage rank, high school GPA, verbal and math sections of the SAT, a Basic Information Questionnaire for demographics, the California Psychological Inventory (CPI), and the Tagatz Information Processing Test (TIPT). Simple correlations, multiple correlations, and regression analyses were performed. Crisco concluded that: for the majority group, degree of relationship between first semester GPA and each of the achievement-proficiency variables was significant. For Black Americans, individual achievement-proficiency measures were all significant in predicting first semester GPA. Because no significant differences in regression were found between the minority subjects using the TIPT and CPI, groups were combined for a stepwise multiple regression analysis. Analysis revealed that those who obtain high scores, and therefore those who tend to employ more analytic problem-solving (scholastic) strategies, perform better academically in engineering than those with low scores. To Crisco, a field dependent (global) problem solving strategy is counter-

productive and does not maximize predicted grade success for minority engineering students. He also concluded that differences in academic performance for individual minority engineering students reflect differences in cognitive strategy usage, as well as ability differences.

Knott (1977) attempted to determine: 1) which personality variables as indicated by the CPI differentiate among Black engineering students, Black non-engineering students, White engineering students and White non-engineering students; 2) which work values, as shown by the Work Values Inventory (WVI), differentiate among the same groups; 3) what basic vocational interests as shown by the Strong Campbell Interest Inventory (SCII) differentiate among groups; 4) what occupational interests as shown by the SCII, differentiate among groups. Are group members different with respect to their academic orientation (SCII-AOR Scale)? Are group members different with respect to introversion-extroversion (SCII-IE) scale? Four groups of 30 each represented Black engineering, Black non-engineering, White engineering, and White non-engineering. Instruments were the CPI, SCII, the

WVI, and a questionnaire to elicit basic background and family information. Data were analyzed by discriminant analysis. Results indicated that basically different profiles characterized the groups. Personality variables which significantly discriminated between groups of engineers and non-engineers were Socialization, Self-Concept, Good Impression, Achievement via Conformance, Intellectual Efficiency, and Flexibility. Significantly discriminating Basic Interest themes were Enterprising and Conventional. The White engineering group was most similar to the Black engineering group and dissimilar to the White and Black non-engineering groups on Socialization, Self-Control, Achievement via Conformance, and Intellectual Efficiency. Those characteristics successfully discriminated engineering from non-engineering students. The Black engineering group valued work which offered security more than the White engineering group. The White engineering group was characterized by a significantly higher interest in Agriculture, Nature, and Adventure than the Black engineering group. The White non-engineering group showed higher interests on the Agriculture, Nature, and Adventure scales than

the Black non-engineering group, but were equivalent on the Mechanical scale. The Black engineering group showed higher interest on the Mathematics, Medical Sciences, Medical Services, and Music/Dramatics scale than the White engineering group, and both engineering groups were lower than non-engineering groups on the Writing scale. Black engineering and non-engineering groups were significantly higher than White engineering and non-engineering groups on Merchandising, Sales, Business Management, and Office Practice scales. White engineering and non-engineering groups were characterized by and tended to score higher on the Realistic theme than the Black groups. Knott attributed this difference to cultural differences in the races. Two discriminant functions were derived: one was labeled Conventional-Realistic and the other was not statistically significant. These functions correctly classified all groups at different levels. No differences were found among groups on Academic Orientation. Engineering groups were found to be more introverted than non-engineering groups. The White engineering group was most introverted, the Black non-engineering group was most extroverted.

Adjective Checklist

Dillard (1984) attempted to provide a descriptive analysis of the relationship of selected variables to success of Black "at risk" engineering students. Questions asked in her study were: 1) Which academic variables contribute to prediction of success for Black "at risk" engineering students after two years of study; 2) which special program participation variables contribute significantly to prediction of success for Black "at risk" engineering students following 2 years of study; 3) which personality variables contribute significantly to prediction of success of Black "at risk" engineering students; and 4) is there a change in the variables of endurance, achievement, and self - confidence for Black "at risk" engineering students after one year of program participation? The sample consisted of 33 Black students admitted to the Compensatory Engineering Program at the University of Pittsburgh beginning summer prematriculation program 1982. "At risk" was defined as "students who are educationally deprived as evidenced by test scores and academic records which preclude admission to a regular program in engineering in the state of Pennsylvania".

She determined that high school GPA and math pre-test scores contribute most to prediction of success of Black "at risk" engineering students. There were no special program participation variables contributing to prediction of success. Results indicated that individual correlations between selected personality variables and success were low. However, when the three personality variables (Achievement, Endurance, and Self-Confidence) were analyzed as a set, they contributed significantly to the prediction of success. No significant change occurred in endurance, achievement, and self-confidence after one year of program participation. Dillard recommended that information on personality variables become a formal part of admissions criteria for Black engineering students.

Brown, Cross, and Selby (1990) conducted a study to describe and compare personality profiles of entering freshmen engineering students with those of persisters in engineering to ascertain what racial differences in personality might exist between and within the freshmen and persisters and to draw implications for classroom introduction. They

administered Gough and Heilbrun's (1980) ACL and the Group Embedded Figures Test (1971) to 129 freshman engineering students enrolled in the fall Introduction to Engineering class. Results indicated that more structure is needed by freshmen than persisters; opportunities for competitive and collaborative projects should be provided in all or most classes; academic support services be developed with the unique needs of freshmen, African-American persisters, White persisters and women specifically addressed; African-American engineering students tend to be less competitive than their White counterparts; African-American persisters tend to be less assertive, assume the initiative less often and defer to others; and African-American student tends to value inner feelings and intuitive evocation of identity. Overall results of this study provide evidence that consideration of personality variables could help establish an effective instructional program.

Retention Studies

Reid, Johnson, Entwhisle, & Angers (1962) identified characteristics of those who graduated from the Newark College of Engineering. The 36% who

graduated within the first four years had higher mean scores than those of the entering class as a whole on the following tests: the SAT-Math, College Ability Test-Quantitative, Cooperative Intermediate Algebra Test, the Reading Comprehension portion of the Cooperative English Test, and scores on the Educational Testing Service College Ability Test - Verbal. Those who graduated earlier had higher high school class rank and they noted that engineering graduates had significantly lower literary interests than drop-outs on the Kuder Preference Record literary scale. Reid, et al., also noted that the group which had voluntarily withdrawn but was still eligible to return had significantly less interest in mechanical activities and somewhat higher interest in clerical-office detail activities than the entering class. Students who were removed for academic deficiencies showed lower average test scores than graduates and, specifically, lower scores in mechanical and artistic interests. These students also had significantly greater interest in persuasive and social service activities than those who graduated.

Grande and Simons (1967), investigated academic status in relation to personal values and aptitude variables. They randomly selected sample of 20 Dean's list and 20 academic probation engineering sophomores and administered the College Entrance Examination Board Scholastic Ability Test and the Personal Values Inventory. Dean's list engineering students reported a higher high school record, stronger need for achievement, deeper involvement in struggling for successful academic performance, than pre-college peer groups. The Dean's list group constituted a constructive academic influence, stronger belief in the efficacy of planning as an ingredient of academic success, sharper definition of self as one who works hard academically, and greater degree of self-control as indicated by avoidance of wild parties, drinking, and thrill-seeking. There were no statistically significant differences between the two groups in terms of socioeconomic status (a factor which may be directly relevant to differences between minority and non-minority students), degree to which the home supports a positive academic self-image as reported by the student, faking or overstatement, or self-insight. The

conclusion was that academically successful engineering students differ from less successful engineering students in certain measurable characteristics. These variables may be able to explain the potential value that personal-social orientation contains as a characteristic capable of distinguishing between successful and relatively less successful engineering students.

Penick and Morning (1983) undertook a two-part retention research program. In the first part, they evaluated 11 projects which planned to augment or modify one or more minority student support services. In the second part, they used data from 51 originally submitted proposals seeking money for these support services, and the 11 funded projects to draw conclusions about factors contributing to retention. Data analysis revealed three support mechanisms significantly related to retention success: (a) monitoring of student performance and early warning of academic difficulty; (b) formal interaction among the MEP, its students, and the engineering faculty; and (b) a summer pre-freshman program to diagnose academic

strengths and weaknesses of the participants and provide academic assistance as needed.

A number of significant findings were revealed by analysis of techniques employed in the 11 funded projects. The most important finding was that retention can be dramatically improved through addition or modification of one or more support mechanisms to those already in place. Some of the other significant findings and recommendations are: (a) Summer sessions, as short as two weeks, help improve retention if they are followed during the academic year by courses with sessions to increase study time; (b) retention is better when services are provided by an MEP or non-engineering minority program than one designed for all students (specialized support efforts); (c) MEP support services are used more often by students with strong high school preparation and accurate academic self-concepts; (d) study skills courses must be more readily available and carefully scrutinized, since they are one of the most desired, but least effectively delivered, support services; (e) career awareness materials must stress the importance of hard work and problem-solving ability in addition to

the other attractive aspects of engineering; (f) recruiters and admissions officers should consider previous participation in a pre-engineering program and academic self-concept in the decision to admit students, in addition to traditional predictors, since both are positively related to minorities' persistence in engineering; (g) college recruiters and pre-engineering programs should make a more concerted effort to reach minority students who attend high schools with small minority populations, since they usually receive less encouragement from teachers and counselors to study engineering; (h) student organizations have been shown to be effective in the delivery of support services; therefore, MEP's should assist student organizations in attracting and involving the more academically able students who have traditionally been underrepresented in them.

A study undertaken by the California Postsecondary Education Commission (CPEC, 1985) demonstrated that the MEP in the California State University and University of California systems is increasing retention rates of ethnic minority students in engineering. This study also identified the following problems that must be

resolved if the program is going to continue to be successful in the coming years:

1) Not all campuses are at the same level in implementation of the MEP.

2) Most campuses do not pay the salary of the director through institutional funds, with the result of one campus having four different program directors in the four years of its operation.

3) Success of the existing program warrants its expansion to all public universities and its availability to all interested minority students in engineering.

Gordon, Gordon, Lloyd, Margolis, Nembhard, and Armour-Thomas (1986) investigated the current status of engineering education for minority students at both the pre-collegiate and the collegiate levels in the United States. Their analysis indicated that the field of pre-collegiate and collegiate programs in engineering education for underrepresented minority students is very active and has been relatively effective in increasing the number of Black and Hispanic persons who enter the engineering professions. Growth of minority participation in engineering is outstanding when

compared to other professions. However, compared to the majority, the production of minority engineers is quite modest. Observations of existing programs for minorities include: 1) Unevenness in the quality of conceptualization and design of programs. Some have clear conceptions of the problems and approaches to solve them, others lack such clear vision and appear to be opportunistic, faddish, and ritualistic in their program design. 2) Unevenness in the quality of program delivery. Some programs were carefully executed, attention was given to details, and they were sensitive to psychological, political and social factors. Some were well staffed and appeared to offer attention to problems of curriculum content, quality of instruction, and the monitoring of student progress. In other cases, they found evidence of form without substance, under-staffed programs, little appreciation for the complexities of student academic development, and nearly no indication of institutional commitment to these programs. 3) Inadequate representation and application of the current knowledge of cognitive science and psychology. 4) Contradiction between content mastery, required for entrance to programs of

study, and process mastery, required for professional competence. Emphasis is on content mastery for the educational setting, yet professional demand is for practical application of the knowledge. 5) Emphasis on the discovery of talent or identification of persons who show that they have already developed abilities. This is at the expense of the marginal student who needs the most resourceful developmental interventions. 6) Potential conflicts between the mechanisms of expanded minority participation and the mechanisms of leadership development. Greater emphasis is required to develop minority leadership with an engineering background.

The overriding recommendation was an emphasis on increasing minority students' early life exposure to mathematics and science and on increasing remedial instruction in order to increase the academic talent pool.

Daniels, LeBold, and Blalock (1988) describe an MEP at Purdue University and offer insights regarding what will constitute an effective minority engineering program. They described the major features of a comprehensive undergraduate recruitment and retention

program for women and minorities in engineering. They asserted that isolated programs that are of short duration or have narrow focus have little impact. However, comprehensive programs can be effective and have significant impact.

Jakubowski, Lovett, & Ehasz-Sans (1988) address factors affecting retention of engineering students at an urban university (University of Toledo). All engineering students are required to take a one credit Orientation to Engineering course that introduces them to the various areas of engineering and, more importantly, to study skills and various survival techniques. Grades of all engineering students are closely monitored. Those having grade problems are given special attention. Not all retention effort is directed toward the weaker students. A primary concern of the college is to keep academically capable students in college. The college is currently conducting a phone survey to determine why students who have GPA's above 2.0 are dropping out. Additionally, the university tries to convey interest in the student's return and facilitate this process by sending readmit forms, registration materials, etc.

Early life exposure as a critical element in preparing minority students for engineering and the sciences was recognized by the engineering community in Southeastern Pennsylvania in 1973.

Tobin and Woodring (1988) described a program to create opportunities for minorities in engineering, pharmacy and other mathematics and science - related professions. At that time General Electric convened a meeting with officials of the Pennsylvania school district to discuss how private industry could help increase the number of minority students and women graduating from engineering colleges. As a result, the Philadelphia Regional Introduction for Minorities in Engineering (PRIME) was formed. PRIME is designed to encourage more minority students to enter engineering and other technical and scientific professions. Elements of this precollege intervention program include: (a) academic program enrichment - such as in-school or after-school science clubs, special Saturday programs, summer school review or challenge classed, and opportunities for high-school students to take college-level courses, (b) instructional applications - e.g. math and science courses are linked to real-world

applications, (c) student internships and research projects, (d) academic advisement and counseling - student progress is monitored by both teachers and advisers at PRIME's participating colleges and universities, and (e) science fairs, college fairs, industry and college visitations, and field trips.

PRIME has been recognized by news media as well as President Reagan's Task Force on Voluntary Initiatives as a conspicuous example of how private sector initiatives, in partnership with urban educational systems, can enhance the quality of urban education.

McCauley (1988) studied 8 variables and their relationship to persistence of Blacks at a predominantly White university. She noted that attrition rate of Blacks was significantly higher than that of Whites. Despite intervention strategies employed to promote persistence of Blacks, many leave. Nonpersisters identified homogeneity of the university as a contributing factor to their decision to drop out. The study demonstrated that, even when intervention strategies are employed to promote the persistence of Blacks on a predominantly White, suburban campus, many Blacks leave the university prior to completing a

program of studies. McCauley feels that the role of educating Blacks does not rest with colleges and universities alone. Commitment at all levels from the Federal government to the students is necessary to prevent the revolving door syndrome. Minority students must be assisted to recognize the importance of, and responsibility for, their studies.

LeBold and Ward (1988) discussed problems associated with measuring engineering retention at an American Society for Engineering Education (ASEE) Conference. They noted that considerable variation was reported in defining retention and attrition. Engineering retention and attrition is defined, estimated, and calculated in a variety of ways. A primary problem is to develop a comprehensive definition of retention and attrition. Contemporary studies tend to use the positive term "retention" instead of attrition.

McAnulty and O'Connor (1987) examined experiences of Black engineering graduates of a White engineering school. They sought to evaluate experiences as minority engineering students and as professional engineers. They reflect a general concern that,

because such a small percentage of engineering graduates are from minority groups, this will result in a small percentage of future minority business leaders.

Tinto (1975, 1989) developed a model of student attrition (he prefers the term "departure") based upon the quality of students' relationships with the academic and social systems of a university. In fact, he paralleled the process of educational departure with other processes of leaving which occur among all human communities. He argued that, in both instances, departure mirrors the absence of social and intellectual integration into the mainstream of community life and the social support such integration provides. His final analysis maintains that institutions have a special responsibility and an obligation to insure that all students, without exception, have sufficient opportunities and resources to complete their course of study. This responsibility, if appropriately carried out by the institution, will in turn be mirrored by the student in the form of commitment to the institution and the educational opportunities it offers. In order to

assess student departure, Tinto insists that such an assessment be student-centered, meaning it must ascertain the character of student academic and social life within the institution. It must detail the social, as well as the academic, experiences of students. He posits the view that retention should not be the ultimate goal of institutional action, though it may be a desirable outcome of institutional efforts. Instead, students and institutions would be better served, if a concern for the education of students, their social and intellectual growth, were the guiding principles of institutional action.

The estimated graduation rate for all students who received degrees from engineering programs between 1983-84 and 1987-88 was 63.9%. The graduation rate for minorities over the same time period was 36.9%. Since the number of overall engineering enrollments has declined for that period of time, improving the graduation rate for underrepresented minorities takes on added significance.

Using this information, Friedman and Kay (1990) performed a national survey of minority engineering students to gather data that can be used in guiding

efforts to improve graduation rates. They cited Tinto's model as having been applied to four general attrition research categories: (a) studies of general student populations, (b) studies that include ethnicity as a variable, but not engineering; (c) studies that include engineering as a variable, but not ethnicity; and (d) studies that include both ethnicity and engineering as variables. They argue that few studies with minority populations and/or engineering programs have focused on institutional and goal commitment, which Tinto's model suggests are the student values with the most direct impact on dropout decisions. Their findings generally supported Tinto's model of student attrition when applied to minority students in engineering programs. Student commitment to the university was the most important influence on academic performance. Academic and social commitment did not significantly predict GPA. (Friedman and Kay cautioned, however, that this should not be taken as failure to support Tinto's model). Student centered programs are seen as the correlate of student success most directly under the institution's control. Minority presence on campus, whether student or

faculty, also contributed significantly to student success. They found financial aid to be critical for minority students, noting that the more successful students had fewer financial problems in college. A recommendation was made to evaluate existing support programs for minority engineering students to determine which components are most effective and where additional resources are required. Their final suggestion was that non-minority faculty can have a positive influence on student performance when they are perceived as very helpful. This makes a powerful case for faculty training to increase cultural awareness and understanding of cultural differences as a means of retaining minority students.

Landis (1990) supports the building of collaborative learning communities for minority engineering students to improve retention rates. Three primary elements that are key to success of a learning community are: (a) clustering students in common sections of their classes (for example, all Black freshmen will be in the same calculus, physics, and chemistry classes), (b) a freshman orientation course, and (c) a student study center. He argues that when an

institution ensures that minority students in a particular course are in the same sections of that course, know each other, and have been encouraged to work together, a high level of collaborative learning will occur.

Summary

The literature is inconclusive regarding personality variables that differentiate minorities from non-minorities in engineering. One study, (Brown & Cross, 1990), suggests that black engineering students may differ from White engineering students in significant ways (blacks less competitive, assertive; less emphasis on power orientation, more patient, less outspoken). Overall however, the literature would suggest that engineers and students selecting engineering as a major would be similar in personality and interests, regardless of race. The literature also suggests that engineering students would be dissimilar to students and individuals in other fields on the same measures.

Chapter III

Methodology

This chapter describes criteria used to select universities from which the sample population of engineering students were drawn and criteria that define student participants. Instrumentation of the study is explained and procedure describing steps followed to administer instruments and statistical techniques used to analyze the data is presented.

Selection of Universities

Universities selected for this study have Accreditation Board of Engineering and Technology (ABET) affiliation. ABET accredited institutions were selected because ABET is a federation of national engineering organizations which reviews and accredits Engineering and Engineering Technology programs. ABET accreditation means that the engineering programs approved by them meet the stringent criteria established by the engineering profession. The ABET catalogue includes: name, affiliation of the institution (i.e., State supported, Independent, Religious Affiliation, or Federal), total enrollment at the institution, minority/total engineering enrollment,

and presence or absence of an MEP (ABET, 1987). Additional demographic data was extracted from Peterson's Guides (1990).

Institutions selected for participation in this study were, with MEP's, New Mexico State University and Old Dominion University; Mississippi State University and the University of Arizona with no MEP. Several universities were asked to participate in the study (North Dakota State University; Oklahoma State University; University of Texas, El Paso) but declined. One university (University of Maryland) agreed to participate, but did not return the requested data within time limits to complete the study. The two universities that agreed to provide both Hispanic and Native American data, University of Arizona and New Mexico State University, were not able to obtain Native American samples. According to a letter received from New Mexico State University, "several attempts were made to contact the American Indian students but to no avail." The Minority Engineering Coordinator at the University of Arizona reported that one of the Native American Engineering students actually administered the instruments to Native American students, but the data

were never returned, and, therefore was not included in this study.

Friedman and Miazaki (1990), assert that minority freshmen tend to register at large, public universities which are moderately selective and less costly than private institutions. There is little balance in terms of ethnic mix. In this study, in order to obtain adequate data to provide meaningful statistics, data were collected from colleges/universities having an enrollment of greater than 10,000 students. Findings by Friedman and Miazaki (1990), preclude setting an upper limit on university enrollment to be considered in this study. In order to provide adequate minority representation, an effort was made to obtain a sample of 50 full-time enrolled Black engineering students, 35 full-time enrolled Hispanic engineering students and, 30-35 Native American engineering students at each institution. There are 79 colleges/universities in the United States meeting the described criteria. Of these 79 institutions, 29 are identified by NAMEPA as not having an MEP.

Subjects

Subjects for this study were 226 full-time enrolled, male and female undergraduate students in their sophomore, junior, and senior years at four United States universities. Enrollment status (sophomore, junior, senior) was categorized by the respective institutions. Freshmen were excluded from the sample, because they may not have declared engineering as a major or, some universities do not allow engineering students to declare their major before the sophomore year. Another reason for using sophomores and above is that this is the first year participants of an MEP can evaluate its effectiveness. Universities were also categorized by whether or not their university had an MEP program that was listed in the National Association of Minority Engineering Program Administrators (NAMEPA) 1990-91 National Data Book. If the university was listed in the Data Book, it was categorized as having an MEP although there are institutions with an MEP who are not affiliated with NAMEPA.

Table 1 presents the summary of characteristics for the samples.

The youngest group of students were Hispanics from the University of Arizona, with a mean age of 19.2, the oldest were Blacks at ODU with a mean age of 25.0. Sixty-eight females (nine African American, 17 Hispanic and 42 White) and 158 (30 African American, 52 Hispanic

TABLE 1

SUMMARY OF DEMOGRAPHIC CHARACTERISTICS

GROUP	N	RACE/ETHNIC	MALE (N)	AGE	FEMALE (N)	AGE	MEP
1 UA	20	WHITE	8	24.6	12	22.1	NO
2 UA	34	HISPANIC	24	21.1	10	19.2	NO
3 UNM	30	WHITE	16	22.5	14	21.4	YES
4 UNM	35	HISPANIC	28	23.2	7	20.5	YES
5 MS	19	African American	13	21.0	6	20.3	NO
6 MS	28	WHITE	21	22.5	7	20.6	NO
7 ODU	20	African American	17	21.6	3	25.0	YES
8 ODU	40	WHITE	31	25.0	9	24.7	YES

and 76 White) males participated in the study. The smallest sub-group was that of African American females at ODU (3). Total representation by African American females was nine subjects. The largest sub-group was that of White males at ODU (31).

Old Dominion University (MEP) provided the largest number of subjects (60) while Mississippi State (no MEP) provided the fewest (47).

Instruments

Three instruments were used to collect data: two questionnaires and a standardized psychological test. One questionnaire was a modified version of Landis' (1985) Minority Engineering Program evaluation form that focuses on student awareness of specific minority engineering services, if they have used or participated in these services, and the degree of satisfaction with the services. (See Appendix A).

The second instrument was a revised version of the 1988 Engineering Survey at the University of Toledo (Jakubowski, Lovett, and Ehasz-Sanz, 1988). This instrument was used to determine factors influencing choice of major and university; study, work, and extracurricular involvement; awareness and satisfaction with student support services and selected academic courses. (See Appendix B)

The third instrument was The Adjective Checklist (Gough, 1985). The ACL is an alphabetized list of 300 adjectives commonly used to describe a person to which subjects respond by marking those adjectives considered to be self-descriptive. The ACL has 37 scales in five areas: Method of Response Scales assessing

characteristic modes of operating; Need Scales, based on Murray's theory of needs; Topical Scales, assessing research-derived personality characteristics; Transactional Analysis Scales, reflecting five ego states or functions recognized in Transactional Analysis and, Origence-Intellectence Scales, measuring structural aspects of creativity and intelligence. The ACL has been used in more than 700 studies (Buros, 1978) and the manual gives normative data on approximately 10,000 subjects. None of the instruments were timed. (See Appendix C)

Procedure

A survey of underrepresented minority engineering students and their White counterparts at two predominantly White universities having MEP's and two predominantly White universities without MEPs was conducted in the spring/fall of 1991 and spring of 1992. Appropriate officials at each university were contacted and agreed to participate in the study. Packets containing the ACL and both questionnaires (MEP Evaluation and Engineering Survey) were prepared for minority students and packets containing the Adjective Checklist and The Engineering Survey only were prepared

for White students. Instructions for administration of the instruments were included, and a self-addressed, postage pre-paid, return mailing envelope was included with the packet of instruments. Officials at each university administered the ACL and questionnaires.

Analysis of Data

In the first phase of analysis, profiles were generated from frequency counts of responses to individual items on the Engineering Survey and Minority Engineering Program Questionnaires. Objectives were to clarify information regarding factors influencing choice of major, university, study, work and extracurricular involvement; awareness and satisfaction with student support services and selected academic courses, and to summarize experiences as minority engineering students at a predominantly White university. Also in this phase, ACLs were scored and profiles constructed.

In the second phase of analysis, ACL scale scores of all groups were compared using Analysis of Variance with SAS. A Tukeys Studentized Range post hoc test was performed to identify differences between any two scale score means. A factor analysis was performed using

principal components with varimax rotation on total results of ACL scores.

In the third phase of analysis, individual factors from ACL scores were subjected to a discriminant analysis on PROC DISCRIM in SAS to determine if racial groups could be classified according to personality test scale scores as represented by factor scores. A chi squared goodness-of-fit test was conducted to determine whether observed classification by discriminant analysis differed significantly from expected frequencies.

Chapter IV

Data Analysis and Results

This chapter is presented in three parts. The first part describes results from the Engineering Survey. This survey was completed by all students participating. How each group responded to questions regarding choice of major, university, study habits, work habits, extracurricular activities, and awareness of student support services is compared and discussed.

The second part provides findings from results of statistical analysis of ACL scores. The ACL provides personality profiles on each individual in the study. These individual profiles were combined, by group, and mean scale scores for each group were calculated and subjected to factor analysis. Five factors were extracted and subjected to a discriminant analysis and chi-squared procedure.

The third part of this chapter offers results from the Minority Engineering Program evaluation questionnaire. Similarities and differences between Black and Hispanic groups attending universities with and without Minority Engineering Programs are presented and discussed.

Results of the Engineering Survey

Table 10 located in Appendix D presents tabulation of the Engineering Survey. Factors influencing choice of major and/or university for the eight groups are shown first.

Age of Decision to Attend School

The decision to attend college was made before 9th grade for 82 percent of Hispanic engineering students at University of Arizona (no MEP) but only 52 percent of Hispanic engineering students at New Mexico State (MEP) had made the decision to attend college by 9th grade.

All African American engineering students at Mississippi State University (no MEP) had decided to attend college by 11th grade. African American engineering students at ODU (MEP) were similar in that 90 percent had decided to attend college by 11th grade.

Twenty-three percent of Whites at ODU, 72 percent of Whites at Mississippi State, 72 percent of Whites at New Mexico State, and 90 percent of Whites at University of Arizona had decided to attend college by ninth grade.

Present University Cited as First Choice

Sixty-two percent of Hispanic engineering students at University of Arizona, 54 percent of Hispanic engineering students at New Mexico State, 32 percent of African American engineering students at Mississippi State, but only 10 percent of African American engineering students at ODU indicate that the university they were attending was their first choice.

Thirty-eight percent of White engineering students at University of Arizona, 47 percent of White engineering students at New Mexico State, 50 percent of White engineering students at Mississippi State, and 30 percent of African American engineering students at ODU indicate that the university they were attending was their first choice.

The number one preference given by seven of the eight groups who were not attending their first choice of a university was "another public four year college or university." Only White engineering students at Mississippi State did not select "another public four year college or university" as their preferred institutional setting. Their preference was a "Two year college".

Primary Reasons for College Choice

Primary reasons for the choice of college were: geographic proximity, which was most important to ODU students (White 34 percent, African American 30 percent) and University of Arizona students (African American 26 percent, White 26 percent); financial reasons, which were most important to White students at New Mexico State (24 percent) and equally important along with geographic reasons (24 percent) to Hispanic students at New Mexico State; program of study available, which was most important to African Americans at Mississippi State (31 percent); quality of programs and faculty, which was most important to White students at Mississippi State (28 percent).

Grade When Major Was Selected

Grade when major was selected identified some differences between groups.

Fifty percent of African American engineering students from both ODU and Mississippi State selected their major by the 11th grade. Twelve percent of White engineering students from Mississippi State did so. At Mississippi State, 44 percent of White students said their major was selected while attending college.

African American engineering students at Old Dominion and Mississippi State and Hispanic engineering students at New Mexico State indicated that 50 percent or more had decided upon engineering by the eleventh grade. The minority group exception was Hispanic engineering students at the University of Arizona who indicated that 47 percent had made the decision to major in engineering by eleventh grade.

Reasons for Choosing Engineering

The primary reason given for choosing engineering was "preference for math and sciences in high school." This answer was given most frequently by all ethnic groups regardless of University. High income expectations was the second reason given for choosing engineering with all groups except Whites at the University of Arizona who gave that as their least important reason.

Primary Source of Funding College

Scholarship or grant money was the primary source of funding for Hispanics at the University of Arizona (31 percent), all students at New Mexico State (Hispanics 41 percent, Whites 37 percent); and all students at Mississippi State (African Americans 38

percent, Whites 26 percent). White students at the University of Arizona (38 percent), Mississippi State (26 percent), and Old Dominion (38 percent) and African American students at Old Dominion University (27 percent) cited "parents' or relatives' contribution" as their primary source of funding.

Results indicate that White engineering students receive funding for college from parents or relatives in higher percentages than either African Americans or Hispanics at all universities in this study.

Study Habits, Work Habits and Extracurricular Activities

Number of Hours Employed Per Week

Fifty-three to 61 percent of students in four of the eight groups (Hispanics at Univ. of Arizona, Whites at New Mexico State, Whites at Mississippi State, and Whites at Old Dominion) report that they are not employed. Of those employed, 9-40 percent work 1-15 hours per week and 10-40 percent work 16 or more hours per week.

Twenty percent of African American engineering students at ODU are not employed. None report being employed over 40 hours per week.

Thirty-five percent of African American engineering students at Mississippi State are not employed. None report being employed over 40 hours per week.

Forty-four percent of Hispanic engineering students at New Mexico State are not employed. None report being employed over 40 hours per week.

Fifty-three percent of Hispanic engineering students at the University of Arizona are not employed. None report being employed over 40 hours per week.

Place of Employment

Of students who report being employed, 30 percent of African American engineering students at ODU report working off campus, 50 percent on campus;

Fifty-five percent of African American engineering students at Mississippi State report working off campus, 11 percent on campus;

Fifty percent of Hispanic engineering students at New Mexico State report working off campus, 6 percent on campus;

Thirty-four percent of Hispanic engineering students at the University of Arizona report working off campus, 17 percent on campus.

Forty percent of White engineering students at both University of Arizona and New Mexico State report working on campus. Seven percent of White engineering students at Mississippi State and ODU report working on campus.

Hours Spent in Study Per Week

Data obtained regarding hours spent in study indicates that 48-55 percent of all students report spending 11-20 hours studying per week. Over 20 percent of all groups except African American engineering students reported studying over 21 hours per week. No African American engineering students at ODU reported studying over 20 hours per week and 16 percent of African American engineering students at Mississippi State reported studying more than 20 hours per week. If the rule of thumb for average time invested studying is two study hours for each class hour, no ethnic group reported 100 percent of their members studying an equivalent of a fifteen semester-hour class load, i.e. over 20 hours. The conclusion is that most students, regardless of race, are not spending enough time studying.

Primary Study Location

"Home" was the primary study location reported by all students with the exception of African American engineering students at Mississippi State. Forty-three percent of these students reported that their primary study location was their residence hall.

Time Spent in Extracurricular Activities

Time spent in extracurricular activities shows sharp contrast between White engineering students at Mississippi State and all other groups. Over half (fifty-four percent) of Whites at Mississippi State reported that they spent no time in extracurricular activities, while the next highest percentage indicating no time in extracurricular activities was that of African American engineering students at Mississippi State with 17 percent.

The University of Arizona was the only university indicating that both White and Hispanic engineering students spent some time in extracurricular activities: sixty-two percent of Hispanic engineering students said they spent a minimum of 1-5 hours in extracurricular activities and 38 percent of White engineering students spent a minimum of 1-5 hours in these activities.

Seventy percent of African American engineering students at ODU reported spending 1-5 hours in extracurricular activities compared with 55 percent of Whites, and 20 percent reported spending 6-10 hours in these activities compared with 28 percent of Whites.

Sixty-one percent of African American engineering students at Mississippi State reported spending 1-5 hours in extracurricular activities compared with seven percent of Whites and 22 percent reported spending 6-10 hours in these activities compared with 29 percent of Whites.

Fifty-nine percent of Hispanic engineering students at New Mexico State reported spending 1-5 hours in extracurricular activities compared with 53 percent of Whites and 21 percent reported spending 6-10 hours in these activities compared with 27 percent of Whites.

Sixty-two percent of Hispanic engineering students at the University of Arizona reported spending 1-5 hours in extracurricular activities compared with 38 percent of Whites and 29 percent reported spending 6-10 hours in these activities compared with 48 percent of Whites.

If the percentages of all students spending time in extracurricular activities are compared, with the exception of Whites at Mississippi State, 80 percent - 100 percent report spending between one and ten hours in such activities.

Satisfaction with Clubs, Organizations, etc.

Satisfaction with clubs and organizations reflected an overall approval for clubs and professional organizations and a less positive response for social, student government, and dances/social activities (25 percent approval or less).

Forty-eight percent of African American engineering students at ODU indicated satisfaction with professional/major organizations, 63 percent of African American engineering students at Mississippi State indicated satisfaction with professional/major organizations, 53 percent of Hispanic engineering students at New Mexico State indicated satisfaction with professional/major organizations, and 35 percent of Hispanic engineering students at New Mexico State indicated satisfaction with professional/major organizations.

White approval ratings for clubs ranged from a low of 29 percent at ODU to a high of 45 percent at the University of Arizona. White approval ratings for professional/major organizations ranged from a low of 36 percent at Mississippi State to a high of 56 percent at ODU.

Awareness and Use of Student Support Services

Someone to Talk to About Academic Concerns

Sixty-two to ninety percent of all groups indicated they had someone to talk to about academic concerns.

Ninety percent of African American engineering students at ODU indicated they had someone with whom they could talk to about academic concerns, compared to 77 percent of Whites.

Sixty-six percent of African American engineering students at Mississippi State indicated they had someone with whom they could talk about academic concerns, considerably less than the 86 percent of Whites.

Eighty-six percent of Hispanic engineering students at New Mexico State indicated they had someone

with whom they could talk to about academic concerns which was close to the 90 percent indicated by Whites.

Sixty-five percent of the Hispanic engineering students at the University of Arizona indicated they had someone with whom they could talk about academic concerns, similar to the 62 percent of Whites.

Accessibility to Personal Confidante

African American engineering students at ODU and at Mississippi State indicated that the person they could talk to was an advisor or instructor in engineering, 32 percent for Old Dominion and 47 percent for Mississippi State. Hispanic engineering students also identified an advisor or instructor in engineering, 59 percent at New Mexico State but only 14 percent at the University of Arizona who listed friend or classmate 39 percent of the time and administration or staff member 33 percent of the time.

Fifty-five to seventy-one percent of all groups indicated they had someone to talk to about non-academic concerns.

The major discrepancy in percentages by race was at the University of Arizona where 59 percent of Hispanic engineering students indicated they had

someone with whom they could talk about non-academic concerns, compared with 71 percent of Whites.

Reasons for Meetings

The primary reasons for meetings with advisors for all groups were registration and academic information.

Knowledge of Existing Programs or Services

The best known student programs and/or services were the university level tutoring, and the honors student program.

The summary of use of student support services and academics indicates that the reported use of student services was significantly lower than the reported knowledge of its existence. White students at all four institutions reported using the honors student program at much larger percentages than the percentage who were aware of the program.

Reasons for Course Difficulty

Students in all but one group (Whites at Mississippi State) found courses to be more difficult than expected. The primary reasons cited by the largest percentages of students were poor time management skills, and foreign instructors. Students in all but one group (Whites at Mississippi State) found courses to be more difficult than

expected. The primary reasons cited by the largest percentages of students were poor time management skills, and foreign instructors.

Adjective Checklist Results

The ACL was used to determine if significant differences exist between ethnic groups of engineering students at universities with and without a Minority Engineering Program. Five factors were identified from factor analysis and further analyzed with discriminant analysis and chi square.

One purpose of the data analysis was to determine if personality differences exist between various groups of engineering students at selected schools. Dependent variables are scales on the ACL which were analyzed to determine potential relationships to independent variables of students and schools. Scores are based on a mean of 50 and a standard deviation of 10 with the range for "average" 40-60. Means of all scales except Communality of Hispanics at University of Arizona fell within average range. This group had an average of 33.0 on Communality.

Table 2 shows mean scale scores and standard deviations of ACL responses for each minority ethnic group represented in the study.

TABLE 2

Means and Standard Deviations for Minority Students on the ACL

Scales	Hispanic Arizona (57)		Hispanic New Mexico(65)		Black Mississippi (44)		Black ODU (60)	
	M	S.D.	M	S.D.	M	S.D.	M	S.D.
Modus Operandi								
1. No. Checked	40.0	4.0	50.3	11.7	43.3	9.1	46.7	10.1
2. Favorable	44.3	6.8	51.6	8.9	49.1	7.1	52.8	8.6
3. Unfavorable	53.3	5.7	45.7	8.8	49.2	7.2	44.0	6.2
4. Communality	33.0	8.4	48.7	8.5	45.4	11.5	43.6	10.3
Need Scales								
5. Achievement	51.7	7.5	50.9	9.1	50.1	7.6	51.3	6.5
6. Dominance	54.6	7.1	53.3	9.7	53.5	9.0	54.7	7.8
7. Endurance	47.4	5.5	49.6	7.8	47.9	5.7	52.1	6.5
8. Order	46.5	4.4	49.1	8.8	47.3	3.7	49.2	6.5
9. Intraception	40.9	6.5	50.2	7.6	48.4	7.5	49.8	7.7
10. Nurturance	45.1	6.2	53.9	6.9	49.9	8.0	53.9	8.5
11. Affiliation	47.3	6.3	52.4	9.4	52.3	7.9	56.3	7.8
12. Heterosexuality	50.7	9.2	54.2	8.5	53.4	6.0	58.5	7.1
13. Exhibition	54.2	4.7	51.2	9.8	51.8	8.4	51.0	8.3
14. Autonomy	54.5	5.1	48.5	7.0	52.9	7.8	50.4	7.2
15. Aggression	54.7	4.6	49.8	7.1	51.9	10.1	49.1	9.3
16. Change	48.3	7.1	49.1	8.4	50.1	7.8	50.8	5.6
17. Succorance	46.9	6.3	48.5	9.7	48.4	5.0	42.5	6.3
18. Abasement	43.9	5.9	47.2	8.5	45.2	8.7	44.1	7.4
19. Deference	42.5	5.4	50.6	7.7	46.0	9.1	47.6	9.2
Topical Scales								
20. Counseling readiness scale	50.1	8.6	46.7	8.1	49.8	7.4	44.0	7.2
21. Self-control	44.7	5.7	48.5	10.4	44.1	9.4	46.9	8.8
22. Self-confidence	55.2	6.4	53.0	10.5	52.2	9.1	54.9	6.9
23. Personal Adjustment	45.1	6.9	52.3	9.4	49.2	8.4	53.7	7.2
24. Ideal self scale	54.9	4.7	50.0	9.5	51.3	8.3	56.3	7.0

25. Creative personality scale	49.1	7.1	47.9	8.5	48.8	6.6	50.5	7.0
26. Military leadership scale	42.6	6.3	49.5	9.4	46.6	7.4	47.4	9.7
27. Masculine attributes scale	57.0	6.4	51.1	7.6	55.0	7.7	54.9	7.5
28. Feminine attributes scale	42.5	7.1	51.2	8.0	43.7	8.3	47.9	8.1
Transactional Analy.								
29. Critical parent	53.5	5.4	48.2	10.0	52.6	10.7	47.1	10.4
30. Nurturing parent	46.8	6.4	52.7	9.3	49.0	8.3	55.0	8.2
31. Adult	47.9	6.8	47.5	9.5	46.5	6.0	50.2	8.6
32. Free child	53.9	5.8	51.7	10.4	53.1	7.3	54.0	7.3
33. Adapted child	50.7	6.4	47.3	11.0	48.0	6.3	42.9	7.8
Origence-Intellectence								
34. A-1	54.0	7.2	55.1	9.0	56.4	9.8	57.7	7.3
35. A-2	48.4	7.2	43.1	9.1	47.7	6.7	42.4	6.7
36. A-3	42.5	6.6	51.5	9.5	48.5	8.5	51.8	9.2
37. A-4	48.5	6.7	49.2	9.3	44.5	8.6	48.7	7.8

Table 3 shows mean scale scores and standard deviations of each ethnic group represented, and an analysis of variance between groups. Four scales Communality, Intraception, Affiliation, and Heterosexuality showed significant differences at the .05 level of significance. A Tukey's studentized range post hoc test was performed to determine which specific groups differed from one another on each of the four personality scales. Findings of these statistical tests are presented on the following pages. Of the 37 scales on the ACL, only four scales, or approximately 11 percent showed significant differences between

racial groups. Generally, there appear to be more differences between schools than between ethnic groups.

TABLE 3

Comparison of Scores on the Adjective Checklist for Hispanic, African American and White Engineering Students - By Race

Scales	Hispanic		Black		White		F Ratio
	Mean	S.D.	Mean	S.D.	Mean	S.D.	
Modus Operandi							
1. No. Checked	45.2	10.1	45.2	9.7	47.1	9.2	1.37
2. Favorable	47.9	8.7	51.2	8.1	50.3	8.0	2.64
3. Unfavorable	49.5	8.3	46.3	7.1	48.5	8.4	2.08
4. Communality	40.8	11.5	44.4	10.8	47.0	9.2	9.84*
Need Scales							
5. Achievement	51.3	8.3	50.7	6.9	51.6	8.1	.16
6. Dominance	54.0	8.5	54.1	8.3	53.3	8.3	.23
7. Endurance	48.5	6.8	50.2	6.5	50.4	7.1	1.83
8. Order	47.8	7.0	48.3	5.5	50.1	7.6	2.68
9. Intraception	45.6	8.4	49.1	7.6	48.2	8.8	3.14*
10. Nurturance	49.5	7.9	52.1	8.4	49.4	9.3	1.53
11. Affiliation	49.8	8.4	54.5	8.0	49.4	8.0	5.80*
12. Heterosexuality	52.4	9.0	56.3	7.0	51.4	8.5	4.73*
13. Exhibition	52.7	7.8	51.4	8.2	51.6	8.2	.48
14. Autonomy	51.5	6.8	51.5	7.5	51.2	8.6	.05
15. Aggression	52.2	6.4	50.4	9.6	52.5	9.7	.84
16. Change	48.7	7.1	50.4	6.6	49.5	9.0	.53
17. Succorance	47.7	8.1	45.1	6.5	45.8	9.7	1.48
18. Abasement	45.5	7.4	44.6	7.9	45.6	9.6	.21
19. Deference	46.5	7.7	46.9	9.1	46.9	9.4	.04
Topical Scales							

20. Counseling readiness scale	48.4	8.5	46.6	7.7	47.9	9.1	.56
21. Self-control	46.6	8.5	45.6	9.0	46.7	9.2	.19
22. Self-confidence	54.1	8.7	53.7	7.9	53.5	8.7	.11
23. Personal adjustment	48.7	8.9	51.7	8.0	50.3	8.1	1.89
24. Ideal self scale	52.4	7.9	54.1	7.9	51.3	9.2	1.51
25. Creative personality scale	48.5	7.9	49.7	6.8	51.1	9.0	2.17
26. Military leadership scale	46.0	8.7	47.0	8.6	48.7	8.4	2.39
27. Masculine attributes scale	54.1	7.6	54.9	7.5	54.4	9.5	.12
28. Feminine attributes scale	46.9	8.7	46.0	8.3	46.2	9.0	.19
Transactional Analy.							
29. Critical parent	50.9	8.4	49.5	10.7	50.6	10.8	.24
30. Nurturing parent	49.8	8.4	52.3	8.6	50.4	8.1	1.21
31. Adult	47.7	8.2	48.5	7.7	49.7	8.3	1.33
32. Free child	52.8	8.4	53.6	7.2	52.1	10.4	.37
33. Adapted child	49.0	9.2	45.1	7.6	46.8	8.7	2.69
Origence-Intellectence							
34. A-1	54.6	8.1	57.1	8.4	53.8	10.8	1.56
35. A-2	45.7	8.6	44.8	7.1	45.9	8.6	.28
36. A-3	47.0	9.3	50.3	8.9	48.6	8.6	1.87
37. A-4	48.8	8.1	46.8	8.3	50.2	8.5	2.38

None of the four scales identified as being significantly different reflected significant differences between African American engineering

students attending universities with Minority Engineering Programs and African American engineering students attending universities without Minority Engineering Programs.

Of the four scales identified as being significantly different, scores between Communality and Intraception had a significant difference between Hispanics attending a university with a Minority Engineering Program and Hispanics attending a university without a Minority Engineering Program. The mean score on Communality of Hispanic engineering students at the University of Arizona, which has no Minority Engineering Program, was significantly lower from mean scores of all other universities in this study. Low scorers on Communality tend to be ambivalent in relating to others, express opposition in deviant ways, tend to be contentious and defensive, and find it difficult to conform to the everyday expectations of interpersonal life.

The mean scale score on Intraception for Hispanic engineering students at the University of Arizona was significantly lower than all other groups of students except mean scale score of White engineering students at Old Dominion University, which has a Minority Engineering Program.

Hispanic engineering students at the University of Arizona and White students at ODU were statistically significantly lower from African American engineering students at Old Dominion University on Affiliation. African American engineering students at ODU had the highest mean on Affiliation of all groups indicating that they tend to be more comfortable in social situations, like to be with people, and adapt easily to the changing demands of group process. There were no significant differences between any other African American or White groups on this scale.

Mean scale scores on Communality by Hispanics at the University of Arizona were significantly different from all other group scores on that scale regardless of ethnic group or absence or presence of a Minority Engineering Program.

Scale scores on Affiliation and Heterosexuality indicate no significant difference between Hispanic engineering students and White engineering students at either school.

The overall outcome of ACL test scores is described as follows:

Communality was significantly different between Hispanic engineering students at the University of Arizona and all other groups of students on this scale.

No other significant differences between any other groups of engineering students on this scale was indicated. The Communality scale attempts to serve the functions of helping identify unreliable or randomly completed protocols and assess the factor of "communality". High scorers on Communality appear to be reliable, considerate of others, free of pretense, and comfortable in interpersonal relationships. Low scorers are ambivalent in relating to others, may express opposition in deviant ways, tend to be contentious and defensive, and find it difficult to conform to the everyday expectations of interpersonal life. All groups in this study scored less than the mean scale score of 50. The lowest mean score other than Hispanic engineering students at the University of Arizona was that of African American engineering students at Old Dominion University with a score of 43.6.

The Intraception scale score of Hispanic students at the University of Arizona was significantly lower than all other groups of students except White engineering students at Old Dominion University. African American students at Old Dominion University had the highest mean score on this scale. The definition of Intraception is to engage in attempts to

understand one's own behavior or the behavior of others. High-scorers are seen as logical and foresighted, and as valuing intellectual and cognitive matters. Low-scorers appear to have a narrower range of interests, be somewhat superstitious, and to be less capable in coping with stress or trauma. High-scorers tend to be complex and internally differentiated, whereas low-scorers tend to be simple and prosaic.

Comparing scores on Affiliation, Hispanics and Whites at the University of Arizona and Whites at Old Dominion University were not significantly different, however they were significantly different from scale scores by African Americans at Old Dominion University. No other groups were significantly different on this scale. African Americans had the higher mean score and Whites and Hispanics the lower. The definition of Affiliation is to seek and maintain numerous personal friendships. High-scorers on Affiliation are comfortable in social situations, like to be with people, and adapt easily to the changing demands of group process. Little if at all given to soul-searching, high-scorers gloss over inner complexities and prefer to take people and events at face value. Low-scorers agonize over the meaning of relationships, complicates them, and fears involvement. An underlying

current of anxiety and preoccupation makes wholehearted participation in social interaction difficult if not impossible.

Whites and Hispanics at the University of Arizona were significantly different from African Americans at Old Dominion University, on the Heterosexuality scale, but not significantly different between Hispanics and Whites at New Mexico State. African Americans had the higher mean score and Whites the lower. Heterosexuality is defined as seeking the company of and deriving emotional satisfaction from interactions with opposite-sex peers. High-scorers on Heterosexuality plunge into life with gusto, respond warmly to interpersonal encounters, like the company of the opposite sex, have vigorous erotic drives, and appear to be blessed by good health and abundant vitality. Low-scorers tend to think too much, keeping people at a distance; fear the challenges and opportunities of interpersonal life, and fall back on a too narrow and restricted role repertoire.

Factor and Discriminant Analyses

Factor analysis, Principal Components method using Varimax rotation, was computed for the ACL scores of all subjects. Five factors were extracted which had eigenvalues of 1.0 or greater and these five factors were retained in the rotations. The five factors combined accounted for 77 percent of the variance. Table 4 gives the loadings above .75 for all factors except factors four and five. Factor four has a high loading on only one scale, High Origence, Low Intellectence; and Factor five has high loadings on two scales, Number Checked and High Origence, High Intellectence (negative loading).

Highest loadings on Factor one (proportion of variance = 0.241) were found on the scales for Nurturance (.90), Affiliation (.83), Favorable (.78), Personal Adjustment (.77), Nurturing parent (.76), Critical parent (-.75), Unfavorable (-.76). This factor was labeled "Personableness".

Factor two (proportion of variance = 0.219) is defined by Adult (.90), Endurance (.84), Order (.83), Low Origence, High Intellectance (.80); Achievement (.76), Military Leadership (.76), and Adapted Child (-.78)). This factor was labeled "Productiveness"

Factor three (proportion of variance = 0.213) consists of Exhibition (.87), Free Child (.85), Dominance (.75), Deference (-.76), Abasement (-.77) and Self-Control (-.83). This factor was labeled "Spontaneity".

Factor four (proportion of variance = 0.049) consists of High Origence, Low Intellectance only (.65). This factor was labeled "Expressiveness".

Factor five (proportion of variance = .043) consists of Number Checked (.59) and High Origence, High Intellectance (-.57). This factor was labeled "Strong-willed".

Factor analysis in the ACL Manual (Gough & Heilbrun, 1980) extracted six factors from the original 37 scales. Highest loadings for Factor 1 were found on the scales for Achievement, Endurance, Order, Adult, A-4, and Adapted Child (negative loading). This factor was labeled "Potency" and high scorers may be characterized as resourceful, resolute, and goal-oriented.

Table 4

Factor Loadings of ACL Scores After Varimax Rotation

Scale	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
Nurturance	.90				
Affiliation	.83				
Favorable	.78				
Personal Adjust.	.77				
Nurturing Parent	.76				
Critical Parent	-.75				
Unfavorable	-.76				
Adult		.90			
Endurance		.84			
Order		.83			
Low Origence High Intellectence		.80			
Achievement		.76			
Military Leadership		.76			
Adapted Child		-.78			
Exhibition			.87		
Free Child			.85		
Dominance			.75		
Deference			-.76		
Abasement			-.77		
Self Control			-.83		
High Origence Low Intellectence				.65	
Number Checked					.60
High Origence High Intellectence					-.57
Proportion of Variance	0.241	0.219	0.213	0.049	0.043

Factor 2 was defined by Dominance, Exhibition, Aggression, and Free Child with positive loadings and by Self-Control and Abasement with negative loadings. This factor was labeled "Assertiveness" and high scorers may be characterized as ascendent, demanding,

and strong-willed. Factor 3 was indexed by Favorable, Nurturance, Affiliation, Personal Adjustment, Nurturing Parent, and A-3, all with positive weights. This factor was labeled "Sociability" and high scorers may be characterized as compassionate, optimistic, and attentive to others. Factor 4 was assessed by Intraception, Autonomy, Change, Creative Personality, and A-2 with positive loadings and Deference with a negative loading. This factor was labeled "Individuality" and high scorers may be characterized as imaginative, ingenious, and unconventional. Factor 5 was indexed by No. Ckd, Unfavorable, Succorance, Feminine Attributes, and Critical Parent. This factor was labeled "Dissatisfaction" and high scorers may be characterized as introspective, anxious, and self-critical. Factor 6 was measured by five scales. Positive weights were assigned to both Communality and Military Leadership and negative weights to Ideal self, Masculine Attributes, and A-1. This factor was labeled "Constriction" and high scorers may be characterized as serious, self-disciplined, and rule respecting.

The three descriptions with largest positive correlations for the sample group on Factor 1 were "to engage in behaviors that provide material or emotional benefits to others; to seek and maintain numerous

personal friendships and adaptable, outgoing and protective of those close to them"; compared with "Is productive; get things done, genuinely values intellectual and cognitive matters and is power oriented" for those of the "norm" group.

The three descriptions with the largest positive correlations for the sample group on Factor 2 were "productive, work centered, reliable, ambitious; to persist in any task undertaken; and to place special emphasis on neatness, organization and planning in ones activities"; compared with "behaves in an assertive fashion, initiates humor and enjoys sensuous activities (including touch, taste, smell, physical contact) power oriented" for those of the "norm" group.

The three descriptions with the largest positive correlations for the sample group on Factor 3 were "to behave in such a way as to elicit the immediate attention of others, ebullient and enterprising, not at all inclined to exercise self-restraint or to postpone gratifications, and to seek and maintain a role as a leader in groups"; compared with "emphasizes being with others, gregarious, has warmth, has the capacity for close relationships, compassionate, and is cheerful" for those of the "norm" group.

The three descriptions with the largest positive correlations for the sample group on Factor 4 were "possess strong instincts, a taste for merrymaking, and easy distractibility; compared with "enjoys sensuous experiences, "tends to be rebellious and nonconforming" and "enjoys aesthetic impressions" for those of the "norm" group.

The three descriptions with the largest positive correlations for the sample group on Factor 5 were "tend to be expressive individuals, eager to explore the world around them but somewhat inconsistent and even capricious in their reactions, seems to be an attractive person, vivacious and quickly enthusiastic, but somewhat self-seeking and lacking in responsibility"; compared with "is introspective and concerned with self as an object, has a readiness to feel guilty and is basically anxious" for those of the "norm" group.

Factorial structure for the Norm group was similar to that of the sample group on three scales: Three scales for Norm Factor 1 were the same as scales contained in Sample Factor 2 (Adult, Endurance and Order); Three scales for Norm Factor 2 were similar to scales contained in Sample Factor 3 (Exhibition, Free Child, and Dominance); and three scales contained in

Norm Factor 3 were the same as scales contained in Sample Factor 1 (Nurturance, Affiliation, and Favorable).

A discriminant analysis using factor scores for each of the five factors extracted from factor analysis was performed to determine if racial groups could be classified according to personality test scale scores as represented by these factor scores. Table 5 shows the results of this discriminant analysis.

Table 5

Discriminant Analysis for Classification of ACL Scores by Race

	Discriminant Function Classification			
	Black	Hispanic	White	Total
Black	63.9	19.4	16.7	100.0
Hispanic	25.7	48.6	25.7	100.0
White	30.0	31.0	35.0	100.0
Total	34.1	31.0	35.0	100.0

(Chi square value = 31; Chi square table value 9.88 at df=4)

A chi squared goodness-of-fit test was computed on the classification derived from discriminant analysis to determine whether observed classification by discriminant analysis differs significantly from expected frequencies.

African Americans were correctly classified 63.9 percent of the time; Hispanics were correctly

classified 48.6 percent of the time; and Whites correctly classified 35.0 percent. This data does not, however, account for the fact that African Americans are incorrectly classified as Hispanic or Whites approximately 36 percent of the time, Hispanics incorrectly classified as African Americans or Whites approximately 51 percent of the time, and Whites incorrectly classified as African Americans or Hispanics 65 percent of the time. The findings do indicate that African Americans and Hispanics are correctly identified half or more of the time. This may indicate that students are more alike than they are different.

Minority Engineering Program Questionnaire Results

Percentages of students who knew about availability of services offered is presented in column A, those who participated in the service more than once are shown in column B of the Minority Engineering Questionnaire results tables. These percentages represent those students who knew about the service or/and utilized it compared to the total number of students responding. Column C presents the degree of satisfaction with the service and is computed as the score in each category compared to total number of responses per category. Degree of satisfaction

responses were: excellent, good, fair, poor. Excellent or good were taken together and designated as "favorable". Fair and poor were taken together and designated as "unfavorable".

University of Arizona

Results of Hispanic engineering students responses to the Minority Engineering Program Questionnaire at the University of Arizona (N=34) are shown in Table 6.

Percentages of students who were aware of available services described on the questionnaire range from a low of 15 percent (N=5) on awareness of community college outreach and relation to regional precollege program to high of 97 percent (N=33) on awareness of a tutoring program. Percentages of students who actually used or participated in and MEP service more than once a year ranged from a low of 3 percent (N=1) on the relation to a regional precollege program, to a high of 41 percent (N=14) on the tutoring program.

Fifty percent or more of Hispanic students at the University of Arizona responded most favorably (excellent) to four service categories: tutoring personal/social counseling, summer prefreshman year program, and staff for MEP. They responded favorably

(good or excellent) to all categories except Space for MEP.

Table 6
Minority Engineering Program Questionnaire Results
University of Arizona - Hispanic
(Expressed in Percentages)

Aware	Used	Service	Satisfaction			
			Favorable		Unfavorable	
61	26	Freshman orientation course	35	50	7	7
65	38	ME Student study center	29	59	12	0
29	6	Clustering of ME students in classes	22	44	11	22
59	29	ME student organization(s)	43	36	21	0
59	18	Structured study groups	25	50	8	16
79	24	Academic advising	33	33	16	16
35	12	Monitoring of student progress	17	50	17	17
97	41	Tutoring program	57	29	9	5
53	18	Summer job placement	36	45	18	0
38	18	Career development activities for ME students	0	63	37	0
59	24	Personal/social counseling	55	27	18	0
56	24	Financial aid/scholarships	27	46	27	0
44	24	Summer prefreshman year program	83	17	0	0
21	6	Assistance with housing/financial aid	25	25	50	0
47	21	High school outreach	29	71	0	0
15	6	Community college outreach	25	75	0	0
15	3	Relation to regional precollege program	25	50	25	0
53	26	Staff for MEP	69	23	8	0
35	9	Space for MEP	17	17	17	50
38	18	Engineering faculty involvement	44	33	11	11

New Mexico State

The results of Hispanic engineering students responses to the Minority Engineering Program Questionnaire at New Mexico State University (n=27) are shown in Table 7.

Table 7

Minority Engineering Program Evaluation
New Mexico State University - Hispanic
(Expressed in percentages)

Aware	Used	Service	Satisfaction			
			Favorable		Unfavorable	
74	44	Freshman orientation course	23	69	8	0
52	4	ME Student study center	33	66	0	0
41	30	Clustering of ME students in classes	50	25	25	0
89	48	ME student organization(s)	63	37	0	0
37	11	Structured study groups	40	60	0	0
81	48	Academic advising	53	40	7	0
70	19	Monitoring of student progress	33	33	11	22
74	37	Tutoring program	50	50	0	0
85	37	Summer job placement	75	25	0	0
70	30	Career development activities for ME students	55	33	11	0
63	19	Personal/social counseling	66	17	17	0
100	78	Financial aid/scholarships	74	26	0	0
48	7	Summer prefreshman year program	25	25	50	0
52	26	Assistance with housing/financial aid	40	40	20	0
78	41	High school outreach	54	46	0	0
26	4	Community college outreach	100	0	0	0
22	4	Relation to regional precollege program	100	0	0	0
70	30	Staff for MEP	75	25	0	0
41	19	Space for MEP	60	20	20	0
70	41	Engineering faculty involvement	62	38	0	0

Percentages of students who were aware of available services described on the questionnaire range from a low of 22 percent (n=6) on the relation to the regional precollege program, to a high of 100 percent (n=27) on awareness of the financial aid/scholarships services. Percentages of students who actually used or participated in available services more than once a year ranged from 4 percent (n=1) who used the community college outreach service to 78 percent (n=21) who used the financial aid/scholarships service.

One hundred percent of Hispanic students at New Mexico State University responded in the most favorable category (excellent) to two service categories: Community College Outreach and Relation to Regional Precollege Program. Fifty percent or more of these students responded in the most favorable degree of satisfaction category (excellent) to fourteen service categories. The categories were: clustering of ME students in class, ME student organization(s), academic advising, tutoring program, summer job placement, career development activities for ME students, personal/social counseling, financial aid/scholarships, high school outreach, community college outreach, relation to regional precollege program, staff for MEP,

space for MEP, and engineering faculty involvement. They responded favorably (good or excellent) to all categories.

Table 8
Minority Engineering Program Evaluation
Mississippi State University - African American

Aware	Used	Service	Satisfaction Favorable		Satisfaction Unfavorable	
56	13	Freshman orientation course	25	50	-	25
31	13	ME Student study center	-	33	66	-
44	19	Clustering of ME students in classes	-	50	50	-
88	63	ME student organization(s)	16	66	16	-
50	19	Structured study groups	25	50	-	25
94	44	Academic advising	12	50	25	12
44	25	Monitoring of student progress	33	33	33	-
69	38	Tutoring program	20	40	20	20
50	19	Summer job placement	40	60	-	-
50	19	Career development activities for ME students	-	100	-	-
56	25	Personal/social counseling	20	40	20	-
88	31	Financial aid/scholarships	13	63	13	13
44	13	Summer prefreshman year program	25	25	50	-
31	6	Assistance with housing/financial aid	33	66	-	-
63	13	High school outreach	40	-	60	-
25	6	Community college outreach	-	33	33	33
19	6	Relation to regional precollege program	50	50	-	-
25	13	Staff for MEP	-	50	50	-
31	13	Space for MEP	33	33	33	-
31	19	Engineering faculty involvement	25	50	25	-

Mississippi State University

The results of African American engineering students responses to the Minority Engineering Program Questionnaire at Mississippi State University (n=16) are shown in Table 8.

Percentages of students who were aware of available services described on the questionnaire range from 19 percent (n=3) who were aware of relation to regional precollege program to 94 percent (n=15) who were aware of academic advising. Percentages of students who actually used or participated in services more than once a year ranged from 6 percent (n=1) who received assistance with housing/financial aid, community college outreach assistance and used the services of the regional precollege program to 63 percent (n=4) who participated in Minority Engineering student organizations.

Half of the African American engineering students at Mississippi State University responded in the most favorable category (excellent) to the regional precollege program. Fifty percent or more of these students responded favorably (good or excellent) to all other service categories except the following, to which they responded unfavorably (fair or poor): ME student study center; Clustering of ME students in classes;

Summer prefreshman year program; High school outreach; Community college outreach; Staff for MEP.

Old Dominion University

The results of African American engineering students responses to the Minority Engineering Program Questionnaire at Old Dominion University (n=20) are shown in Table 9.

Percentages of students who were aware of available services described on the questionnaire range from 30 percent (n=6) who were aware of community college outreach services and relation to regional precollege program to 85 percent (n=17) who were participated in Minority Engineering organizations. Percentages of students who actually used or participated in services more than once a year ranged from 5 percent (n=1) who participated in community college outreach assistance to 55 percent who participated in Minority Engineering student organizations.

Half or more of the African American engineering students at Old Dominion University responded in the most favorable category (excellent) to the following categories: Clustering of ME students in classes, ME student organization(s), summer prefreshman year program, high school outreach, community college

outreach, relation to regional precollege program, staff for MEP, space for MEP, engineering faculty involvement. They responded in a positive direction (good or excellent) to all other categories.

Summary

No African American engineering students at ODU and only 16 percent of African American engineering students at Mississippi State indicated that they study more than 21 hours per week as compared with 24 percent and 29 percent of Whites at ODU and Mississippi State respectively, who report studying more than 21 hours per week, and both are low. Twenty percent of African American engineering students at ODU and 48 percent of African American engineering students at Mississippi State are studying more than 15 hours per week compared with 48 percent and 54 percent of Whites at ODU and Mississippi State respectively. African American engineering students at Old Dominion University are the exception in this study reporting that they spend fewer hours in study. If the average number of classroom hours taken per semester is 15, only 20-48 percent of all African American engineering students in this study are studying more than one hour per week for each hour of classroom instruction compared to 48-54 percent of Whites at the same universities. The rule of thumb is

Table 9
Minority Engineering Program Evaluation Results
Old Dominion University - African American Engineering Students
(Expressed in percentages)

Aware	Used	Service	Satisfaction			
			Favorable		Unfavorable	
65	20	Freshman orientation course	20	70	10	0
60	35	ME Student study center	40	50	0	10
35	20	Clustering of ME students in classes	50	0	50	0
85	55	ME student organization(s)	80	0	7	13
60	25	Structured study groups	29	57	0	14
80	45	Academic advising	46	46	8	0
40	15	Monitoring of student progress	29	29	29	13
75	35	Tutoring program	36	55	0	9
45	10	Summer job placement	29	57	14	0
65	20	Career development activities for ME students	30	30	20	20
55	5	Personal/social counseling	29	71	0	0
75	40	Financial aid/scholarships	36	45	9	9
60	20	Summer prefreshman year program	63	25	12	0
50	25	Assistance with housing/financial aid	25	38	25	12
60	10	High school outreach	71	29	0	0
30	5	Community college outreach	60	40	0	0
30	15	Relation to regional precollege program	60	20	20	0
60	25	Staff for MEP	70	10	0	20
50	25	Space for MEP	50	25	25	0
65	30	Engineering faculty involvement	67	8	16	8

two hours of study for each hour of classroom instruction, therefore students should be studying a minimum of thirty hours per week. Hispanic engineering students indicate that 45-61 percent are studying more than 15 hours per week.

Ninety-five percent to 100 percent of African American engineering students report spending 10 hours or less in extracurricular activities. Eighty-eight to 91 percent of Hispanic engineering students report spending less than 10 hours per week in extracurricular activities. This indicated that, although what may be perceived as inadequate amounts of time are spent studying outside the classroom, engineering minority students' "free" time is not spent in extracurricular activities.

Students appear to be aware of available support services for both academic and non-academic concerns but, few use them. Students most frequently sought a friend as the person to talk with for both academic and non-academic concerns.

An average of 57 percent of all groups of students met with their faculty advisor one time during the quarter or semester (range 40-77 percent). The reasons for meetings cited most frequently were for registration only. Next most frequently cited reasons for meeting with the faculty advisor were for academic and career information.

Personality Characteristics

Four of 37 scales on the ACL showed significant differences between groups, indicating that personality

profiles of these engineering students are very similar.

Factor analysis results on Factor One, Personableness, describe engineering students as individuals who attempt to provide emotional benefit to others, who seek to maintain numerous personal friendships. They tend to be adaptable, outgoing, protective of those close to them, capable of initiating and carrying through tasks, prefer continuity, seek to sustain relationships, less egoistic than and more tolerant of weaknesses of others, desirous of bringing people together, are dependable, tactful and less judgmental than most people.

Descriptions on Factor 2 scales, Productiveness, are of people who tend to be productive, work centered, reliable, ambitious, self disciplined, uncomfortable in expressing affection, possessing a strong sense of duty. They tend to work consciously, eschew frivolity and the non-essential, dislike change and variety, and would be considered analytic, logical, astute, and intellectually capable. They tend to be self-disciplined, find it hard to give in and unbend or give in to impulse, and usually strive to be outstanding in anything they attempt.

Factor 3, Spontaneity, describes the samples as tending to behave in a way that seeks the attention of others, not inclined to exercise self-restraint, sweeps others along in a rush toward enjoyment, seeks and maintains the leadership role, delights in competition and taking risks, is assertively self-confident, and responds quickly.

Factor 4, labeled Expressiveness, describes the samples as adventurous, easy going, relaxed and sophisticated.

Factor 5, labeled Strong Willed, described the samples as expressive, attractive, vivacious, quickly enthusiastic, self-sufficient, strong willed, avoiding of emotional intimacy, and annoyed by those who are not are not insightful.

MEP Versus No MEP

Comparisons of African American engineering students at a university with a formal MEP (ODU) with African American engineering students at a university without a formal MEP (Mississippi State) indicate that students at Old Dominion had a higher percentage of awareness of the existence of university and program services and a higher percentage of use of these services than students at Mississippi State. Students at Old Dominion expressed a higher percentage of

awareness of services on thirteen of the twenty services listed compared to Mississippi State students who indicated a greater percentage of awareness on seven of the services offered. The reverse may have been expected since ODU is a university with a large commuter population. Students at Old Dominion also indicated that they participated in the services of their MEP more than one time a year on thirteen of the twenty services listed on the questionnaire.

Comparisons of Hispanic engineering students at a university with a formal MEP (NM State) with Hispanic engineering students at a university without a formal MEP (University of Arizona) indicate that students at New Mexico State University had a higher percentage of awareness of the existence of University and program services and a higher percentage of use of these services than students at the University of Arizona.

Students at New Mexico State expressed a higher percentage of awareness of services on seventeen of the twenty services listed compared to University of Arizona who indicated a higher percentage of awareness on seven of the services offered.

Students at New Mexico State also indicated that they had a higher percentage of participation on

fourteen services of their MEP than students at the University of Arizona.

Results of the MEP survey indicate that the two universities in this study not listed as having formal MEP's do have many MEP components in place. Awareness and use of these components was higher at universities where a formal MEP was in place.

Chapter V

Summary and Conclusions

The purposes of this study were to investigate whether there are common characteristics associated with Hispanic, African American, and Native American engineering students who persist at predominantly white colleges and universities and whether they are similar or different from White students attending the same colleges and universities. This study also sought to develop a personality profile of minority engineering students to determine if these profiles differed significantly from White engineering students attending the same university. Another purpose was to determine which components of MEP's are most valued or used by minority engineering students.

Information regarding factors influencing choice of university and major were collected along with study, work and extracurricular activities involvement information, awareness and use of student support services and satisfaction with these services was also compiled in this study.

This study was also undertaken because there have been few non-cognitive empirical studies conducted to assist in retention efforts for minority engineers. There have been few nationwide studies undertaken to

determine which components of MEP's are most used or valued by minority engineering students.

Four, predominantly white universities participated in the study. No Native American participation was included in the study for reasons stated in chapter three.

The study attempted to answer the following questions: (1) What factors, reported by the sample, most influenced their choice of major, university, study, work and made up their extracurricular involvement? (2) Are there personality differences, on the Adjective Checklist, between African American engineering students attending universities with Minority Engineering Programs and African American engineering students attending universities without Minority Engineering Programs? (3) Are there personality differences, on the Adjective Checklist, between Hispanic engineering students attending universities with Minority Engineering Programs and Hispanic engineering students attending universities without Minority Engineering Programs? (4) Are there personality differences between White engineering students and African American engineering students at universities with Minority Engineering Programs, and between White engineering students and African American

engineering students at universities without Minority Engineering Programs? (5) Are there personality differences between White engineering students and Hispanic engineering students at universities with Minority Engineering Programs, and between White engineering students and Hispanic engineering students at universities without Minority Engineering Programs? (6) Which components of MEPs are most used by minority engineering students? (7) Which components of MEPs are least used by minority engineering students?

The major findings between ethnic groups are four scales on the ACL, Commiunaility, Affiliation, Intraception, and Homosexuaolity which are statistically significant between the some of the groups.

Age of Decision to Attend School

All African American engineering students at Mississippi State University (no MEP) had decided to attend college by 11th grade. African American engineering students at ODU (MEP) were similar in that 90 percent had decided to attend college by 11th grade.

Present University Cited as First Choice

Sixty-two percent of Hispanic engineering students at University of Arizona, 54 percent of Hispanic engineering students at New Mexico State, 32 percent of

African American engineering students at Mississippi State, but only 10 percent of African American engineering students at ODU indicate that the university they were attending was their first choice.

Primary Reasons for College Choice

Primary reasons for the choice of college were: geographic proximity, which was most important to ODU students (White 34 percent, African American 30 percent) and University of Arizona students (African American 26 percent, White 26 percent); financial reasons, which were most important to White students at New Mexico State (24 percent) and equally important along with geographic reasons (24 percent) to Hispanic students at New Mexico State; program of study available, which was most important to African Americans at Mississippi State (31 percent); quality of programs and faculty, which was most important to White students at Mississippi State (28 percent).

Grade When Major Was Selected

Fifty percent of African American engineering students from both ODU and Mississippi State selected their major by the 11th grade. African American engineering students at Old Dominion and Mississippi State and Hispanic engineering students at New Mexico

State indicated that 50 percent or more had decided upon engineering by the eleventh grade.
engineering by eleventh grade.

Reasons for Choosing Engineering

The primary reason given for choosing engineering was "preference for math and sciences in high school." This answer was given most frequently by all ethnic groups regardless of University.

Study Habits, Work Habits and Extracurricular Activities

Number of Hours Employed Per Week

Fifty-three to 61 percent of students in four of the eight groups (Hispanics at Univ. of Arizona, Whites at New Mexico State, Whites at Mississippi State, and Whites at Old Dominion) report that they are not employed.

MEP Versus No MEP

Comparisons of African American engineering students at a university with a formal MEP (ODU) with African American engineering students at a university without a formal MEP (Mississippi State) indicate that students at Old Dominion had a higher percentage of awareness of the existence of university and program services and a higher percentage of use of these services than students at Mississippi State. Students

at Old Dominion expressed a higher percentage of awareness of services on thirteen of the twenty services listed compared to Mississippi State students who indicated a greater percentage of awareness on seven of the services offered. The reverse may have been expected since ODU is a university with a large commuter population. Students at Old Dominion also indicated that they participated in the services of their MEP more than one time a year on thirteen of the twenty services listed on the questionnaire.

Comparisons of Hispanic engineering students at a university with a formal MEP (NM State) with Hispanic engineering students at a university without a formal MEP (University of Arizona) indicate that students at New Mexico State University had a higher percentage of awareness of the existence of University and program services and a higher percentage of use of these services than students at the University of Arizona.

Students at New Mexico State expressed a higher percentage of awareness of services on seventeen of the twenty services listed compared to University of Arizona who indicated a higher percentage of awareness on seven of the services offered.

Students at New Mexico State also indicated that they had a higher percentage of participation on

fourteen services of their MEP than students at the University of Arizona.

Results of the MEP survey indicate that the two universities in this study not listed as having formal MEP's do have many MEP components in place. Awareness and use of these components was higher at universities where a formal MEP was in place.

Findings and Recommendations

Some of the major findings and recommendations that can be drawn from this study are:

Finding:

Most minority engineering students had made a decision to attend college by ninth grade and had decided to major in engineering by the 11th grade. This would indicate that minorities who want to study engineering appear to know so at a much earlier age.

Recommendation:

Recruiting for engineering needs to begin before students are in middle school.

Finding:

The primary factor influencing choice of engineering as a major was "preference for math and sciences in high school".

Recommendation:

Recruiting efforts could focus on minority students in math and science classes in middle school because large percentages of these students indicated a preference for these courses and an early preference for engineering.

Finding:

Responses indicate that 42 percent-69 percent of minorities are using scholarship or grant money and student loans.

Recommendations:

Although these appear to be substantial percentages of students utilizing available funds, minorities also appear to be required to work during the school week, perhaps at the expense of study time. Additional information about these types of funding should be made available to minority engineering students at an earlier school age. This information could be disseminated by counselors in middle and high schools.

Counselors and faculty at universities could be kept apprised of scholarship/grant money available for minority students and could encourage and assist students to apply for this money.

Finding:

Larger percentages of minorities spend less time studying than Whites.

Recommendations:

Efforts need to be made to encourage all students, especially minorities, to spend more time studying. Studying an appropriate number of hours per classroom hour should be encouraged by faculty, advisors, and any personnel at an MEP center. It is possible that students are not aware of an expected minimum number of hours studying for adequate performance in a course. Explain the rule of two hours of study time for each hour of classroom time to students.

Development of structured study groups and use of the Minority student study centers should be encouraged by faculty, advisors, and administrators of Minority Engineering Programs.

Meetings with study groups and instructors at specific times could be scheduled weekly.

Finding:

Time management was cited as a major reason for course difficulty.

Recommendations:

Students could be exposed to time management skills training early on in their academic career.

The advising system for freshmen in engineering needs to be examined. Freshman students probably need more than academic advising (i.e. course scheduling).

Finding:

Services most frequently used by African American engineering students are university level tutoring and the counseling center.

Recommendation:

Tutors and staff at the counseling centers could be made aware of general statistics indicating many minorities do not study adequate amounts of time outside class and could encourage their pupils to "spread the word" about available counseling services.

Finding:

Overall awareness of services in the university and MEP program available was higher at those universities with formal MEPs.

Recommendation:

Encourage all colleges offering engineering degrees to seek information regarding participation in a Minority Engineering Program.

Finding:

Expressed satisfaction on the MEP Questionnaire was especially high for: clustering of ME students in classes, Minority Engineering student organizations,

staff for MEP, and space for MEP from students at ODU and New Mexico State, the two universities in the study having formal MEPs.

Recommendation:

Landis suggests that clustering is the one thing that costs little and has an enormous impact on the quality of the educational environment and hence the academic performance of minority engineering students. This approach to course assignment may be the single most important effort made by any university.

Conclusions

Awareness and use of university and Minority Engineering Program services may result in an increased retention and graduation rate of minority engineering students, however improved retention will be contingent upon services offered by the program. More minority engineering graduates in the workforce will offer the potential for greater representation by minorities in managerial and executive corporate positions. Such a trend could build upon itself to inspire greater minority engineering retention and educate larger percentages of minority engineering graduates.

Prior studies (Dillard, Knott) have suggested that personality and interests of engineering students are similar regardless of race. This study tends to

validate those findings and is somewhat at odds with the study by Brown, Cross and Selby. Much of the data on personality characteristics of engineers and engineering students is 10-30 years old and, because the personality characteristics of engineering students and engineers may be more diverse than recent studies would indicate, additional studies in this area are recommended.

Additional study of MEP's is also suggested, focusing on a larger population of minority engineering students nationwide taking the MEP questionnaire. Additional studies could attempt to include Native Americans and a larger population of African American and Hispanic engineering students.

Comparisons of African American engineering students at a university with a formal MEP (ODU) with African American engineering students at a university without a formal MEP (Mississippi State) indicate that students at Old Dominion had a higher percentage of awareness of the existence of services and a higher percentage of use of these services than students at Mississippi State. Students at Old Dominion expressed a higher percentage of awareness of services on thirteen of the twenty services listed compared to Mississippi

State students who indicated a greater percentage of awareness on seven of the services offered.

Students at Old Dominion also indicated that they participated in the services of their MEP more than one time a year on thirteen of the twenty services listed on the questionnaire.

Comparisons of Hispanic engineering students at a university with a formal MEP (NM State) with Hispanic engineering students at a university without a formal MEP (University of Arizona) indicate that students at New Mexico State University had a higher percentage of awareness of the existence of services and a higher percentage of use of these services than students at the University of Arizona.

Students at New Mexico State expressed a higher percentage of awareness of services on seventeen of the twenty services listed compared to University of Arizona who indicated a higher percentage of awareness on seven of the services offered.

Students at New Mexico State also indicated that they had a higher percentage of participation on fourteen services of their MEP than students at the University of Arizona.

This information would indicate the strong positive influence of a formal Minority Engineering

Program. Awareness of services available was higher at those universities with formal MEPs. Expressed satisfaction was especially high for: clustering of ME students in classes, Minority Engineering student organizations, staff for MEP, and space for MEP from ODU and New Mexico State, the two universities in the study having formal MEPs.

Differences that emerge between groups in this study based on ACL and MEP questionnaire information, tend to be more identified by university than by ethnic category.

Appendix A

ENGINEERING SURVEY 1991-92

Items 1-25 pertain to factors influencing your college experience. Please read through this list of factors and circle the answer(s) that best describes your feelings. Please circle as many choices per question as appropriate.

College or University_____ Date____

Gender: M___ F___ Age___ Major_____

Racial/Ethnic Group
_Asian American
_Black (African American)
_Hispanic (Non-Mexican American)
_Hispanic (Mexican-American)
_Inuit
_Native American
_Pacific Islander
_White
_Other

Classification
_Freshman
_Sophomore
_Junior
_Senior

Status
_Full-time
_Part-time
_Transfer

1. When did you make the decision to attend college?
   1 - grade school
   2 - junior high
   3 - 9, 10, or 11th grade
   4 - senior year in high school
   5 - after graduating from high school

2. Was this college/university your first choice?
   1 - yes
   2 - no

3. What kind of college or university was your first choice?
   1 - two-year college
   2 - another public four-year college or university
   3 - private four-year college or university
   4 - a vocational or technical school

4. Why did you choose this school? (Select as many reasons as you like)
   1 - financial reasons
   2 - geographic location
   3 - quality of programs and faculty
   4 - program of study available here
   5 - to be with friends
   6 - academic support available
   7 - to play athletics
   8 - to begin program here, then transfer
   9 - other

5. When did you select your major?
   1 - grade school
   2 - junior high
   3 - 9, 10, or 11th grade
   4 - senior year in high school
   5 - after graduating from high school
   6 - in college

6. What were your top 1 or 2 reasons for choosing engineering?
   1 - close relative is an engineer
   2 - engineers earn high salaries
   3 - liked math and sciences in high school
   4 - high achiever in high school
   5 - parents' expectations
   6 - always wanted to be an engineer
   7 - didn't know what else to major in
   8 - friends are engineering majors
   9 - other

7. What is your primary source of funding for college?
   1 - parents/relatives
   2 - summer employment
   3 - college employment (work-study or other part-time)
   4 - student loan
   5 - scholarship or grant

8. How many hours per week do you work this semester?
   1 - not employed
   2 - 1-7 hours
   3 - 8-15 hours
   4 - 16-24 hours
   5 - 25-40 hours
   6 - more than 40 hours

9. Place of employment?
   1 - not employed
   2 - on campus
   3 - off campus

10. How many hours per week do you estimate that you spend studying?
    1 - none
    2 - 1-5 hours
    3 - 6-10 hours
    4 - 11-15 hours
    5 - 16-20 hours
    6 - 21 or more hours

11. Where do you study most often?
    1 - at home
    2 - library
    3 - residence hall
    4 - student union
    5 - other

12. How many hours per week do you estimate that you are involved with clubs, organizations, or any athletics?
    1 - none
    2 - 1-5 hours
    3 - 6-10 hours
    4 - 11-20 hours
    5 - 21 or more hours

13. If you participated with clubs, organizations or in athletics, circle if you <u>are</u> satisfied with the following?
    1 - social fraternity/sorority
    2 - student government
    3 - clubs
    4 - professional/major organizations
    5 - dances and social activities

14. Do you have anyone at the University to go to regularly when you need to talk to someone about academic concerns?
    1 - yes
    2 - no

15. Is this person:
    1 - your advisor who schedules classes
    2 - an instructor in engineering
    3 - an instructor not in engineering
    4 - a classmate
    5 - a friend
    6 - an administrator or staff member
    7 - a mental health professional
    8 - other

16. Do you have anyone at the University to go to regularly when you need to talk to someone about non-academic concerns?
    1 - yes
    2 - no

17. Is this person:
    1 - your advisor who schedules classes
    2 - an instructor in engineering
    3 - an instructor not in engineering
    4 - a classmate
    5 - a friend
    6 - an administrator or staff member
    7 - a mental health professional
    8 - other

18. How often per quarter or semester do you meet with your faculty advisor?
    1 - never
    2 - once
    3 - 2-3 times
    4 - more than 3 times

19. Reason for meeting with your faculty advisor?
    1 - registration only
    2 - career information
    3 - help with academic problems
    4 - help with social or personal problems
    5 - referral to other campus resources
    6 - academic information
    7 - other

20. Check all of the following programs or services that are available at the university.
    1 - Peer Counseling
    2 - Counseling Center
    3 - Honors Student Program
    4 - Special Services
    5 - Reading Classes
    6 - Writing Center
    7 - Tutoring
    8 - Minority Mentor Program

21. Check all of the following that you used more than once.
    1 - Peer Counseling
    2 - Counseling Center
    3 - Honors Student Program
    4 - Special Services
    5 - Reading Classes
    6 - Writing Center
    7 - Tutoring
    8 - Minority Mentor Program

22. Did you find college courses more difficult than you expected?
    1 - yes
    2 - no

23. What made these courses more difficult?
    1 - poor reading skills
    2 - poor note-taking skills
    3 - poor test taking skills
    4 - poor time management skills
    5 - foreign instructors
    6 - large classes
    7 - insufficient background to understand the material
    8 - poor math skills
    9 - other

Appendix B

Appendix C

EVALUATION OF YOUR MINORITY ENGINEERING PROGRAM

College or University_____ Date____

Gender: M___ F___ Age___ Major_____

Items 1-20 pertain to specific areas of most Minority Engineering Programs (MEP).

In Column A place a check (✓) by those services you know are available through the MEP at your university.

In Column B place a check (✓) by those MEP services you have used or participated in more than once a year.

In Column C rate the degree of satisfaction with those services you checked in Column B.

1=Excellent
2=Good
3=Fair
4=Poor

A	B		Service	C 1	2	3	4
___	___	1.	Freshman orientation course	___	___	___	___
___	___	2.	ME Student study center	___	___	___	___
___	___	3.	Clustering of ME students in classes	___	___	___	___
___	___	4.	ME student organization(s)	___	___	___	___
___	___	5.	Structured study groups	___	___	___	___
___	___	6.	Academic advising	___	___	___	___
___	___	7.	Monitoring of student progress	___	___	___	___
___	___	8.	Tutoring program	___	___	___	___
___	___	9.	Summer job placement	___	___	___	___
___	___	10.	Career development activities for ME students	___	___	___	___

A	B		Service	C 1	2	3	4
—	—	11.	Personal/social counseling	—	—	—	—
—	—	12.	Financial aid/ scholarships	—	—	—	—
—	—	13.	Summer prefreshman year program	—	—	—	—
—	—	14.	Assistance with housing/financial aid	—	—	—	—
—	—	15.	High school outreach	—	—	—	—
—	—	16.	Community college outreach	—	—	—	—
—	—	17.	Relation to regional precollege program	—	—	—	—
—	—	18.	Staff for MEP	—	—	—	—
—	—	19.	Space for MEP	—	—	—	—
—	—	20.	Engineering faculty involvement	—	—	—	—

Thank you for your time and consideration in completing this questionnaire. Please add any comments in the space below concerning your views about your college experience, good or bad. We are particularly interested in comments that pertain to the support you have received in college from other people, offices or organizations.

Appendix D

Table 10

Personal Factors in Selection of Major and University
(Expressed in Percentages

Items	Univ of AZ		NM State		Miss. State		Old Dominion	
	White	Hisp	White	Hisp	White	African American	White	African American
Age of Decision to Attend School	n=21	n=34	n=30	n=35	n=27	n=19	n=40	n=20
Grade school	71	50	a47	42	55	37	15	15
Junior high	19	32	27	9	17	53	8	35
9, 10, 11th grade	4	18	10	27	10	11	28	40
Senior year in high school	0	0	3	12	7	0	18	10
Past high school graduation								
Present University Cited as First Choice								
Yes	38	62	47	54	50	32	30	10
No	62	38	53	46	50	68	70	90
Preferred Institutional Setting								
Two year college	0	4	0	3	43	19	26	15
Another public 4 year college or univ.	75	59	71	42	29	69	69	60
Private four year college or university	25	33	29	21	29	13	3	20
Vocational or technical school	0	4	0	0	0	0	3	5

Items	Univ of AZ		NM State		Miss. State		Old Dominion	
	White	Hisp.	White	Hisp.	White	African American	White	African American
Primary Reason for College Choice								
Financial	23	24	25	24	18	18	16	18
Geographic proximity	26	26	23	24	21	27	34	30
Quality of programs and faculty	17	18	20	21	28	14	13	20
Program of study available	17	14	19	15	23	31	23	17
Maintain friendships	8	6	0	8	6	6	1	5
Available academic support	5	6	8	6	1	0	1	3
Play Division I athletics	0	0	1	1	0	0	2	1
Preparation for subsequent transfer	0	6	2	0	1	0	5	3
Other	5	0	1	2	1	4	5	1
Grade of School When Major Was Selected								
Grade school	5	3	7	3	4	0	0	5
Junior high	5	9	10	18	4	11	5	20
9, 10, 11th grade	27	35	17	29	4	42	18	25
Senior year in high school	32	**18**	40	15	37	42	20	20
Past high school graduation	5	12	7	18	7	0	35	5
During college	27	24	20	18	44	5	25	25

Items	Univ of AZ		NM State		Miss. State		Old Dominion	
	White	Hisp.	White	Hisp.	White	African American	White	African American
Reasons for Choosing Engineering								
Close relative is an engineer	7	6	13	12	7	5	9	5
High income expectations	2	20	19	17	24	21	15	22
Preference for math and sciences in high school	40	38	28	32	31	44	37	3
High achiever in high school	2	9	18	14	8	18	11	7
Parental expectations	4	5	8	1	0	3	1	7
Early preference for engineering	7	9	7	12	14	3	10	12
Lack of another major	0	3	3	3	7	0	5	5
Friends who are engineering majors	0	6	1	4	3	3	1	0
Other	7	3	3	6	7	5	11	7
Primary Source of Funding College								
Parents' or relatives' contribution	38	22	32	12	26	12	38	27
Summer employment	15	14	13	18	16	8	11	9
Employment during the academic year	12	16	8	18	6	12	7	21
Student loan	23	18	11	6	26	31	27	24
Scholarship or grant	12	31	37	41	26	38	18	18

Study and Work Habits,
Extracurricular Activities
(Expressed in Percentages

Items	Univ of AZ		NM State		Miss. State		Old Dominion	
	White	Hisp.	White	Hisp.	White	African American	White	African American
Number of Hours Employed Per Week								
Not employed	45	53	53	44	61	35	68	20
1-7	5	3	10	9	11	10	2	15
8-15	23	24	27	15	4	15	7	25
16-24	14	15	10	24	11	40	10	35
25-40	9	6	0	9	11	0	10	5
41+	5	0	0	0	4	0	2	0
Place of Employment								
Not employed	45	49	53	44	59	37	66	20
On-campus	40	34	40	50	7	53	7	30
Off-campus	14	17	7	6	11	11	27	50
Hours Spent in Study Per Week								
0	0	0	0	0	0	0	0	0
1-5	4	0	3	3	11	0	5	15
6-10	19	24	13	18	7	32	18	30
11-15	19	24	23	18	29	21	28	35
16-20	29	24	27	32	25	32	24	20
21+	29	21	33	29	29	16	14	0

Items	Univ of AZ		NM State		Miss. State		Old Dominion	
	White	Hisp.	White	Hisp.	White	African American	White	African American
Primary Study Location								
Home	59	41	64	54	52	14	64	54
Library	9	30	6	22	7	29	20	26
Residence Hall	14	11	15	5	28	43	7	9
Student Center	5	16	0	0	0	0	2	0
Other	14	3	15	20	14	14	7	13
Hours Spent in Extracurricular Activities								
0	0	0	3	9	54	17	15	5
1-5	38	62	53	59	7	61	55	70
6-10	48	29	27	21	29	22	28	20
11-20	10	9	13	12	4	0	2	5
21+	4	0	3	0	7	0	0	0
Satisfaction with the following clubs, organizations, etc.								
Social fraternity/sorority	8	10	8	6	14	25	12	6
Student government	0	0	4	3	5	0	0	0
Clubs	45	46	31	32	32	0	29	29
Professional/major organizations	42	35	40	53	36	63	56	48
Dances and social activities	5	10	17	5	9	13	3	16

Awareness and Use of Student Support Services
(Expressed in Percentages)

Items	Univ of AZ		NM State		Miss. State		Old Dominion	
	White	Hisp.	White	Hisp.	White	African American	White	African American
Someone to talk to about academic concerns								
Yes	62	65	90	86	86	66	77	90
No	38	35	10	14	14	33	23	10
Accessibility to Personal Confidante								
Advisor	28	6	22	20	29	27	42	28
Instructor in engineering	22	8	22	29	13	20	23	4
Other instructor or faculty member	0	8	2	2	0	0	0	4
Classmate	17	14	13	9	3	13	7	12
Friend	22	25	22	18	35	27	14	32
Administrator or staff member	0	33	15	16	16	13	7	12
Mental health professional	0	0	2	0	0	0	0	0
Other	11	6	2	7	3	0	7	8
Confidante for non-academic concerns								
Yes	71	59	77	71	75	66	58	55
No	29	41	23	29	25	33	42	45

Items	Univ of AZ		NM State		Miss. State		Old Dominion	
	White	Hisp.	White	Hisp.	White	African American	White	African American
Non-academic confidante								
Scheduling advisor	0	0	0	0	0	0	3	6
Instructor in engineering	5	4	3	5	8	0	6	0
Instructor - not engineering	0	0	0	0	8	0	0	0
Classmate	15	11	21	18	8	13	13	18
Friend	60	59	65	53	67	81	61	53
Administrator or staff member	5	19	3	13	0	0	6	6
Mental health professional	0	0	6	f 0	0	0	0	0
Other	20	7	3	11	4	6	10	18
Frequency of Meeting with Advisor Per Semester								
Never	24	43	10	12	4	6	5	5
Once	38	34	43	53	36	44	45	50
2-3 times	29	11	43	26	54	28	43	40
More than 3 times	10	11	3	9	7	22	7	5
Reasons for Meetings								
Registration only	17	21	36	56	43	42	42	57
Career information	26	19	16	15	17	17	10	0
Help with academic problems	4	13	20	6	12	8	18	4
Help with social/personal problems	0	2	4	0	0	0	2	0
Referral to other campus resources	4	6	2	0	5	0	3	0
Academic information	43	29	22	19	21	25	22	26
Other	9	10	4	4	2	8	3	13

Items	Univ of AZ		NM State		Miss. State		Old Dominion	
	White	Hisp.	White	Hisp.	White	African American	White	African American
Knowledge of Existing Programs or Services								
Peer counseling	15	15	10	11	11	18	6	11
Counseling center	15	13	15	16	18	18	15	17
Honors Student Program	19	14	16	16	19	18	16	15
Special Services	12	11	12	14	14	10	12	9
Reading Classes	4	8	7	9	8	4	10	10
Writing Center	5	12	11	11	8	5	17	15
Tutoring at the University level	20	16	16	16	17	18	17	19
Minority Mentor Program	11	12	11	7	5	10	7	12

Satisfaction with Student Support Services and Academics

Items	Univ of AZ		NM State		Miss. State		Old Dominion	
	White	Hisp.	White	Hisp.	White	African American	White	African American
Use of Programs or Services								
Peer counseling	0	19	0	5	0	27	0	4
Counseling Center	0	5	13	11	12	0	10	8
Honors Student Program	62	7	31	5	53	7	20	0
Special Services	0	3	23	30	6	7	5	13
Reading classes	0	0	3	0	0	0	10	4
Writing Center	0	14	13	0	0	0	45	13
Tutoring at the University level	5	38	18	43	29	47	10	29
Minority Mentor Program	0	14	0	5	0	13	0	29
Course Difficulty Greater Than Expected								
Yes	52	66	50	60	37	63	53	60
No	48	33	50	40	63	27	47	40

Items	Univ of AZ		NM State		Miss. State		Old Dominion	
	White	Hisp.	White	Hisp.	White	African American	White	African American
Reasons for Course Difficulty								
Poor reading skills	0	5	4	5	10	6	10	8
Poor note-taking skills	12	5	2	5	7	9	6	8
Poor test-taking skills	7	11	7	15	10	11	12	8
Poor time management skills	12	31	17	24	24	31	18	18
Foreign Instructors	23	13	31	20	24	11	31	21
Large classes	19	13	6	3	7	3	6	15
Insufficient background to understand material	12	6	15	15	3	9	6	21
Poor math skills	2	5	6	3	0	0	0	3
Other	14	13	13	11	14	20	10	0

References

Accreditation Board for Engineering and Technology, Inc. (1987). Accredited programs leading to degrees in engineering. New York, New York, ABET, 1987.

Beall, L., & Bordin, E. S. (1964). The development and personality of engineers. Personnel and Guidance Journal, 43. 23-32.

Brown, N. W., Cross, E. J., Jr., and Selby, G. (1990). Personality characteristics of black engineering students on the Adjective Checklist. College Student Journal. 23. 233-240.

Brown, N. W., Cross, E. J., Jr., and Selby, G. (1990). Personality of students persisting in engineering - comparisons and implications for instruction. Proceedings 1990 ASEE Annual Conference 1990, 165-167.

Buros, O.K. (1978). The eighth mental measurement yearbook. Highland Park, NJ: Gryphon Press.

Retention of engineering students: A report to the legislature in response to senate concurrent resolution 16 (1985). California Postsecondary Education Commission (1985)).

Costello, F. J. (1977). A study on the validity of admissions policy as applied to the school of engineering at an urban university (Report No. HE 010 890). New Haven CT: University of New Haven. (ERIC Document Reproduction Service No. ED 165 627)

Crisco, J. J.(1976). The prediction of academic performance for minority engineering students from selected achievement-proficiency, personality, cognitive style, and demographic variables. Dissertation Abstracts International, 36 10-A 6545.

Davis, J. A. (1965). Undergraduate career decisions. Chicago: Adeline, 1965.

Dillard, G. D. (1985). A descriptive analysis of the relationship of selected variables to the success of African American "at risk" engineering students. Dissertation Abstracts International, 46 4-A, 895, 04194209.

Friedman, D. L., & Kay, N. W. (1990). Keeping what we've got: A study of minority student retention in engineering. Engineering Education, 407-412.

Friedman, D.L., & Miyazaki, L. (1990, August). Engineering enrollment trends, 1986-87 to 1989-90. Research Letter of the National Action Council for Minorities in Engineering, Inc. Volume 1, Number 2, (Available from National Action Counsel for Minorities in Engineering.

Izard, C. E. (1960). Personality characteristics of engineers as measured by the EPPS. Journal of Applied Psychology. 44, 332-335.

Hayden, D.C., & Hollway, E.L., (1985). A longitudinal study of attrition among engineering students. Engineering Education, 664-668.

Jakubowski, G.S., Lovett, G., & Ehasz-Sanz, M. (1988). External factors that affect the retention of engineers: An urban university perspective. Proceedings 1988 of the ASEE Annual Conference Proceedings. Portland, Oregon, 838-842.

Knott, James L. (1978). Personality interests and values among black and White engineering and non-engineering students. Dissertation Abstracts International, 38 9-B, 4519.

Korn, H.A. (1962). Differences between majors in engineering and physical sciences on CPI and SVIB

scores. Journal of Counseling Psychology, 9, 309-312.

Landis, R.B. (1985). Improving the retention and graduation of minorities in engineering. National Association of Minority Engineering Program Administrators. New York, N.Y.

Landis, R.B. (1990). Building collaborative learning communities. ASEE Annual Conference Proceedings. Portland, Oregon, 1204-1208.

LeBold, W.K., Ward, S.K. (1988). Engineering retention: National and institutional perspectives. ASEE Annual Conference Proceedings, 843-851.

McAnulty, B. H., & O'Connor, C. A. (1987). The experience of black engineering graduates. Journal of College Student Personnel. 37, 546-551.

McCauley, D.P. (1988). Effects of specific factors on blacks' persistence at a predominantly White university. Journal of College Student Development. 29, 57-60.

Molnar, G. F. & Delauretis, R. J., Predicting curriculum mobility of engineering students: A

comparison of discriminant procedures. Journal of Counseling Psychology. 20, 50-59.

Neal, R. & King, P. (1969) Comparison of multivariate and configural analysis for classifying engineering students. Journal of Counseling Psychology, 16, 563-568.

Office of Technology Assessment. (1985). Demographic trends and the science and engineering workforce. (OTA Publication No. OTA-TM-SET-35). Washington, D.C. U.S. Government Printing Office.

Penick, B.E., & Morning, C.E. (1983). The retention of minority engineering students. Report on the 1981-82 NACME retention research program. New York, New York: NACME. (ERIC Document Reproduction Service No. ED 247 325).

Peterson's guide to four-year colleges 1991 (21st ed.).(1990). Princeton, NJ: Peterson's Guides Inc.

Reid, J.W., Johnson, A.P., Entwhisle, F.N. , & Angers, W.P.(1962). A four-year study of the characteristics of engineering students. Personnel and Guidance Journal, 41, 38-43.

Robinson, B. E., (1982). Sex-stereotyped attitudes of male and female preschool teachers as a function of personality characteristics. Psychological Reports, 1982, 50, 203-208.

Scott, N. A., & Sedlacek, W. E., (1975). Personality differentiation and prediction of persistence in physical science and engineering. Journal of Vocational Behavior. 6, 205-216.

Statistical Report 1988. National Action Council for Minorities in Engineering, New York, 1988.

Sedlacek, W. E., & Brooks, G., Jr. (1970) African American freshmen in large colleges: A survey. Personnel and Guidance Journal. 14. 307-309.

Sedlacek, W.E. & Webster, D. W. (1978). Admission and retention of minority students in large universities. Journal of College Student Personnel, 19. 242-249.

Sackett, R.L. (1940). "Selection" of engineering students-discussion. Engineering Education, 595-600.

Southworth, J. A. & Morningstar, M. E. (1970). Persistence of occupational choice and personality

congruence. Journal of Counseling Psychology, 17, 409-412.

Stonewater, K. (1981). Strategies for increasing minority engineering enrollment and retention. Engineering Education, 72, 175-177.

Summerskill, J. (1962). Dropouts from college. In: N. Sanford (Ed.). The American College. New York: John Wiley.

The Task Force on Women, Minorities, and the Handicapped in Science and Technology, Final Report. (1989). Changing america: The new face of science and engineering.

The Task Force on Women, Minorities, and the Handicapped in Science and Technology, Interim Report. (1988). Changing america: The new face of science and engineering.

Tinto, V. (1975). Dropouts from higher education: A theoretical synthesis of recent research. Review of Educational Research, 45, 89-125.

Tinto, V. (1985). Dropping out and other forms of withdrawal from college. In Noel, L., Levitz, R., Saluri, D., & Associates (Eds.), Increasing student retention: Effective programs and

practices for reducing the dropout rate (pp. 28-43). San Francisco: Jossey-Bass.

Tinto, V. (1987). Leaving college. Chicago: University of Chicago Press.

Tobin, A. & Woodring, R., (1988). PRIME: A model precollege minority program. Engineering Education, 747-749.

Williams, J. E., & Bennett, S. M. (1975). The definition of sex stereotypes via the Adjective Check List. Sex Roles, 1975, 1, 327-337.

Young, H.A., McAnulty, B.H., & Daly, B.E. (1981). Persistence and perception: White and black engineering students. Engineering Education, 72, 177-179.