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ABSTRACT

Predictive models of persistence and success in baccalaureate engineering programs were developed by analyzing five intellective and nine nonintellective variables. The 1984 entering freshman class in the College of Engineering at the Pennsylvania State University was studied. Usable data were obtained from 1,044 students, or 65% of the population. Data sources were: admissions records; results of the Freshman Testing Counseling and Advising Program, Testing and Counseling/Advising Phases; and transcripts and registration information. Four predictive models were developed that employed intellective and nonintellective variables that defined students' abilities, motives, and interests. Two of the models predicted academic achievement: the first predicted a student's cumulative grade point average (GPA); the second predicted engineering GPA, which isolated specific engineering foundation courses in mathematics, physics, and chemistry. The other two models predicted the probability of students' persisting successfully in engineering versus other enrollment status outcomes. The usefulness of the models for academic advising is addressed. The survey questionnaire and a freshman engineer data collection form are appended. (SW)

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IDENTIFICATION OF PREDICTORS OF PERSISTENCE AND SUCCESS IN BACCALAUREATE ENGINEERING: IMPLICATIONS FOR ACADEMIC ADVISING

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INTRODUCTION

Original studies attempting to predict college grades of engineering students date back to early in the 20th Century (Mann, 1918; Stoddard and Hammond, 1923). These attempts led to the development of a testing movement in engineering and the design of tests for the selection of engineering students. In conjunction with the development of such tests as the Engineering and Physical Science Test (EPST) at The Pennsylvania State College, Sackett (1940) recognized the need for "better counseling," as part of the selection process for students considering engineering. More recently, Wankat (1986) has pointed out the need to improve the academic advising of engineering students.

While the use of massive test batteries measuring a wide range of intellective variables has declined over the years, there has been a recent recognition of the importance of non-intellictive factors related to success in engineering programs of study (LeBold, 1958). Early attempts to examine non-intellective variables relied on existing psychometric instruments; for example, Elton and Rose (1967) utilized the Omnibus Personality Inventory while Elkins and Luetkemeyer (1974) employed the California Psychological Inventory and the Holland Vocational Preference Inventory as measures of non-intellective variables. Similarly, Taylor and Hanson (1972) utilized the Strong Vocational Interest Blank for this purpose.

The present study differs in a number of basic ways from previous studies. In the area of academic performance, not only general performance but also performance in specific courses considered vital for success in engineering, was studied. In regard to persistence in engineering, not only persistence but also successful persistence was

studied along with unsuccessful persistence and successful non-persistence in engineering. In contrast with studies which have utilized general psychometric instruments, assessments of non-intellective variables were obtained through student responses on specially designed self-report inventories and through interviews conducted by trained professional advisers.

STATEMENT OF THE PROBLEM

When the educational plans of college students are unduly influenced by non-personal external factors, the risk of inappropriate planning is increased significantly. This situation frequently exists with many students who choose baccalaureate engineering programs of study. Based mainly on excellent employment opportunities, enrollments in these programs have increased by approximately 70% in the last decade (Ellis, 1985). As a consequence of this increase, a disproportionate number of students are selecting baccalaureate engineering programs for inappropriate reasons. Often these choices are based solely on extrinsic reasons such as employment opportunities, monetary rewards and status. Such motives by themselves are not likely to support persistence and success in baccalaureate engineering programs. Often such motives are coupled with a lack of adequate ability and genuine interest in mathematics and science, as well as a misconception of the engineering curriculum and the world of work of engineers (Dickason, 1969; Springob, 1974).

Currently there is a national attrition rate of approximately 50% for college students pursuing engineering majors (Hayden and Holloway,

1985). Much of this attrition may be attributed to inappropriate educational planning. For the students involved in this attrition, there is a costly and time consuming consequence which is often accompanied by emotional stress both for students and their families. In addition, this high attrition rate contributes significantly to the overall retention concerns of the institutions involved.

Current educational practices related to this problem, especially counseling and advising at the secondary and post secondary levels, are both inappropriate and inadequate. They are inappropriate because they do not address many of the characteristics of individual students which relate to persistence and success in their intended educational fields. They are inadequate because information on many of the individual student variables that predict both persistence and success in engineering is not available for academic advising purposes.

Consequently, advising focuses on course requirements for specific majors with little attention given to the individual student's interests, abilities, and appropriateness of educational plans. Thus, the present approach to academic advising is not student-centered.

Although this is a national issue, very few studies have been conducted which address a wide range of both intellective and non-intellective variables related to both persistence and success in engineering. As Hayden and Holloway (1985) pointed out, research has not provided guidelines for the identification of students at risk for attrition. Most research has focused on a limited number of intellective variables as they relate to academic performance. However, Durio, et. al. (1980) recognized that it was more difficult to predict persistence than to predict academic performance, and suggested that a variety

of non-intellective variables be studied in addition to intellective ones as predictors of both persistence and academic performance. Although some researchers have examined a variety of non-intellective variables (Beronja and Bee, 1986; Foster, 1976; Lent, et. al, 1986; Marks, 1970; Taylor and Whetstone, 1983, Wyckoff, 1982), no studies of a comprehensive nature have been conducted examining a broad range of both intellective and non-intellective variables.

The identification of predictors of persistence and success in engineering programs of study has important implications for counseling and advising (LeBold, 1958). Such predictors can become significant advising tools which can be used to actively involve students in the advising process (Hayden and Holloway, 1985). Thus, students can be assisted in accurately assessing their personal interests and abilities with respect to the likelihood of their persisting and being successful in engineering programs of study. Such applications of predictor information in the advising process is basically consistent with the "identify and consult model" (Hayden and Holloway, 1985), which assists students in an early evaluation of their choice of engineering with the identification of specific areas of risk for success in engineering programs of study.

An explicit assumption is being made in conjunction with this study concerning the usefulness of predictor information in academic advising, i.e. students are more likely to function well academically and make sound educational decisions when they clearly understand which of their interests and abilities pose possible risks with respect to success and persistence in their chosen field of study. By being well informed, students will be better able to choose early in their educational careers, those curricular paths appropriate to their interests and abilities.

PURPOSE

The purpose of this study was to develop predictive models of persistence and success in baccalaureate engineering programs of study by analyzing five intellective and nine non-intellective variables in relation to these criteria.

The long-term outcome can contribute significantly to the improvement of academic advising for students considering engineering majors and thus can improve student retention.

METHOD

Data Source

The 1984 entering freshman class in the College of Engineering at the Pennsylvania State University served as the population for this study. From a total class of 1605, data was obtained on 1220 students. Because of unuseable data the final sample size was 1044, representing 65% of the population.

Data Collection

The Freshman Testing Counseling and Advising Program (FTCAP) is provided for all entering freshman at the Pennsylvania State University. This Program has two stages, one day each; 1) testing and 2) counseling and advising. These two stages, plus undergraduate admissions office records and transcript information after one year of enrollment, provided the data for this study. Table 1 lists the dependent and independent variables, a description of the variables, their measurement levels and the data source for each variable.

There were four sources of data for the study.

1. Admissions Records: SAT Scores (SATM, SATV) High School Grade Point Averages (HSGPA), and Gender (GEN) were obtained from admissions records. For purposes of admission, high school grade point averages are based upon grades in academic courses only and are converted to a 0.0 to 4.0 scale.

2. Freshman Testing Counseling and Advising Program - Testing Phase: Both intellective and non-intellective data were obtained through this phase of the program. Intellective data were in the form of selective placement scores on a battery of tests, including Algebra (ALG) and Chemistry (CHEM-S) administered to all freshman admitted to the University. The Mathematics Test (algebra) was developed by the Mathematics Association of America, the Chemistry Test was developed by the University's Chemistry Department. The results of these tests, which measure mathematics and science achievement, determine beginning level course work in mathematics and chemistry.

In addition to the placement examinations, all freshman are required to complete a comprehensive Educational Planning Survey. The survey requests that students provide detailed information regarding high school academic experiences, expectations and concerns about college, educational and occupational plans, and reasons for attending college. This information, which is used in the Counseling and Advising phase of the program, provided some of the non-intellective data. This included expected number of College Study Hours (ST), and Non-Science Points (NSPTS) which is a measure of a student's consistency of major choice as measured by the student's assignment of points (out of 100) to non-science versus science majors. A copy of The Educational Planning Survey is in Appendix 1.

3. Freshman Testing Counseling and Advising Program - Counseling and Advising Phase: This phase, which constitutes the first stage of academic advising for all freshmen, provides each student an individualized academic advising interview with a professional academic adviser. The purpose of the interview is to assist new freshmen in evaluating their educational plans by relating their personal characteristics such as abilities, academic preparation and interests to their intended program of study.

Selected academic advisers were trained to conduct the interviews in order to obtain data on the following student non-intellective variables: Attitudes Towards High School Mathematics, Physics and Chemistry (MATH, PHYS, CHEM); Reason for Engineering Choice (REAS); Certainty regarding their intended major (CERT); and Knowledge of their intended major (KNOW). The measurement levels of each variable are listed in Table 1. The interview data collection form and the adviser training manual are in Appendix 2.

4. Transcripts and Registration Information: Data on the dependent variables, Cumulative Grade Point Average after one year (CGPA), Engineering Grade Point Average after one year (EGPA), and Enrollment Status after one year (STATUS) were obtained from student transcripts and registration (class schedules) information. Table 1 lists the measurement levels for these variables.

Description of the Sample

Frequency distributions were obtained for all dependent and independent variables. Tables 2-17 provide these distributions along with means and standard deviations for the continuous variables.

TABLE 1: DESCRIPTIONS OF VARIABLES

VARIABLE NAMES	VARIABLE DESCRIPTION	MEASUREMENT LEVEL	SOURCE OF DATA
Dependent Variables			
Cumulative Grade Point Average (CGPA)	overall grade point average after one year	continuous variable (0.00 to 4.00)	student transcripts
Engineering Grade Point Average (EGPA)	grade point average in required mathematics, physics, and chemistry courses after one year	continuous variable (0.00 to 4.00)	student transcripts
Enrollment Status (STATUS)	enrollment status after one year	1: continuing in baccalaureate engineering - successful 2: continuing in baccalaureate engineering - other 3: continuing in baccalaureate non-engineering - successful 4: continuing in baccalaureate non-engineering - other 5: non-continuing	student transcripts and registration data

TABLE 1: DESCRIPTION OF VARIABLES

VARIABLE NAMES	VARIABLE DESCRIPTION	MEASUREMENT LEVEL	SOURCE OF DATA
Independent Variables - Intellective			
High School Grade Point Average (HSGPA)	converted grade point average based on high school academic courses only	continuous variable (0.00 to 4.00)	admission records
Scholastic Aptitude Test Score Mathematics (SATM)		continuous variable (200 to 800)	admission records
Scholastic Aptitude Test Score Verbal (SATV)		continuous variable (200 to 800)	admission records
Algebra Score (ALG)	subscore of University's mathematics placement test	continuous variable (0 to 32)	FTCAP - testing phase
Chemistry Score (CHEM-S)	score on University's chemistry placement test	continuous variable (0 to 20)	FTCAP - testing phase

TABLE 1: DESCRIPTION OF VARIABLES

VARIABLE NAMES	VARIABLE DESCRIPTION	MEASUREMENT LEVEL	SOURCE OF DATA
Independent Variables Non-Intellective			
Gender (GEN)		• male • female	admission records
Attitude Towards High School Mathematics (MATH)	students' reactions to high school mathematics	. like . indifferent/dislike	FTCAP - counseling and advising phase
Attitude Towards High School Physics (PHYS)	students' reactions to high school physics	. like . indifferent/dislike	FTCAP - counseling and advising phase
Attitude Towards High School Chemistry (CHEM)	students' reactions to high school chemistry	. like . indifferent/dislike	FTCAP - counseling and advising phase
College Study Hours (ST)	anticipated college study hours per week	continuous variable (0 to 60)	FTCAP - testing phase
Non-science Points (NSPTS)	consistency of major choices	continuous variable (0 to 100)	FTCAP - testing phase
Reason for Engineering Choice (REAS)	intrinsic (genuine) vs extrinsic (superficial) reasons	. genuine . superficial	FTCAP - counseling and advising phase
Certainty (CERT)	expressed certainty regarding intended major	. very certain . about 50/50 . slightly uncertain . uncertain	FTCAP - counseling and advising phase

TABLE 2 - DISTRIBUTION OF GENDER (GEN) BY ENROLLMENT STATUS

GENDER	CONTINUING BACCALAUREATE ENGINEERING SUCCESSFUL	CONTINUING BACCALAUREATE ENGINEERING OTHER	CONTINUING BACCALAUREATE NON-ENGINEERING SUCCESSFUL	CONTINUING BACCALAUREATE NON-ENGINEERING OTHER	NON-CONTINUING BACCALAUREATE	TOTAL N	TOTAL %
FEMALE	77	30	39	9	21	176	16.86
MALE	439	203	114	20	92	868	83.14
TOTAL	516	233	153	29	113	1044	100.00

TABLE 3 - DISTRIBUTION OF HIGH SCHOOL GRADE POINT AVERAGE (HSGPA) BY ENROLLMENT STATUS

HSGPA	CONTINUING BACCALAUREATE ENGINEERING SUCCESSFUL	CONTINUING BACCALAUREATE ENGINEERING OTHER	CONTINUING BACCALAUREATE NON-ENGINEERING SUCCESSFUL	CONTINUING BACCALAUREATE NON-ENGINEERING OTHER	NON-CONTINUING BACCALAUREATE	TOTAL N	TOTAL %
0.00 - 1.99	0	0	0	0	0	0	0
2:00 - 2.49	3	7	1	3	2	16	1.53
2:50 - 2.99	57	53	22	5	24	161	15.42
3.00 - 3.49	176	112	55	11	61	415	39.75
3.50 - 4.00	280	61	75	10	26	452	43.30
Totals	516	233	153	29	113	1044	100
$\bar{X}$	3.48	3.23	3.51	3.22	3.25	3.38	
S.D.	0.38	0.40	0.39	0.48	0.37	0.40	

TABLE 4 - DISTRIBUTION OF SCHOLASTIC APTITUDE TEST SCORES-MATHEMATICS (SATM) BY ENROLLMENT STATUS

SATM	CONTINUING BACCALAUREATE ENGINEERING SUCCESSFUL	CONTINUING BACCALAUREATE ENGINEERING OTHER	CONTINUING BACCALAUREATE NON-ENGINEERING SUCCESSFUL	CONTINUING BACCALAUREATE NON-ENGINEERING OTHER	NON-CONTINUING BACCALAUREATE	TOTAL N	TOTAL %
200 - 299	0	0	0	0	0	0	0.00
300 - 399	0	0	1	0	4	5	0.48
400 - 499	31	24	17	2	22	96	9.20
500 - 599	157	95	60	14	52	378	36.21
600 - 699	235	88	62	13	33	431	41.26
700 - 800	92	26	13	0	2	133	12.74
Totals	515	233	153	29	113	1043	99.91
$\bar{X}$	618.23	591.86	591.00	577.62	556.20	600.50	
S.D.	73.80	75.47	76.59	63.53	74.19	76.96	

TABLE 5 - DISTRIBUTION OF SCHOLASTIC APTITUDE TEST SCORES-VERBAL (SATV) BY ENROLLMENT STATUS

SATV	CONTINUING BACCALAUREATE ENGINEERING SUCCESSFUL	CONTINUING BACCALAUREATE ENGINEERING OTHER	CONTINUING BACCALAUREATE NON-ENGINEERING SUCCESSFUL	CONTINUING BACCALAUREATE NON-ENGINEERING OTHER	NON-CONTINUING BACCALAUREATE	TOTAL N	TOTAL %
200 - 299	5	2	0	0	0	7	0.67
300 - 399	44	16	12	1	19	92	8.81
400 - 499	187	95	52	10	49	393	37.64
500 - 599	200	101	56	13	36	406	38.89
600 - 699	71	19	31	5	9	135	12.93
700 - 799	8	0	2	0	0	10	0.96
Totals	515	233	153	29	113	1044	100.00
$\bar{X}$	505:03	493.10	517.14	517.28	483.81	502.18	
S:D:	87:10	77.76	90.13	71.85	80.95	84.94	

TABLE 6 - DISTRIBUTION OF ALGEBRA SCORES (ALG) BY ENROLLMENT STATUS

ALG	CONTINUING BACCALAUREATE ENGINEERING SUCCESSFUL	CONTINUING BACCALAUREATE ENGINEERING OTHER	CONTINUING BACCALAUREATE NON-ENGINEERING SUCCESSFUL	CONTINUING BACCALAUREATE NON-ENGINEERING OTHER	NON-CONTINUING BACCALAUREATE	TOTAL N	TOTAL %
0 - 5	0	0	0	0	0	0	0.00
6 - 10	2	2	4	0	13	21	2.02
11 - 15	25	35	15	2	22	99	9.48
16 - 20	71	52	35	13	24	195	18.68
21 - 25	172	87	57	10	37	363	34.77
26 - 30	219	49	36	4	17	325	31.13
30 - 32	26	8	6	0	0	40	3.83
Totals	515	233	153	29	113	1043	99.91
$\bar{X}$	24:46	21:67	21.95	20.72	19.24	22.80	
S:D:	4:59	5:12	5.21	3.99	5.99	5.26	

TABLE 7 - DISTRIBUTION OF CHEMISTRY SCORES (CHEM-S) BY ENROLLMENT STATUS

CHEM-S	CONTINUING BACCALAUREATE ENGINEERING SUCCESSFUL	CONTINUING BACCALAUREATE ENGINEERING OTHER	CONTINUING BACCALAUREATE NON-ENGINEERING SUCCESSFUL	CONTINUING BACCALAUREATE NON-ENGINEERING OTHER	NON-CONTINUING BACCALAUREATE	TOTAL N	TOTAL %
0	0	1	1	0	1	3	0.29
1 - 5	25	24	17	2	23	91	8.72
6 - 10	156	102	61	20	52	391	37.45
11 - 15	211	77	55	7	28	378	36.21
16 - 20	117	27	19	0	7	170	16.28
Totals	509	231	153	29	111	1033	98.95
$\bar{X}$	12:10	10:27	10.25	9.03	8.59	10.94	
S:D:	3:88	4.07	4:35	2.67	4.22	4.18	

TABLE 8 - DISTRIBUTION OF ATTITUDES TOWARO HIGH SCHOOL MATHEMATICS (MATH) BY ENROLLMENT STATUS

MATH	CONTINUING BACCALAUREATE ENGINEERING SUCCESSFUL	CONTINUING BACCALAUREATE ENGINEERING OTHER	CONTINUING BACCALAUREATE NON-ENGINEERING SUCCESSFUL	CONTINUING BACCALAUREATE NON-ENGINEERING OTHER	NON-CONTINUING BACCALAUREATE	TOTAL N	TOTAL %
LIKE	487	216	129	28	97	957	91.67
INDIFFERENT/ DISLIKE	27	15	23	1	15	81	7.76
TOTALS	514	231	152	29	112	1038	99.43

TABLE 9 - DISTRIBUTION OF ATTITUDES TOWARD HIGH SCHOOL PHYSICS (PHYS) BY ENROLLMENT STATUS

PHYS	CONTINUING BACCALAUREATE ENGINEERING SUCCESSFUL	CONTINUING BACCALAUREATE ENGINEERING OTHER	CONTINUING BACCALAUREATE NON-ENGINEERING SUCCESSFUL	CONTINUING BACCALAUREATE NON-ENGINEERING OTHER	NON-CONTINUING BACCALAUREATE	TOTAL N	TOTAL %
LIKE	449	183	111	25	91	859	82.28
INDIFFERENT/ DISLIKE	66	48	42	4	21	181	17.34
TOTALS	515	231	153	29	112	1040	99.62

TABLE 10 - DISTRIBUTION OF ATTITUDES TOWARD HIGH SCHOOL CHEMISTRY (CHEM) BY ENROLLMENT STATUS

CHEM	CONTINUING BACCALAUREATE ENGINEERING SUCCESSFUL	CONTINUING BACCALAUREATE ENGINEERING OTHER	CONTINUING BACCALAUREATE NON-ENGINEERING SUCCESSFUL	CONTINUING BACCALAUREATE NON-ENGINEERING OTHER	NON-CONTINUING BACCALAUREATE	TOTAL N	TOTAL %
LIKE	384	144	104	20	74	726	69.54
INDIFFERENT/ DISLIKE	131	85	49	9	38	312	29.89
TOTALS	515	229	153	29	112	1038	99.43

TABLE 11 - DISTRIBUTION OF ANTICIPATED COLLEGE STUDY HOURS PER WEEK (ST) BY ENROLLMENT STATUS

ST	CONTINUING BACCALAUREATE ENGINEERING SUCCESSFUL	CONTINUING BACCALAUREATE ENGINEERING OTHER	CONTINUING BACCALAUREATE NON-ENGINEERING SUCCESSFUL	CONTINUING BACCALAUREATE NON-ENGINEERING OTHER	NON-CONTINUING BACCALAUREATE	TOTAL N	TOTAL %
0 - 10	74	35	16	2	23	150	14.37
11 - 20	237	116	80	18	48	499	47.79
21 - 30	141	62	42	8	31	284	27.20
31 - 40	41	16	8	0	8	73	6.99
41 - 50	8	0	1	0	0	9	.86
51 - 60	1	0	1	0	0	2	.19
Totals	502	229	148	28	110	1017	97.40
$\bar{X}$	20.54	19.39	19.95	19.07	18.97	19.99	
S.D.	9.02	7.85	8.60	6.95	8.29	8.58	

TABLE 12 - DISTRIBUTION OF POINTS ASSIGNED TO NONSCIENCE MAJORS (NSPTS) BY ENROLLMENT STATUS

NSPTS	CONTINUING BACCALAUREATE ENGINEERING SUCCESSFUL	CONTINUING BACCALAUREATE ENGINEERING OTHER	CONTINUING BACCALAUREATE NON-ENGINEERING SUCCESSFUL	CONTINUING BACCALAUREATE NON-ENGINEERING OTHER	NON-CONTINUING BACCALAUREATE	TOTAL N	TOTAL %
0	394	158	87	11	73	793	77.96
1 - 10	23	13	10	3	10	59	5.65
11 - 20	24	9	12	2	6	53	5.08
21 - 30	17	8	11	3	4	43	4.12
31 - 40	9	5	9	4	1	28	2.68
41 - 50	3	6	6	0	2	17	1.63
51 - 60	1	2	3	1	2	9	0.86
61 - 70	2	0	0	0	0	2	0.19
71 - 80	0	0	2	0	0	2	0.19
81 - 90	0	0	0	0	0	0	0.00
91 - 100	1	2	1	1	2	7	0.67
Totals	474	203	141	25	100	943	90.33
$\bar{X}$	3:95	6:34	11:97	17.36	7.43	6.39	
S:D.	11:02	15:79	19:51	24.24	18.26	15.23	

TABLE 13 - DISTRIBUTION OF REASON FOR ENGINEERING CHOICE (REAS) BY ENROLLMENT STATUS

REAS	CONTINUING BACCALAUREATE ENGINEERING SUCCESSFUL	CONTINUING BACCALAUREATE ENGINEERING OTHER	CONTINUING BACCALAUREATE NON-ENGINEERING SUCCESSFUL	CONTINUING BACCALAUREATE NON-ENGINEERING OTHER	NON-CONTINUING BACCALAUREATE	TOTAL N	TOTAL %
GENUINE	417	166	99	20	77	779	74.62
SUPERFICIAL	81	54	43	6	30	214	20.50
TOTALS	498	220	142	26	107	993	95.12

TABLE 14 - DISTRIBUTION OF EXPRESSED CERTAINTY REGARDING INTENDED MAJOR (CERT) BY ENROLLMENT STATUS

CERT	CONTINUING BACCALAUREATE ENGINEERING SUCCESSFUL	CONTINUING BACCALAUREATE ENGINEERING OTHER	CONTINUING BACCALAUREATE NON-ENGINEERING SUCCESSFUL	CONTINUING BACCALAUREATE NON-ENGINEERING OTHER	NON-CONTINUING BACCALAUREATE	TOTAL	
						N	%
VERY CERTAIN	339	144	76	14	69	642	61.49
FIFTY/FIFTY	107	52	54	10	30	253	24.23
VERY UNCERTAIN	64	34	22	4	12	136	13.03
TOTALS	510	230	152	28	111	1031	98.75

TABLE 15 - DISTRIBUTION OF KNOWLEDGE OF INTENDED MAJOR (KNOW) BY ENROLLMENT STATUS

KNOW	CONTINUING BACCALAUREATE ENGINEERING SUCCESSFUL	CONTINUING BACCALAUREATE ENGINEERING OTHER	CONTINUING BACCALAUREATE NON-ENGINEERING SUCCESSFUL	CONTINUING BACCALAUREATE NON-ENGINEERING OTHER	NON-CONTINUING BACCALAUREATE	TOTAL N	TOTAL %
ACCURATE KNOWLEDGE	382	162	98	20	75	737	70.59
INACCURATE KNOWLEDGE	122	68	52	9	34	285	27.30
TOTALS	504	230	150	29	109	1022	97.89

TABLE 16 - DISTRIBUTION OF CUMULATIVE GRADE POINT AVERAGE (CGPA) BY ENROLLMENT STATUS

CGPA	CONTINUING BACCALAUREATE ENGINEERING SUCCESSFUL	CONTINUING BACCALAUREATE ENGINEERING OTHER	CONTINUING BACCALAUREATE NON-ENGINEERING SUCCESSFUL	CONTINUING BACCALAUREATE NON-ENGINEERING OTHER	NON-CONTINUING BACCALAUREATE	TOTAL N	TOTAL %
0:00 - 1:99	0	60	0	27	24	111	10:63
2:00 - 2:49	0	116	51	0	25	192	18.39
2:50-2.99	192	34	51	0	11	288	27.59
3.00 - 3:49	191	14	38	0	19	262	25.10
3:50 - 4:00	133	6	13	0	4	150	14.94
TOTALS	516	230	153	27	83	1009	96.65
$\bar{X}$	3:19	2.24	2:78	1.63	2.36	2.80	
S:D:	0:41	0:60	0.48	0.30	0.80	0.68	

TABLE 17 - DISTRIBUTION OF ENGINEERING GRADE POINT AVERAGE (EGPA) BY ENROLLMENT STATUS

EGPA	CONTINUING BACCALAUREATE ENGINEERING SUCCESSFUL	CONTINUING BACCALAUREATE ENGINEERING OTHER	CONTINUING BACCALAUREATE NON-ENGINEERING SUCCESSFUL	CONTINUING BACCALAUREATE NON-ENGINEERING OTHER	NON-CONTINUING BACCALAUREATE	TOTAL N	TOTAL %
0.00 - 1.99	0	138	64	28	73	303	29.02
2.00 - 2.49	108	57	46	1	20	232	22.22
2.50-2.99	103	14	20	0	7	144	13.79
3.00 - 3.49	154	12	14	0	7	187	17.92
3.50 - 4.00	151	12	9	0	6	178	17.05
TOTALS	516	233	153	29	113	1044	100.00
$\bar{X}$	3.09	1.86	2.02	0.96	1.32	2.41	
S.D.	0.59	0.83	0.90	0.56	1.19	1.05	

Statistical Analyses

As listed in Table 1, Cumulative Grade Point Average (CGPA), Engineering Grade Point Average (EGPA) and Enrollment Status (STATUS) were the dependent variables. The fourteen intellective and non-intellective independent variables are also listed in Table 1.

For purposes of analysis, "persistence and success" in engineering was defined as students who, after one year of study, were continuing in the College of Engineering, had at least "C" grades in at least three out of four engineering foundation courses (Calculus I, Calculus II, Physics I, Chemistry I), and had EGPA's of at least 2.00 and CGPA's of at least 2.50. (These criteria essentially reflected the standards used by the College of Engineering to admit students into majors.) Table 18 lists the criteria used to define all enrollment statuses, and Table 19 lists the frequency distribution of the enrollment statuses.

A variety of analyses were conducted using the general linear model. Both continuous dependent variables CGPA and EGPA were assumed to be estimated as a linear combination of fourteen main effects; five intellective variables (HSGPA, SATM, SATV, ALG, CHEM-S) and nine non-intellective variables (GEN, MATH, PHYS, CHEM, ST, NSPTS, REAS, CERT, KNOW). The categorical variables of GEN, MATH, PHYS, CHEM, REAS, CERT, KNOW and the continuous variable ST (nonscience points = 0, nonscience points ≠ 0) were converted to dummy variables (0 or 1) for the analyses.

Separate regression models for CGPA and EGPA were built using the Stepwise Regression Procedure R^2 Technique (SAS, 1985). The best model was defined as that which minimized the error mean square for the model. The significance level was set at P = .10.

TABLE 18: DEFINITION OF ENROLLMENT STATUSES

STATUS	COLLEGE		EGPA		CGPA
Persisting in Baccalaureate Engineering - Successful	Engineering	and	$\geq$ 2.00 and grades $\geq$ "C" in 3 our of 4 engineering foundation courses	and	$\geq$ 2.50
Persisting in Baccalaureate Engineering - Unsuccessful	Engineering	and	< 2.00 or grades $\geq$ "C" in less than 3 out of 4 engineering foundation courses	or	< 2.50
Persisting in Baccalaureate Non-Engineering - Successful	Out of Engineering			and	$\geq$ 2.00
Persisting in Baccalaureate Non-Engineering - Other	Out of Engineering				
Non-Persisting Baccalaureate	Associate Degree, Dropped, Withdrew				

TABLE 19: DISTRIBUTION OF ENROLLMENT STATUS AFTER ONE YEAR (STATUS)

STATUS	N	%
CONTINUING IN BACCALAUREATE ENGINEERING - SUCCESSFUL	516	49.43
CONTINUING IN BACCALAUREATE ENGINEERING - OTHER	233	22:32
CONTINUING BACCALAUREATE NON-ENGINEERING - SUCCESSFUL	153	14.66
CONTINUING BACCALAUREATE NON-ENGINEERING - OTHER	29	2.78
NON CONTINUING - BACCALAUREATE (Enrolled ASSOC, Dropped, Withdrew)	113	10.81
	1044	100.00

The discrete dependent variable STATUS was analyzed in terms of logit models. The log odds of two status ratios of 1) PERSISTING IN BACCALAUREATE ENGINEERING-SUCCESSFUL TO PERSISTING IN BACCALAUREATE NON-ENGINEERING-SUCCESSFUL, and 2) PERSISTING IN BACCALAUREATE ENGINEERING-SUCCESSFUL TO ALL OTHER ENROLLMENT STATUSES were assumed to be estimated as a linear combination of the fourteen independent variables. The models were built using the CATMOD procedure with maximum-likelihood estimation (SAS, 1985). The significance level for entry into the model was set at P = .10.

FINDINGS

The best regression model (as defined by the minimum error mean square among models) for the dependent variable Cumulative Grade Point Average (CGPA) included eight of the fourteen independent variables (Table 20). There were six significant predictor variables. These variables were (listed in order from largest to smallest contribution to total R^2): 1) High School Grade Point Average (HSGPA), 2) Scholastic Aptitude Test Score Mathematics (SATM), 3) GENDER (GEN-M), 4) College Study Hours (ST), 5) Algebra Score (ALG), and 6) Chemistry Score (CHEM-S). The total R^2 for the six variable models was 0.217.

The best regression model (as defined by the minimum error mean square among all models) for the dependent variable Engineering Grade Point Average (EGPA) included eleven of the fourteen independent variables (Table 21). There were eight significant predictor variables. These variables were (listed in order from largest to smallest contribution to total R^2): 1) Algebra Score (ALG), 2) High School Grade Point Average (HSGPA), 3) Scholastic Aptitude Test Score

Mathematics (SATM), 4) Gender-Male (GEN-MALE), 5) College Study Hours (ST), 6) Non-science Points-None (NSPTS-NONE), 7) Chemistry Score (CHEM-S) and 8) Reason for Engineering Choice Genuine (REAS-GENUINE). The total R^2 for the ten variable model was 0.280.

The logistic regression model that best predicted the log odds of the status ratio of students PERSISTING IN BACCALAUREATE ENGINEERING-SUCCESSFUL to ALL OTHER ENROLLMENT STATUSES included seven of the fourteen independent variables (Table 22). All seven predictor variables were significant. These variables were (listed in order from largest to smallest contribution to the total chi-square): 1) Algebra Score (ALG), 2) High School Grade Point Average (HSGPA), 3) Non-Science Points (NSPTS), 4) Chemistry Score (CHEM-S), 5) Reason for Engineering Choice (REAS), 6) Scholastic Aptitude Test Score Verbal (SATV), and 7) Gender (GEN).

The logistic regression model that best predicted the log odds of the status ratio of students PERSISTING IN BACCALAUREATE ENGINEERING-SUCCESSFUL to PERSISTING IN BACCALAUREATE NON-ENGINEERING-SUCCESSFUL included seven of the fourteen independent variables (Table 23). All seven predictor variables were significant. These variables were (listed in order from largest to smallest contribution to the total chi-square): 1) Non-Science Points (NSPTS), 2) Algebra Score (ALG), 3) Gender (GEN), 4) Chemistry Score (CHEM-S), 5) Attitude Towards High School Physics (PHYS), 6) Scholastic Aptitude Test Score Verbal (SATV) and 7) Certainty (CERT).

TABLE 20: STEPWISE REGRESSION FOR DEPENDENT VARIABLE
CUMULATIVE GRADE POINT AVERAGE (CGPA)

EFFECT	B VALUE	F	PROB F	R^2 IMPROVEMENT	R^2 TOTAL
INTERCEPT	-0.376				
HSGPA	0.551	112.98	0.0001***	0.147	0.147
SATM	0.001	15.02	0.0001***	0.038	0.185
ALG	0.013	9.99	0.0016***	0.008	0.193
CHEM-S	0.004	3.87	0.0495**	0.003	0.196
GEN-MALE	0.180	11.56	0.0007***	0.009	0.205
MATH-LIKE	-0.089	1.56	0.2124	0.001	0.206
CHEM-LIKE	0.066	2.43	0.1193	0.002	0.208
ST	0.008	13.33	0.0003***	0.009	0.217

* $P \leq .10$

** $P \leq .05$

*** $P \leq .01$

TABLE 21: STEPWISE REGRESSION FOR DEPENDENT VARIABLE
ENGINEERING GRADE POINT AVERAGE (EGPA)

EFFECT	B VALUE	F	PROB F	R^2 IMPROVEMENT	R^2 TOTAL
INTERCEPT	-2.274				
HSGPA	0.592	60.30	0.0001***	0.043	0.043
SATM	0.002	22.29	0.0001***	0.019	0.062
ALG	0.044	51.91	0.0001***	0.174	0.236
SATV	-0.001	2.11	0.1462	0.002	0.238
CHEM-S	0.008	7.36	0.0068***	0.005	0.243
GEN-MALE	0.315	15.89	0.0001***	0.013	0.256
MATH-LIKE	0.135	1.60	0.2069	0.001	0.257
ST	0.011	11.59	0.0007***	0.010	0.267
NSPTS-NONE	0.169	7.38	0.0067***	0.009	0.276
REAS-GENUINE	0.119	3.11	0.0780*	0.003	0.279
CERT-FIFTY/FIFTY	-0.071	1.13	0.2880	0.001	0.280

* $P \leq .10$

** $P \leq .05$

*** $P \leq .01$

TABLE 22: LOGISTIC REGRESSION FOR PERSISTING IN BACCALAUREATE ENGINEERING-SUCCESSFUL VS. ALL OTHER ENROLLMENT STATUSES

EFFECT	DF	ESTIMATE	CHI-SQUARE	PROB
INTERCEPT	1	-3.823	20.70	0.0001***
NSPTS	1	-0.018	10.27	0.0014***
SATV	1	-0.002	5.70	0.0170**
HSGPA	1	0.687	10.65	0.0011***
ALG	1	0.829	20.83	0.0001***
CHEM-S	1	0.689	9.39	0.0022***
AREAS-GENUINE	1	0.279	8.41	0.0037**
-SUPERFICIAL		-0.279		
GEN-MALE	1	0.199	3.55	0.0596*
-FEMALE		-0.199		

* $P \leq .10$

** $P \leq .05$

*** $P \leq .01$

TABLE 23: LOGISTIC REGRESSION FOR PERSISTING IN BACCALAUREATE ENGINEERING-SUCCESSFUL VS. PERSISTING IN BACCALAUREATE NON-ENGINEERING SUCCESSFUL

EFFECT	DF	ESTIMATE	CHI-SQUARE	PROB
INTERCEPT	1	-0.580	0.57	0.4496
NSPTS	1	-0.033	18.76	0.0001***
SATV	1	-0.003	5.73	0.0166**
ALG	1	0.094	14.72	0.0001***
CHEM-S	1	0.084	7.45	0.0063***
PHYS-LIKE	1	0.328	6.15	0.0131**
-DISLIKE/INDIFFERENT		-0.328		
CERT-COMPLETELY CERTAIN/ SLIGHTLY UNCERTAIN	2	0.334	4.95	0.0261**
-FIFTY/FIFTY		-0.325	3.74	0.0531*
-VERY UNCERTAIN		-0.009		
GEN-MALE	1	0.366	8.07	0.0045***
-FEMALE		-0.366		

* $P \leq .10$

** $P \leq .05$

*** $P \leq .01$

DISCUSSION

The findings of this study allowed for the development of four predictive models. These models employed both intellective and non-intellective variables which defined students' abilities, motives and interests as independent predictor variables. Two of the models predicted academic achievement. The first predicted a student's Cumulative Grade Point Average, while the second predicted an Engineering Grade Point Average which isolated specific engineering foundation courses in mathematics, physics and chemistry. The other two models predicted the probability of students' persisting successfully in engineering versus other enrollment status outcomes. These models incorporated both academic achievement and enrollment status, and can be viewed as a combined prediction of a student's persistence and success in engineering.

Most of the findings revealed in Table 20 are quite common, and are consistent with other studies that have attempted to predict overall academic performance in science-oriented programs of study. Four of the six predictor variables were intellective in nature. As has been found in previous studies, high school grades (Durio, et. al, 1980), SAT-Math (Dickason, 1969; Durio, et. al, 1980; Elkins & Luetkemeyer, 1974; Foster, 1967; Robinson & Cooper, 1984), mathematics achievement (Durio, et. al, 1980; Wyckoff, 1982) and science achievement (Dickason, 1969) contributed most to the predictive model.

Two non-intellective variables were also found to contribute significantly. These were Anticipated Study Time and Gender. The Gender variable was noteworthy in that the Cumulative Grade Point Averages

of males were predicted to be .18 higher than females after controlling for all other variables. The determinants of this finding are unclear, but it is suggested that social factors in the general and/or academic environment(s) may be contributors to this finding. Further study in this area is suggested.

In general, the model for predicting Cumulative Grade Point Averages was the least meaningful of those developed in this study; the dependent variable included a relatively large variety of academic courses, many of which are not technical in nature.

The prediction of Engineering Grade Point Averages was more noteworthy in that there was less variability in the types of courses taken, and these courses constituted foundations which were prerequisites to future engineering study. In addition, the courses making up this dependent variable included those specifically required for entry into engineering majors.

Table 21 reveals the same intellective prediction variables as those identified with Cumulative Grade Point Average. However, in this case mathematics achievement (ALG) contributed much more to the prediction and even far outdistanced the contribution of both SATM and HSGPA. This finding was consistent with recent studies identifing measures of mathematics achievement as the best single predictor of success in engineering (Durio, et. al, 1980).

Another important finding in relation to this particular model was the significant contribution of four non-intellective variables. Once again, it was noteworthy that Gender was a contributor. In this case the Engineering Grade Point Averages for males were predicted to be .315 higher than females after controlling for all other variables. Again,

Anticipated Study Hours was a contributor. In addition, two additional non-intellective variables were identified as significant predictors.

Nonscience Points, a measure of the focus of a student's interest in science programs of study, as defined in Table 1, was a significant predictor variable . Students whose interests were completely focused on science programs of study had a predicted EGPA .169 higher than students whose interests were not as focused. This finding was consistent with Marks (1970), who found that focused interests in science were related to persistence in engineering .

Finally, if students' motives (REAS) for choosing engineering were genuine (intrinsic), .119 was added to the predicted EGPA. Similar results were also found by Beronja and Bee (1987) with respect to Cumulative Grade Point Average.

The next two models represented the essential thrust of this study, i.e. the identification of student characteristics which predicted both persistence and success in a baccalaureate engineering program of study. It is important to note that two different types of student behaviors were predicted by these models. These were successful academic performance and persistence in engineering. It was assumed that there was some degree of independence between academic success and persistence because some students who were successful academically did not persist in engineering, while other students persisted in engineering, but unsuccessfully.

The last two models allowed for statements of the odds of one definitive student outcome compared to another definitive student outcome. Thus, Table 22 provides the model for stating the odds

of a student persisting successfully in engineering after one year versus all other enrollment statuses (including persisting unsuccessfully in engineering, persisting successfully in other majors, persisting unsuccessfully in other majors, dropping and withdrawing). The model consisted of seven predictor variables, four intellective and three non-intellective. The four intellective variables in order of their chi-square contribution were Algebra (ALG), High School Average (HSGPA), Chemistry (CHEM-S), and SAT Verbal (SATV) (a slight negative relationship). The three non-intellective variables in order of their chi-square contribution were a measure of the Non-Science Points (NSPTS), the Reason for Engineering Choice (REAS), and Gender (GEN).

Table 23 provides the model for stating the odds of a student persisting successfully in engineering versus persisting successfully in a non-engineering program of study. Since this model compared two student outcomes, both of which involved successful academic performance in different baccalaureate programs of study, it can be viewed as a model that primarily predicted persistence. Most of the variables included in this model were common to the other models. The noteworthy additions were the inclusion of two new non-intellective predictor variables. These were Attitude Towards High School Physics (PHYS) and Certainty (CERT). Students who liked high school physics and/or expressed a high degree of certainty about their educational plans had higher odds of persisting successfully in engineering versus persisting successfully in non-engineering programs.

The methodology of this study enabled comparisons to be made between a wide variety of enrollment statuses. Examples of additional models are included in Appendix 3.

IMPLICATIONS

National attention has been directed towards the need for research to support academic advising (Potter, 1983). The findings of this study provide a research base that can be used to inform the practice of academic advising, especially for students considering engineering. Even though early studies acknowledged the need to improve the counseling of students considering engineering (Sackett, 1940) and even though there has been much research attempting to identify factors related to persistence or success in engineering, either the data has not lent itself well to the improvement of advising or investigators have given little attention to suggesting ways of applying the data.

The outcome models of this study are uniquely suited for advising purposes because of the following attributes: 1) predictive statements can be made for students on an individual basis because individual student characteristics are analyzed by the models; 2) students and advisers together can examine the likelihood of a variety of predictive outcomes depending on the relevancy of the outcome to the student; 3) the models provide results that are easily interpreted by advisers and understood by students.

To further elaborate on the usefulness of the models, it should be noted that the models will allow students, via the advising process, to understand the extent of risk involved in their educational plans, and to make decisions regarding risk levels that may be personally acceptable. This is possible because students will be able to identify the way their personal characteristics contribute to the predicted outcome. This allows the student to engage in an ideal educational planning process in

which "students should be encouraged to consider an early decision as tentative, a choice to be tested, confirmed or disconfirmed" (Berger, 1967, p. 888).

By isolating those personal characteristics that either reduce or increase their level of risk, students may plan appropriate actions to maximize their strengths and minimize their weaknesses. Such implications for advising were not outcomes of previous studies; e.g. the concept of "risk" typically was used only to identify groups of students as being at high or low risk with no applications to the individual student (Hayden & Holloway, 1985).

To illustrate the application of each of the four predictive models, a hypothetical student with the following characteristics will be used.

HSGPA = 3.00	ST = 20
SATM = 580	NSPT = 10
SATV = 520	PHYS = Like = L
ALG = 25	GENDER = Male = M
CHEM-S = 12	REAS = Genuine = G
	CERT = Fifty/fifty = F

The equation that predicts Cumulative GPA is derived from the significant predictor variables, as indicated in Table 20.

$$\begin{aligned} CPGA &= -.376 + .551(HSPGA) + .001(SATM) + .013(ALG) \\ &\quad + .004(CHEM\text{-}S) + .180(GEN\text{-}M) + .008(ST) \\ &= -.376 + .551(3.00) + .001(580) + .013(25) \\ &\quad + .004(12) + .180(1) + .008(20) \end{aligned}$$

Predicted CPGA = 2.57

The equation that predicts Engineering GPA is derived from the significant predictor variables, as indicated in Table 21.

$$\begin{aligned} EGPA &= -2.57 + .591(HSPGA) + .002(SATM) + .044(ALG) \\ &\quad + .008(CHEM\text{-}S) + .315(SEX\text{-}M) + .011(ST) \\ &\quad + .169(NSPTS\text{-}NONE) + .119(REAS\text{-}G) \end{aligned}$$

$$\begin{aligned} &= -2.57 + .591(3.00) + .002(580) + .044(25) \\ &\quad + .008(12) + .315(1) + .011(20) \\ &\quad + .169(0) + .119(1) \end{aligned}$$

Predicted EPGA = 2.21

The equation that predicts the Natural Log Odds of Persisting Successful Engineers vs. All Other Statuses is derived from the significant predictor variables, as indicated in Table 22.

$$\begin{aligned} \ln \frac{PSE}{AOS} &= -3.823 - .018(NSPTS) + .002(SATV) + .687(HSGPA) \\ &\quad + .083(ALG) + .069(CHEM\text{-}S) + .279(REAS\text{-}G) \\ &\quad - .279(REAS\text{-}S) + .199(GEN\text{-}M) - .199(GEN\text{-}F) \end{aligned}$$

$$\begin{aligned} &= -3.823 - .018(10) + .002(520) + .687(3.00) \\ &\quad + .083(25) + .069(12) + .279(1) - .279(0) \\ &\quad + .199(1) - .199(0) \end{aligned}$$

$$\ln \frac{PSE}{AOS} = .399$$

$$\text{Odds } \ln \frac{PSE}{AOS} = e^{.399} = 2.72^{.399} = \frac{1.5}{1}$$

Probability of Persisting Successful Engineers vs. All Other Statuses =

$$\frac{1.5}{2.5} = 60\%$$

The equation that predicts the Natural Log Odds of Persisting Successful Engineers vs. Persisting Non-Engineers is derived from the significant predictor variables, as indicated in Table 23.

$$\begin{aligned} \ln \frac{PSE}{PSNE} &= -.580 - .033(NSPTS) - .003(SATV) + .094(ALG) \\ &\quad + .084(CHEM\text{-}S) + .328(PHYS\text{-}L) - .328(PHYS\text{-}DI) \\ &\quad + .334(CERT\text{-}CS) - .325(CERT\text{-}F) - .009(CERT\text{-}V) \\ &\quad + .366(GEN\text{-}M) - .366(GEN\text{-}F) \end{aligned}$$

$$= -.580 - .033(10) - .003(520) + .094(25) + .084(12) + .328(1) - .328(0) + .334(0) - .325(1) - .009(0) + .366(1) - .366(0)$$

$$\ln\left(\frac{PSE}{PSNE}\right) = 1.257$$

$$\text{Odds } \ln\left(\frac{PSE}{AOS}\right) = e^{1.257} = 2.72^{1.257} = \frac{3.5}{1}$$

Probability of Persisting Successful Engineers vs. Persisting Successful Non-Engineers $= \frac{3.5}{4.5} = 77\%$

It is obvious that these models would be used most efficiently by developing an interactive computer program to assist in the advising process. Pilot attempts by the authors to design computer-assisted approaches for the use of the models have been initiated. It is stressed, however, that the use of these models through an interactive computer program should not be offered in isolation from the usual one-to-one advising approaches. Also, a standard caution which should be observed whenever statistical data are used in advising the individual student is that any individual case may be an exception to even the most compelling statistics. Therefore, such data should always be placed in the context of more complete personal information about the individual student (Wyckoff, 1982).

A number of suggestions are made for future work in this area. Longitudinal studies from the point of admission to graduation are needed because the predictive models are likely to change each year; original variables may contribute differently to the models over time and significant new variables may emerge.

More sophisticated measures, especially in the non-intellective areas, are likely to improve predictability. For example, preliminary

investigations by the authors using existing scales (Fennema & Sherman, 1976) that measure students' attitudes towards mathematics have been shown to differentiate students in relation to their educational plans.

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APPENDIX 1

EDUCATIONAL PLANNING SURVEY 1984

Name _____
Last First Middle

Home Address _____
Street

_____
City State Zip Code

Phone Number _____ Today's Date _____
(Include Area Code)

Social Security Number _____ Age _____ Sex _____

FRESHMAN TESTING, COUNSELING AND ADVISING PROGRAM 1984

EDUCATIONAL PLANNING SURVEY

DIVISION OF UNDERGRADUATE STUDIES

THE PENNSYLVANIA STATE UNIVERSITY

The information you are asked to provide on the following **6 pages** will enable a Division of Undergraduate Studies adviser during your counseling and advising day to discuss with you your college plans. We are asking only for information which we have found useful in assisting students in their educational planning and in developing programs to foster academic advising. It is important to answer all questions.

A. FAMILY DATA

Now living with: _____
(parents, guardians, spouse, etc.)

	Name	Educational Background (Grades completed, colleges attended, degrees held)	Occupation
Father:			
Mother:			
Spouse:			
Brothers and/or Sisters			

List any languages other than English spoken in your home.

B. HIGH SCHOOL ACADEMIC EXPERIENCES

1. How many hours *per week* (average) did you study outside of class during your last year of high school? _____ Hours

2. How did you react to these subjects in high school/ Respond to each subject area using the scale:
0 = Did not have course 1 = Liked 2 = Indifferent 3 = Disliked

_____ English	_____ Physics	_____ Social Studies	_____ Other _____ Specify
_____ Mathematics	_____ Biology	_____ Foreign Language	
_____ Chemistry	_____ History	_____ Computer Studies	

3. List any college and/or advanced placement courses taken while in high school.

College		Advanced Placement	
_____	What?	_____	What?
_____	Where?	_____	Where?
_____	When?	_____	When?

4. Have you had any schooling other than high school?
_____ YES _____ NO If, YES, _____ What?
_____ When? _____ Where?

C. HIGH SCHOOL AND OUT-OF-SCHOOL EXPERIENCES

1. List your extracurricular activities while in high school (sports, clubs, officer, etc.)

Kind of Activity	When	Degree of Satisfaction (minimal, moderate, high)

2. Excluding school reading assignments, list newspapers, magazines and books you read in the last year. _____

3. Describe your special accomplishments and interests, not just in school work, but in other activities as well (*e.g.*, hobbies, art, leadership, sports).

4. Work History: List the jobs you have held.

Job	Aspects Liked	Aspects Disliked

D. EXPECTATIONS AND CONCERNS ABOUT COLLEGE

1. Listed below are six common reasons students give for attending college Please rank these in the space at the left as they pertain to your personal goals (1 being most important).

RANK

a. _____ To be in activities, join and work for various organizations
b. _____ To meet compatible people, enjoy myself
c. _____ To pursue scholarly activities, for intellectual development
d. _____ To prepare for a vocation, learn what I need to know in order to enter a particular career
e. _____ To satisfy parents or family
f. _____ To become more mature, learn how to take on responsibility and become an adult
g. _____ To be in a place where I can be an individual, not have to conform, do what I want

2. Estimate your grade average after one year at Penn State. (check one)

_____ C
_____ C+
_____ B-
_____ B
_____ B+
_____ A-
_____ A

About how many hours *per week* do you think you will have to study outside of class to earn the grade average you estimate for your freshman year? _____ hours

4. How would you rate yourself in the following study skills areas? Please circle the appropriate number for each item.

ITEM	EXCELLENT	GOOD	AVERAGE	FAIR	POOR
a. Note taking	1	2	3	4	5
b. Organization	1	2	3	4	5
c. Preparation for quizzes & exams	1	2	3	4	5
d. Reading comprehension	1	2	3	4	5
e. Reading speed	1	2	3	4	5
f. Understanding lectures	1	2	3	4	5

5. Indicate how important it will be for you to discuss each of these topics during your individual educational counseling interview. Respond to each topic using the following scale:

1 - Extremely Important 2 Moderately Important 3 Of No Importance

_____ Choice of major	_____ Study skills	Other (please specify)
_____ Academic requirements	_____ Career plans	_____
_____ Advanced placement	_____ Social life	_____
_____ Academic ability	_____ Extracurricular activities	_____
_____ High school preparation for college	_____ Personal problems	_____

E. EDUCATIONAL AND OCCUPATIONAL PLANS

1. There are three parts to this question.

PART I

On Page 6 of this survey is a list of Penn State undergraduate majors. First, scan the entire list of majors. Then, based upon your present thinking and plans about a college career, select up to THREE (3) of the fields in which you might like to major. List these majors and their codes (Example: Accounting-E01) in order of preference on the table below.

PART II

Now determine the relative importance of each of these majors to you. To do this, take a total of 100 points and distribute parts of this total among the majors you selected so that the number of points assigned to each major reflects its importance relative to the other fields. Write this number in the space corresponding to the major under the column titled POINTS in the table below. Be sure that the total number of points assigned adds to 100.

PART III

On the table below, under the column titled REASONS FOR CHOICES, please provide an explanation for each choice of major. To answer this part you should consider: (a) the interests you have in subject matter emphasized by the majors and/or activities involved in vocations related to the major; (b) how your abilities are suited to the requirements of the majors; and (c) the expectations you have about the job opportunities to which the majors might lead.

Part I Majors	Part I Code	Part II Points	Part III Reasons
1.			
2.			
3.		Total: 100 Points	

2. What doubts, if any, do you have about your educational plans? _____

_____

_____

3. Is there any other major you might like to study, but have decided against for some reason (e.g., lack of ability or talent, ineligibility for admission)? If so, what would it be? _____

Why have you decided against it? _____

4. If it were not possible for you to go to college, what would you do instead? _____

_____

5. How certain are you of your first preference of major? (check one)

a. _____ very uncertain
b. _____ about "50-50"
c. _____ slightly uncertain
d. _____ completely certain

6. How long ago did you decide on your major field? (check one)

a. _____ have not yet decided
b. _____ in the past six months
c. _____ between six months and a year ago
d. _____ about a year ago
e. _____ two to four years ago
f. _____ more than four years ago

7. Who would you say has influenced you the most in your consideration of majors? (check one)

a. _____ father
b. _____ mother
c. _____ brother/sister
d. _____ adult acquaintance
e. _____ high school teacher
f. _____ high school counselor
g. _____ college teacher or administrator
h. _____ friend
i. _____ no one

8. How much do you think you know about the major you are considering? (check one)

a. _____ almost nothing
b. _____ only a little
c. _____ a moderate amount
d. _____ a great deal
e. _____ undecided about major; question does not apply

9. Before coming to college, how much time have you spent in activities related to the major you are considering, (e.g., attending lectures, reading books, etc.)? (check one)

a. _____ almost none
b. _____ only a little
c. _____ a moderate amount
d. _____ a great deal
e. _____ undecided about major; question does not apply

10. How does your family (parents, guardians, spouse) feel about the major you are presently considering? (check one)

a. _____ they strongly approve
b. _____ they approve
c. _____ they are neutral
d. _____ they disapprove
e. _____ they are not aware of my considerations about a major

11. Estimate the chances that before graduating you will transfer to a totally different kind of major than the one you are presently considering? (check one)

a. _____ definitely will transfer
b. _____ about 75%
c. _____ about 50%
d. _____ about 25%
e. _____ no chance of transfer

F. EXTRACURRICULAR PLANS

1. Do you plan on holding a part-time job during your freshman year?
YES _____ NO _____ If YES, approximate hours per week _____

2. List any extracurricular activities you plan to participate in. _____

_____

(Continued on Page 5)

G. REASONS FOR ATTENDING PENN STATE

Listed below are 19 reasons that students frequently give for attending Penn State. **Select up to THREE (3) which are most important to you.** Indicate how important each reason is by taking a total of 100 points and distributing parts of this total among your choices. Write the numbers to the left of your choices. Be sure that the total number of points assigned adds up to 100.

POINTS	REASON	POINTS	REASON
1 _____	Offers a large number of majors	11 _____	Wanted to attend the state university for Pennsylvania
2 _____	Brothers, sisters, or friends recommended Penn State	12 _____	Influence and encouragement of a Penn State representative
3 _____	Only school where I was accepted	13 _____	Wanted to attend an out of state school
4 _____	Reputation for research	14 _____	Outstanding reputation in my intended field of study
5 _____	Offers a great variety of social activities	15 _____	Needed the Freshman Counseling and Advising Program that Penn State provides
6 _____	Wanted to attend a large university	16 _____	Offered a major not available at other schools
7 _____	A Penn State degree is highly regarded by employers	17 _____	Teaching reputation of faculty
8 _____	Located close to home	18 _____	Accomplishments of Penn State graduates
9 _____	Has an outstanding reputation for intercollegiate sports	19 _____	Costs are lower
10 _____	Parents recommended Penn State		

Total: 100 POINTS FOR UP TO THREE REASONS

H. COMPLETE THE FOLLOWING SENTENCES.

1. In regard to success in college, my greatest assets are

2. In regard to success in college, my greatest weaknesses are

3. In regard to my educational plans, I feel

4. My parents think my educational plans are

5. As a student, I

6. For my educational planning, I will need

I. PLEASE ADD ANY INFORMATION YOU FEEL WOULD BE HELPFUL TO THE DIVISION OF UNDERGRADUATE STUDIES ~~ADVISER~~ WITH WHOM YOU WILL HAVE YOUR INDIVIDUAL EDUCATIONAL COUNSELING INTERVIEW.

Counselor

Thank you for taking the time to complete this.

THE PENNSYLVANIA STATE UNIVERSITY
COLLEGES & UNDERGRADUATE MAJORS

COLLEGE OF AGRICULTURE
BACCALAUREATE DEGREE (4-Year)
Agricultural Business Management (A06)
Agricultural Economics & Rural Sociology (A07)
Agricultural Education (A12)
Agricultural Mechanization (A14)
Agriculture Science (A15)
Agronomy (A24)
Animal Bioscience (A26)
Animal Production (A32)
Dairy Production (A47)
Entomology (A51)
Environmental Resource Management (A50)
Food Science (A52)
Forest Products (A56)
Forest Science (A55)
Horticulture (A63)
Plant Science (A70)
Poultry Technology & Management (A73)
Wildlife Science (A86)

ASSOCIATE DEGREE (2-Year)
Agricultural Business (A95)
Forest Technology (A98)
Wildlife Technology (A99)

COLLEGE OF ARTS & ARCHITECTURE
BACCALAUREATE DEGREE (4-Year)
Architecture (B10)
Art (B15)
Art Education (B17)
Art History (B25)
Film (B46)
General Arts (B48)
Landscape Architecture (B50)
Music (B60)
Music Education (B62)
Theatre Arts (B70)

BEHREND COLLEGE
BACCALAUREATE DEGREE (4-Year)
Accounting (D20)
Bioscience (D45)
Business Economics (D23)
Communications (D07)
Economics (D25)
Energy and Environmental Technology (D65)
Energy Science and Engineering (D48)
English (D10)
Environmental Science and Engineering (D49)
General Arts & Sciences (D27)
General Business (D28)
History (D12)
Management (D30)
Mathematical Studies (D52)
Physical Science (D60)
Political Science (D34)
Psychology (D38)
Science (D50)
Social & Behavioral Sciences (D39)

COLLEGE OF BUSINESS ADMINISTRATION
BACCALAUREATE DEGREE (4-Year)
Accounting (E01)
Business Logistics (E15)
Economics (E35)
Finance (E40)
Insurance (E43)
Management (E50)
Marketing (E55)
Operations Management (E57)
Quantitative Business Analysis (E58)
Real Estate (E56)

ASSOCIATE DEGREE (2-Year)
Business Administration (E70)

CAPITOL CAMPUS
Junior and Senior years of baccalaureate degree programs are offered in the following divisions:
Behavioral Science & Education (C01)
Business Administration (C02)
Humanities (C03)
Public Affairs (C04)
Science, Engineering, & Technology (C05)

DIVISION OF UNDERGRADUATE STUDIES (T01)
For students who are undecided about their program of study and/or want the opportunity to explore educational alternatives and test out their abilities before making a choice.

COLLEGE OF EARTH & MINERAL SCIENCES
BACCALAUREATE DEGREE (4-Year)
Ceramic Science & Engineering (M02)
Earth Sciences (M04)
Fuel Science (M38)
Geography (M16)
Geosciences (M30)
Metallurgy (M36)
Meteorology (M40)
Mineral Economics (M44)
Mining Engineering (M76)
Petroleum & Natural Gas Engineering (M84)
Polymer Science (M86)

ASSOCIATE DEGREE (2-Year)
Metallurgical Engineering Technology (M90)
Mining Technology (M92)

COLLEGE OF EDUCATION
BACCALAUREATE DEGREE (4-Year)
Communication Disorders (F10)
Elementary & Kindergarten Education (F32)
Home Economics Education (F38)
Rehabilitation Education (F64)
Secondary Education (F70)
Special Education (F77)
Vocational Industrial Education (F86)

COLLEGE OF ENGINEERING
BACCALAUREATE DEGREE (4-Year)
Aerospace Engineering (G05)
Agricultural Engineering (G10)
Architectural Engineering (5 years) (G15)
Chemical Engineering (G17)
Civil Engineering (G20)
Electrical Engineering (G25)
Engineering Science (G50)
Environmental Engineering (G49)
Industrial & Management Systems Engineering (G55)
Mechanical Engineering (G60)
Nuclear Engineering (G65)

ASSOCIATE DEGREE (2-Year)
Architectural Engineering Technology (G74)
Biomedical Equipment Technology (G75)
Chemical Engineering Technology (G73)
Electrical Engineering Technology (G80)
Mechanical Engineering Technology (G88)
Nuclear Engineering Technology (G85)
Railway Engineering Technology (G87)
Solar Heating & Cooling Technology (G89)
Surveying Technology (G90)
Telecommunications Technology (G92)

COLLEGE OF HEALTH, PHYSICAL EDUCATION & RECREATION
BACCALAUREATE DEGREE (4-Year)
Health Education (H01)
Physical Education (H10)
Recreation & Parks (H30)

ASSOCIATE DEGREE (2-Year)
Physical Therapist Assistance (H92)

COLLEGE OF HUMAN DEVELOPMENT
BACCALAUREATE DEGREE (4-Year)
Administration of Justice (J01)
Community Studies (J09)
Health Planning & Administration (J60)
Hotel, Restaurant and Institutional Management (J36)
Individual & Family Studies (J82)
Nursing (J88)
Nutrition (J89)

ASSOCIATE DEGREE (2-Year)
Community Services (J93)
Dietetic Food Systems Management (J98)
Hotel & Food Service (J95)

COLLEGE OF THE LIBERAL ARTS
BACCALAUREATE DEGREE (4-Year)
Advertising (L01)
American Studies (L02)
Anthropology - General (L03)
Anthropology - Medical (L05)
Classics (L11)
Communication Studies (L14)
Comparative Literature (L12)
East Asian Studies (L15)
Economics (L16)
English (L18)
Foreign Service & International Politics (L20)
French (L22)
General Arts & Sciences (L24)
Geography (L26)
German (L28)
History (L34)
Italian (L44)
Journalism (L46)
Labor Studies (L51)
Latin-American Studies (L54)
Linguistics (L59)
Medieval Studies (L61)
Philosophy (L60)
Political Science (L64)
Pre-Law (L68)
Psychology (L70)
Public Service (L74)
Religious Studies (L76)
Russian (L78)
Russian Technical Translation (L79)
Social Work (L73)
Sociology (L92)
Spanish (L94)
Speech Communications (L93)
Telecommunications (L67)
World Literature (L95)

ASSOCIATE DEGREE (2-Year)
Labor Studies (L97)
Letters, Arts, & Sciences (L83)
Sociology (L99)

COLLEGE OF SCIENCE
BACCALAUREATE DEGREE (4-Year)
Astronomy (S01)
Biochemistry (S10)
Biology (S14)
Chemistry (S20)
Computer Science (S25)
Mathematics (S30)
Microbiology (S55)
Microbiology - Medical Technology Option (S56)
Molecular & Cell Biology (S57)
Physics (S65)
Premedical - Medical (6 years) (S69)
Premedicine (S70)
Science (S90)

ASSOCIATE DEGREE (2-Year)
Computer Science (S97)
Medical Laboratory Technology (S98)
Science (S99)
Science - Radiologic Technologist
Radiographer Option (S93)

APPENDIX 2

FRESHMAN ENGINEER DATA COLLECTION FORM

TRAINING GUIDELINES FOR USE OF FRESHMAN ENGINEER DATA COLLECTION FORM

NOT TO BE USED WITH PRE-ENGINEERING (PRE E) FRESHMEN
TO BE USED FOR:
1. Students admitted to Engineering (ENGR) (except those who transfer out of ENGR via FTCAP).
2. Students who transfer into ENGR via FTCAP.

Student's Name _____ Social Security Number _____ Campus Location _____

THE PENNSYLVANIA STATE UNIVERSITY
Division of Undergraduate Studies

FRESHMAN ENGINEER DATA COLLECTION FORM

Developed by
J. Levin, J. Wyckoff

This data will be used as part of a research project conducted by DUS to identify predictors of persistence and success in engineering.

Instructions

In the case of some items data can be recorded directly from the EPS prior to the FTCAP interview. However, other items require substantiation by the adviser in the FTCAP interview. These items are indicated by an asterisk (*) and data should be recorded after completion of the FTCAP interview.

EPS/INTERVIEW

* EPS-B HIGH SCHOOL ACADEMIC EXPERIENCES

2. Mathematics (Subject)

_____ Like _____ Indifference/Dislike

2. Physics (Subject)

_____ Like _____ Indifference _____ Dislike/ Not taken

2. Chemistry (Subject)

_____ Like _____ Indifference/ Not taken _____ Dislike

*(Adviser should assess reactions to the subject matter as opposed to extraneous concerns such as reactions to the teacher, etc.)

EPS-D EXPECTATIONS AND CONCERNS ABOUT COLLEGE

3. Study Time: Hours:_____

EPS-E EDUCATIONAL AND OCCUPATIONAL PLANS

1. Consistency of major choices

a. Total # points to non-science majors (A&A, BA, ED, HPER, HDEV, LA) _____

b. # points to DUS _____

*1. Reasons for Engineering choice

_____ Genuine interest in field and subject matter of engineering (e.g., liking of math/science, technology, problem solving, etc.)

_____ Only superficial interest in engineering (e.g., job opportunities, financial reward; pressure from significant others)

*(Preliminary data to be obtained from EPS statements with confirmation via the FTCAP interview.)

5. Certainty (check one)

_____ Very uncertain

_____ Slightly uncertain

_____ About "50-50"

_____ Completely certain

*8. Knowledge of Major

_____ Moderate to great/ Accurate

_____ Almost nothing/ Inaccurate

*(Student's EPS statements regarding knowledge of B.S. engineering program should be verified during the FTCAP interview. Emphasis should be given to the student's perceptions and expectations of what a B.S. engineering program of study will entail. Accuracy of perceptions should be assessed, e.g., expectations of hands-on practical applications as a significant part of a B.S. engineering education are inaccurate. On the other hand, expectations of the mathematical/scientific theoretical problem-solving approach are accurate.)

JL:Data:4/84

TRAINING GUIDELINES FOR USE OF:

FRESHMAN ENGINEER DATA COLLECTION FORM

AND

PRE-ENGINEERING FRESHMAN YEAR RISK SIGNS CHECKSHEET

J. Levin and J. Wyckoff

These guidelines are written directly for the Freshman Engineer Data Collection Form. However, they may be used with only very minor changes with the Pre-Engineering Checksheets, as well. All data is to be recorded by FTCAP advisers and is to be based on the EPS in conjunction with the FTCAP educational counseling interview. As much as possible, only full-time staff should participate in the project. If part-time staff are used to collect data, they should be experienced in the FTCAP. The DUS representative is responsible for training of all staff who will participate in the project.

Although, at first glance, the data to be collected may seem redundant with that required on the Interview Prep, it really is not because most of the data is based on the outcomes of the FTCAP interview, not on the preparation for that interview.

EPS-B HIGH SCHOOL ACADEMIC EXPERIENCES

Indifference or dislike of mathematics, physics, or chemistry on the EPS should be confirmed or disconfirmed during the FTCAP interview. Below is an example of a series of adviser (A) questions and possible student (S) responses leading to various adviser judgements about the students' reactions to the specified high school courses.

EXAMPLE: Student checks "indifference" to physics on EPS.

(A) I see that you didn't care a lot for physics in high school.

(S) I didn't like being in the class. The teacher was really boring.

(A) What about the subject matter itself?

(S) I really was interested in the material, I liked reading the book and doing the problems. But the teacher was really boring. If I could have had my chemistry teacher for physics it would have been great.

Adviser checks "LIKE"

(S) Some of it I liked and some of it I disliked. I liked the lab and the parts that didn't have a lot of theory and math.

Adviser checks "INDIFFERENCE"

(Adviser should eventually discuss with the student the implications this "indifference" to physics has for the study of engineering.)

(S) That's right. I really didn't like it. The topics were boring, there was too much math and formulas and I really found it hard to understand.

Adviser checks "DISLIKE"

(Adviser should eventually discuss with the student the implications this "dislike" of physics has for the study of engineering.)

EPS-D EXPECTATIONS AND CONCERNS ABOUT COLLEGE

3. Study time - record directly from EPS

EPS-E EDUCATIONAL AND OCCUPATIONAL PLANS

1. Consistency of Major Choice - calculate and record points directly from EPS.

1. Reason for Engineering Choice

The genuiness (intrinsic motives) vs. the superficiality (extrinsic motives) of the students' reasons for choosing engineering should be assessed in the FTCAP interview. A suggested adviser (A) opening question to obtain relevant information and examples of some possible student (S) responses and respective adviser judgements are given below.

(A) What are the main reasons that you have chosen engineering?

(S) I've always enjoyed math and science and have done well in these subjects.

(A) How do you see your interests in these subjects relating to engineering compared to other fields like physics, meteorology, or geology where math and science also are important?

(S) I understand that engineers apply this knowledge to solve problems and also there are more jobs available in engineering after four years of college.

Adviser checks "GENUINE INTERESTS"

(S) I like to work on mechanical things and I built my own stereo. So I'm thinking about either mechanical or electrical engineering.

(A) You obviously have some practical interests that you relate to engineering, but are there any other reasons why you are considering engineering?

(S) My parents and high school teachers told me I should go into engineering and I understand that the job opportunities are real good.

(A) Are there any other reasons?

(S) I can make good money as an engineer.

Adviser checks "SUPERFICIAL INTERESTS"

(S) Well sure, I like math and physics a lot and I want to combine these with my practical interest. I know that I will be studying a lot of math and physics in engineering.

Adviser checks "GENUINE INTERESTS"

(In addition adviser checks "ACCURATE KNOWLEDGE OF MAJOR" under EPS-E #8)

(S) Yes .'m reall; looking forward to being able to continue working on mechanical or electrical things.

(A) Have you looked at the engineering courses that you will take to see whether they are going to involve these practical activities where you can work with your hands?

(S) No I haven't.

(A) There will be very few if any courses where you will be able to do these things. Any such courses will come only after at least two years of advanced mathematics and physics.

(S) Boy, I didn't know that.

Adviser checks "SUPERFICIAL INTERESTS"

(In addition adviser checks "INACCURATE KNOWLEDGE OF MAJOR" under EPS-E #8)

5. Certainty - record directly from EPS.

8. Knowledge of Major

The degree and accuracy of the student's knowledge of engineering should be assessed in the FTCAP interview. Note that this information might have been obtained while discussing the reasons for engineering choice. If not, an attempt should be made to assess it directly. A typical Adviser (A) opening question to obtain relevant information and examples of some student (S) responses and respective adviser judgements are given below.

(A) I see that your main interest is in civil engineering. What do you think civil engineering is all about?

(S) As far as I know it has to do with construction of highways, bridges, buildings and things like that.

(A) How did you find out about this?

(S) I spent the last couple summers working on a highway construction crew and I also had a chance to talk to some of the engineers.

(A) How do you see the things you are going to study in college relating to your summer experiences?

(S) I guess I will have to learn some surveying and how to read blueprints, but I guess I am going to have to study a lot of math and science.

(A) Why do you think that Civil Engineering requires a lot of math and physics?

(S) From what I read and what the engineers told me, you need to know a lot of math and science in order to design highways, bridges and things like that.

Adviser checks "ACCURATE KNOWLEDGE"

(S) I guess I will probably have to take a lot of surveying and drafting courses, because I saw a lot of engineers working with blueprints and doing the surveying work. I guess I will have the opportunity to get outdoors in a good number of my courses.

(A) Are you aware that civil engineers take only one drafting course and one surveying course? The first two years includes the study of high level mathematics and physics.

(S) Yeah, I knew that there was some math and physics but I didn't realize that there was that much.

Adviser checks "INACCURATE KNOWLEDGE"

APPENDIX 3

LOGISTIC REGRESSIONS

- PERSISTING IN BACCALAUREATE ENGINEERING-SUCCESSFUL VS. PERSISTING IN BACCALAUREATE ENGINEERING-UNSUCCESSFUL

- PERSISTING IN BACCALAUREATE ENGINEERING-SUCCESSFUL VS. PERSISTING IN BACCALAUREATE NON-ENGINEERING-UNSUCCESSFUL

TABLE 22: LOGISTIC REGRESSION FOR PERSISTING IN BACCALAUREATE ENGINEERING-SUCCESSFUL VS. PERSISTING IN BACCALAUREATE ENGINEERING-UNSUCCESSFUL

EFFECT	DF	ESTIMATE	CHI-SQUARE	PROB
INTERCEPT	1	-5.462	51.69	0.0001***
HSGPA	1	1.212	25.84	0.0001***
ALG	1	0.072	13.60	0.0002***
CHEM S	1	0.047	3.64	0.0564*

* $P \leq .10$

** $P \leq .05$

*** $P \leq .01$

TABLE 23: LOGISTIC REGRESSION FOR PERSISTING IN BACCALAUREATE ENGINEERING-SUCCESSFUL VS. PERSISTING IN BACCALAUREATE NON-ENGINEERING-UNSUCCESSFUL

EFFECT	DF	ESTIMATE	CHI-SQUARE	PROB
INTERCEPT	1	-4.281	4.67	0.0307**
NSPTS	1	-0.039	13.10	0.0003***
HSGPA	1	1.137	4.10	0.0429**
ALG	1	0.096	3.90	0.0484**
CHEM_S	1	0.066	5.34	0.0209**

* $P \leq .10$

** $P \leq .05$

*** $P \leq .01$