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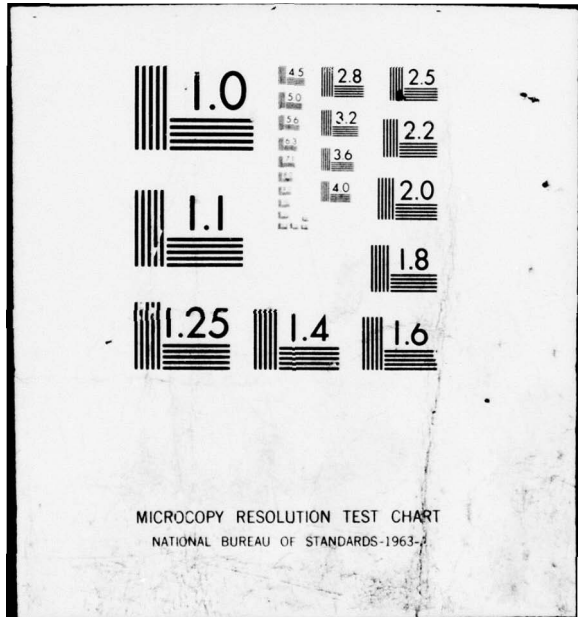
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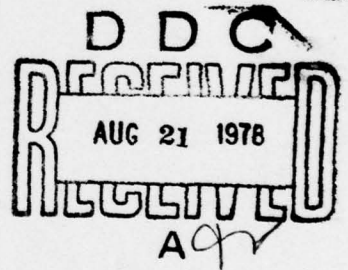
FRANK J. SEILER RESEARCH LABORATORY

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PREDICTING UNDERGRADUATE PILOT TRAINING (UPT)
PERFORMANCE FOR AIR FORCE ACADEMY GRADUATES

FINAL REPORT



CAPT THOMAS D. BAXTER

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PROJECT 2304

AIR FORCE SYSTEMS COMMAND
UNITED STATES AIR FORCE

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) In order to maintain a properly sized and experienced pilot force, pilot production rates must vary from year to year. If pilot requirements are cut back, a corresponding cutback is usually experienced in Undergraduate Pilot Training (UPT). Thus, the manager should be prepared to select to a certain UPT quota from among qualified candidates. This study provides information to the manager to assist in the selection decision for USAF Academy graduates.																				

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20. ABSTRACT (continued)

This study considered a number of factors from Air Force Academy cadet records for the class of 1969 which were thought to be of possible use in predicting UPT performance. The class of 1969 was chosen since it was the last class with UPT performance scores (flying grade, academic grade, and class standing). Predictor variables included medical status as a candidate and as a cadet; college entrance exam board scores; grade point average; and T-41 training, academic, leadership, and graduate order of merit.

The approach was to examine UPT failures and then conduct a regression analysis on the performance of the remainder of the class who completed UPT. Examination of failures showed that those without T-41 training had a UPT failure three times that of those who had T-41 training. Also, those who entered UPT with a medical waiver had a failure rate twice that of those with no waiver. The failure rate for those without T-41 training and with a medical waiver was nearly five times that of those with T-41 training and no waiver. The reader must be cautioned, however, that some cases involved small sample sizes. The regression analysis indicated that no factor or combination of factors examined could reliably predict UPT performance. In predicting UPT academic grade, a best R^2 (multiple correlation coefficient squared) of .33 (33% of error explained) was obtained. The R^2 for the UPT flying grade was only .06 and the R^2 for predicting UPT pass/fail was only .07. The R^2 for UPT order of merit was .34. One might have expected a good correlation between T-41 order of merit and UPT order of merit, however, the R^2 was only .14. Other factors (academic order of merit (.25), grade point average (.25), graduate order of merit (.24)) had greater correlation with the UPT order of merit.

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INTRODUCTION

The Frank J. Seiler Research Laboratory at the U.S. Air Force Academy initiated a work unit in May of 1977 entitled Studies and Applications of Operations Research. The objectives of this work unit include:

1. developing tractable research topics through interaction with various offices throughout the Air Force and Department of Defense;
2. acting as a catalyst between the topic sponsors and members of the Academy faculty by keeping them aware of interesting and important research topics and assisting in contacts with the sponsoring offices;
3. conducting in-house research.

Discussions with personnel in the Registrar's Office at the Academy in conjunction with objective one led to the formulation of several research topics, one of which is the subject of this paper. A preliminary report¹ of this work was published as a technical memorandum in November 1977, however, the substantive portions are included here.

PROBLEM

As pilot requirements fluctuate from year to year, so too must pilot production rates for Undergraduate Pilot Training (UPT). As rates are cut back, managers must become more selective of candidates for pilot training. Thus, it behooves the managers to have as much relevant information as possible to enlighten their selection decision for Undergraduate Pilot Training. This report deals specifically with the problem of selecting from among Air Force Academy graduates.

OBJECTIVE

The objective of the study was to determine if existing Air Force Academy cadet data could be useful in predicting Undergraduate Pilot Training

performance. If one is able to predict performance, then this would be considered when selections for pilot training are made. Other studies^{2,3} have dealt with predicting pilot performance, but this study is somewhat unique in that it addresses only AF Academy graduates and that it considers only existing data.

DATA

The data for the analysis were information for the USAF Academy class of 1969 who went to Undergraduate Pilot Training. The class of 1969 was chosen since it was the last class for which UPT class standing information was recorded. Out of the class of 1969, 448 went to UPT. Forty-six (10.3%) did not complete UPT for the reasons given below.

- 14 Flying Deficient
- 13 Medically Deficient
- 13 Self Initiated Elimination (SIE)
- 3 Manifestation of Anxiety (MOA)
- 2 Training Deaths
- 1 Death Other

APPROACH

A two-part approach was taken to determine if UPT performance was predictable from the data. One part was to examine the UPT failures. The other part was to apply a linear regression program to the data for those who completed UPT to determine if performance could be predicted. Those not completing UPT had no UPT performance scores (flying grade, academic grade, class standing) so they could not be included.

RESULTS

In examining UPT failures it was found that two factors had significant influence on UPT failure. These factors were T-41 training status and cadet

medical code. The T-41 training status was whether or not the cadet had completed T-41 training. Most of those who had not completed T-41 training were coded as not entered. The cadet medical code was as of graduation from the Academy. For this analysis the code was used as pilot qualified or waived. The economics of the T-41 program and the waiver of vision requirements are discussed in the May 1978 "Interfaces."⁴ The article draws on analysis conducted at the USAF Academy in the latter 1960's. It indicates that both the T-41 program and the vision waiver are easily justified from an economic standpoint. This is mentioned as an aside here since the emphasis of this paper is predicting UPT performance, not justifying various programs. Figure 1 shows the impact of the two variables mentioned above and their combinations on UPT failure rate.

The UPT failure rate for those without T-41 training is about 3 times the rate for those with T-41 training. The UPT failure rate for those with a medical waiver was twice the rate of those who were pilot qualified. Combinations follow as might be expected, with the rate for those without T-41 training and with a waiver being nearly 5 times that of those with the opposite combination of factors. The reader must be cautioned, however, that some sample sizes were small as indicated by the chart. However, if one allows the samples one can claim differences in proportions with high reliability. The levels of significance are presented in Table 1.

A T-41 order of merit score was computed by dividing a cadet's class standing in the T-41 program by the number in his T-41 class and subtracting from 100%. Thus, a cadet who was 10th from the top of a T-41 class of 100 would receive an order of merit score of 90%. The average T-41 order of merit score was computed for those who completed UPT and for those who did

not. The average scores were 53% and 38%, respectively. This further substantiates that UPT performance is related to T-41 performance.

One might suspect that most of those who do not have T-41 training and fail UPT would fail because of a flying deficiency. However, as shown in Figure 2, the data do not support this. Most of the failures among those who did not have T-41 training were categorized as medical deficiency.

Similarly, one might expect that most of those who are medically waived and fail UPT would fail because of a medical deficiency. Again, the intuitive is not supported by data. In fact, Figure 3 indicates that there were a higher percentage of medical deficiency eliminations among those without waivers than those with waivers. Investigation into the reasons for the medical waivers might help to explain this and might identify certain kinds of waivers for which there is very high attrition.

This concluded part 1 of the effort with indications that both T-41 training and medical waiver impact UPT performance.

The second part of the examination consisted of using linear-least-squares regression in an attempt to predict UPT performance measures. The variables examined are presented in Table 2. Obviously many of the predictor variables are correlated. A cross correlation matrix is given in Table 3. All order of merit scores were converted to percent scores as previously discussed for T-41 order of merit.

Since T-41 order of merit was not available when the initial runs were made, the regression did not include it when attempting to predict UPT academic grade, UPT flying grade, and UPT pass/fail. Later on, T-41 order of merit was run against the variables individually.

The UPT academic grade was a percentage score attained for the academic portion of UPT. The scores were all very high with the average score being 93.9%. The highest correlation with the UPT academic grade was academic order of merit at graduation from the Academy. That correlation, though significant, was disappointing with an r^2 (simple correlation coefficient squared) of only .30. Even with all variables in the equation (except T-41 order of merit), the R^2 (multiple correlation coefficient squared) was only .33. An r^2 of .15 was obtained with T-41 order of merit alone. Thus, although it appears that significant correlation exists, it is not sufficient to use for prediction purposes.

The UPT flying grades were also quite high with an average of 92.2%. There was complete lack of correlation, however, with an R^2 of .06 with all variables (except T-41 order of merit) in the equation.

Equally poor results were obtained in attempting to predict UPT pass/fail (a 0/1 variable). An R^2 of .07 indicating no correlation was obtained with all variables (except T-41 order of merit) in the equation. Although the two variables (medical code and T-41 training status) were shown to have significant impact on UPT performance, their correlations with UPT pass/fail produced r^2 of only .04 and .02, respectively. This result was not unexpected since many with waivers and/or no T-41 training completed UPT.

It appeared at this point in the study that regression results might be improved if a better measure of UPT performance were available. Therefore, UPT order of merit for the class of '69 was obtained from Air Training Command. Since the class of '69 was divided into several UPT classes, an order of merit score was calculated as before. However, in this case UPT

classes were mixed with other than Academy graduates so order of merit scores were with respect to total UPT classes. This should not have a significant effect on the analysis. The average UPT order of merit score for the class of '69 was 56.6% so it appears that as a class they did slightly better in UPT than those from sources other than the Academy. The results of regression against UPT order of merit are presented in Table 4. Although improved results were obtained, the R^2 of .34 is not high enough to support reliable prediction of UPT performance. Note the correlation with T-41 order of merit produced in r^2 of only .14.

OBSERVATIONS

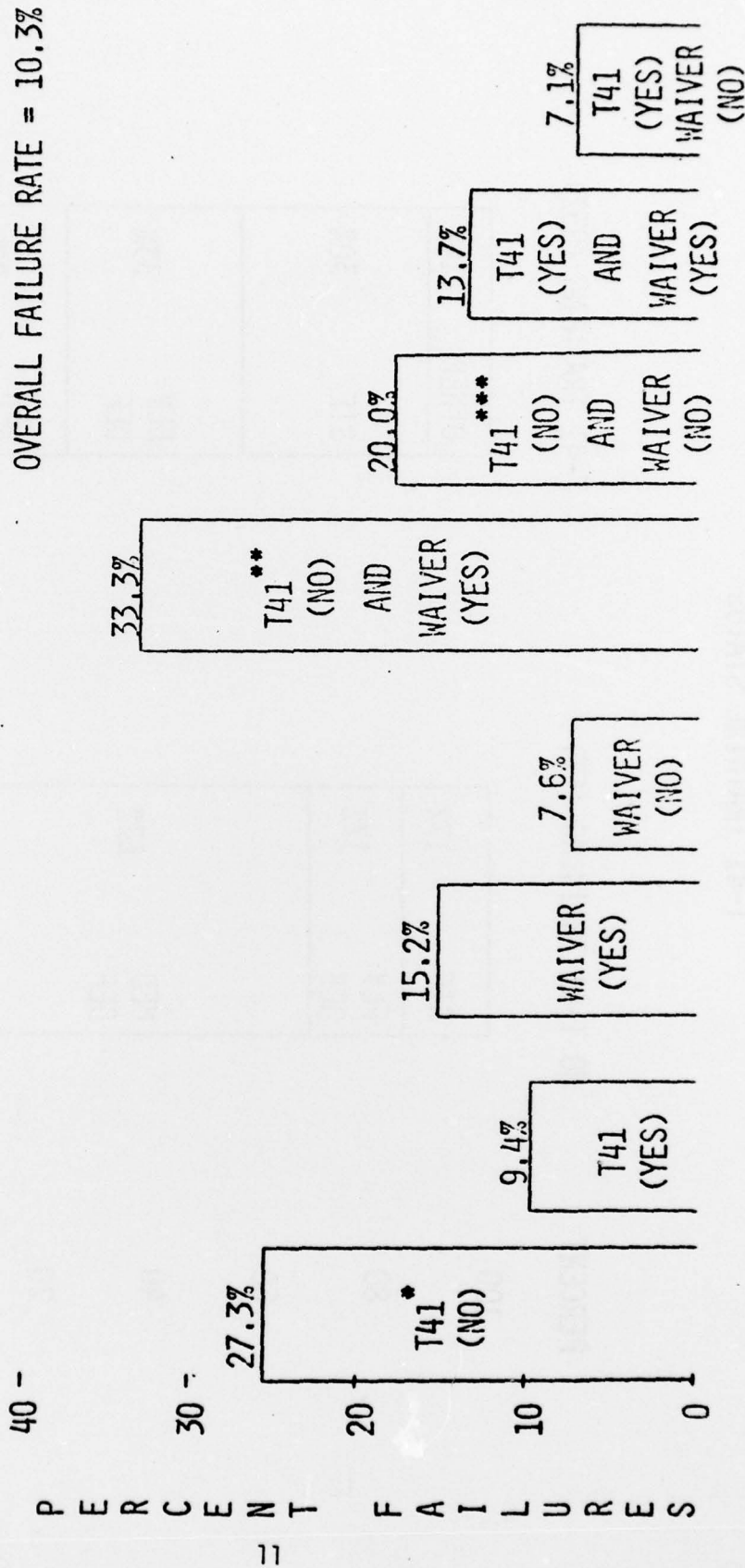
The results indicate that both medical status and T-41 training influence performance in UPT. However, even with the most undesirable combination of the two factors, 2/3 complete UPT. Thus, while the factors are useful as indicators, they are not useful as predictors.

The regression analysis showed some correlation between predictors and UPT performance measures but no factor or combination of factors could reliably predict UPT performance.

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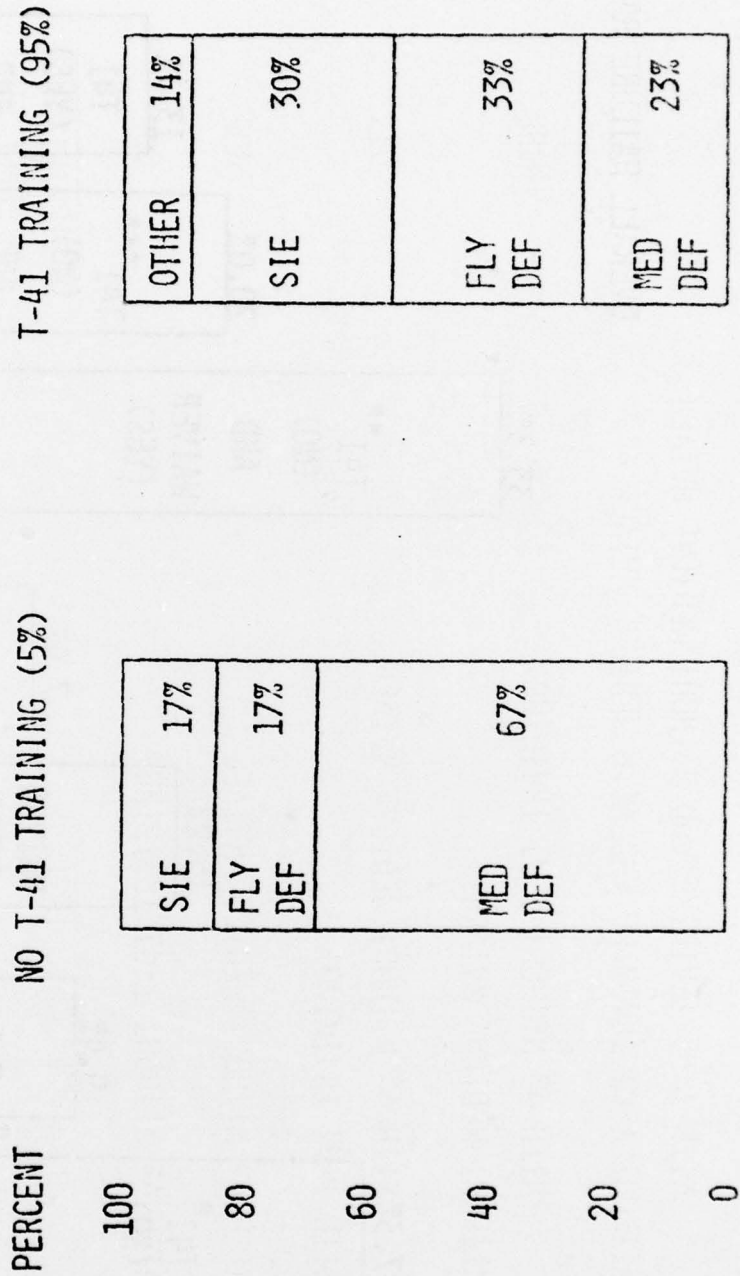
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FIGURE 1
 PERCENTAGE OF UNDERGRADUATE PILOT TRAINING FAILURES
 VERSUS
 T-41 TRAINING STATUS AND MEDICAL STATUS



* SMALL SAMPLE SIZE (6/22 = 27.3%)
 ** SMALL SAMPLE SIZE (4/12 = 33.3%)
 *** SMALL SAMPLE SIZE (2/10 = 20.0%)

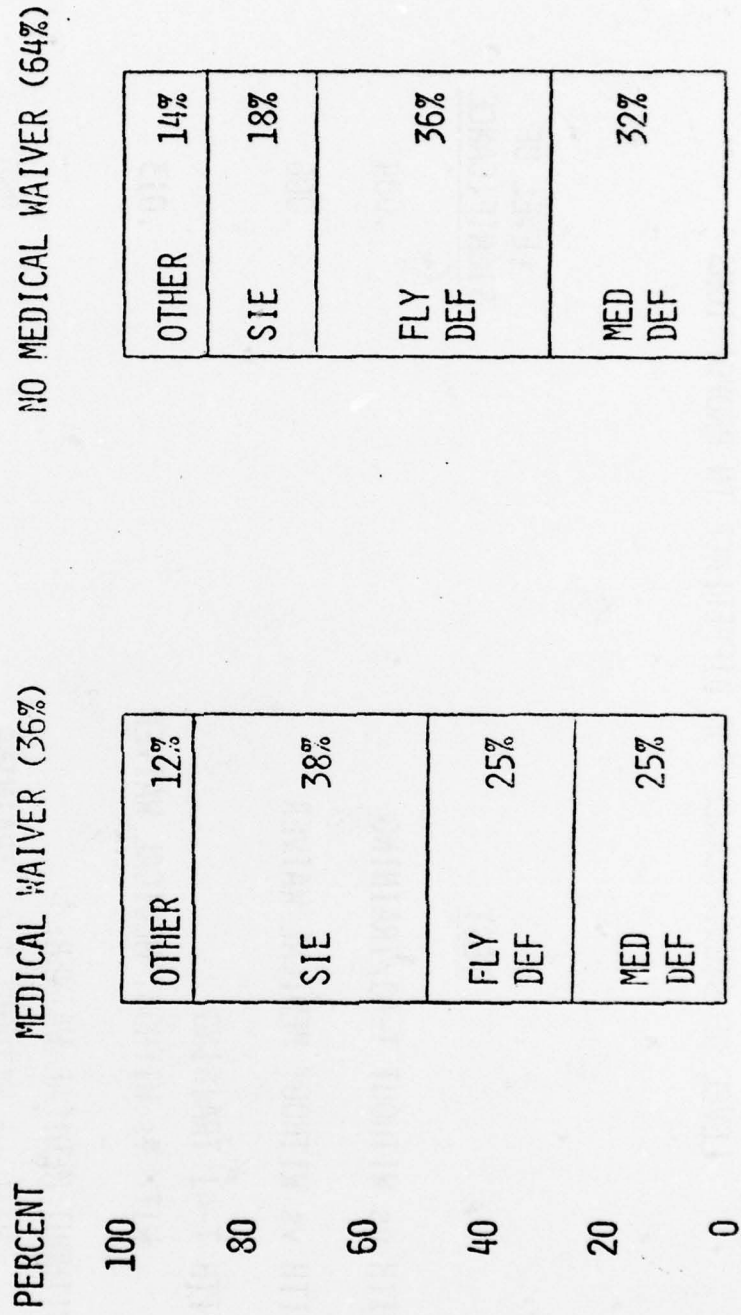
FIGURE 2
 PERCENTAGE IN UPT FAILURE CATEGORIES BY
 T-41 TRAINING STATUS



6/22 = 27.3% FAILURES

40/426 = 9.4% FAILURES

FIGURE 3
 PERCENTAGE IN UPT FAILURE CATEGORIES BY
 MEDICAL STATUS



24/158 = 15.2% FAILURES

22/290 = 7.6% FAILURES

TABLE 1
 LEVEL OF SIGNIFICANCE FOR DIFFERENCE IN PROPORTIONS

<u>TEST</u>	<u>LEVEL OF SIGNIFICANCE</u>
WITH vs WITHOUT T-41 TRAINING	.004
WITH vs WITHOUT MEDICAL WAIVER	.006
WITH T-41 TRAINING:	
WITH vs WITHOUT MEDICAL WAIVER	.013
WITHOUT MEDICAL WAIVER:	
WITH vs WITHOUT T-41 TRAINING	.066
WITHOUT T-41 TRAINING AND WITH MEDICAL WAIVER vs	
WITH T-41 TRAINING AND WITHOUT MEDICAL WAIVER	.001

TABLE 2
REGRESSION VARIABLES EXAMINED

PREDICTORS--

MEDICAL CODE CADET	GRADE POINT AVERAGE
MEDICAL CODE CANDIDATE	ACADEMIC ORDER OF MERIT
VERBAL APTITUDE	LEADERSHIP ORDER OF MERIT
MATH APTITUDE	GRADUATE ORDER OF MERIT
ENGLISH COMPOSITE	T-41 TRAINING STATUS
MATH ACHIEVEMENT	T-41 ORDER OF MERIT

TO PREDICT--

UPT FLYING GRADE	UPT STATUS
UPT ACADEMIC GRADE	UPT ORDER OF MERIT

TABLE 3
CROSS CORRELATION MATRIX

	MCD	MCND	VAPT	MAPT	ECOM	MACH	GPA	ACOM	LDOM	GROM	T41T	T41OM
MCD	1.00	.38	.08	.03	.08	.09	.13	-.11	-.02	-.09	-.06	.05
MCND		1.00	.06	.08	.07	.06	.11	-.10	-.01	-.09	-.10	-.04
VAPT			1.00	.30	.59	.33	.32	-.33	.09	-.23	.09	.13
MAPT				1.00	.26	.67	.37	-.36	.05	-.28	.06	.17
ECOM					1.00	.35	.29	-.28	-.06	-.26	.04	.02
MACH						1.00	.37	-.36	.08	-.29	.13	.13
GPA							1.00	-.98	-.16	-.88	.06	.34
ACOM								1.00	.14	.89	.07	-.31
LDOM									1.00	.50	.02	-.06
GROM										1.00	-.05	-.29
T41T											1.00	X
T41OM												1.00

VARIABLES

MCD----Medical Code Cadet (at graduation)
 MCND---Medical Code Candidate (prior to entry)
 VAPT---Verbal Aptitude (College Entrance Exam Board Score (CEEBS))
 MAPT---Math Aptitude (CEEBS)
 ECOM---English Composite (CEEBS)
 MACH---Math Achievement (CEEBS)
 GPA----Grade Point Average
 ACOM---Academic Order of Merit
 LDOM---Leadership Order of Merit
 GROM---Graduate Order of Merit
 T41T---Cadet T-41 Training (yes/no)
 T41OM--Cadet T-41 Training Order of Merit

TABLE 4
PREDICTING UPT ORDER OF MERIT

	R^2 *
ALL VARIABLES	.34
ONLY	
ACADEMIC ORDER OF MERIT	.25
GRADE POINT AVERAGE	.25
GRADUATE ORDER OF MERIT	.24
T-41 ORDER OF MERIT	.14
MATH APTITUDE	.08

* MULTIPLE CORRELATION COEFFICIENT SQUARED