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ABSTRACT

This report summarizes the techniques used in gathering and maintaining a data file on most of the Army aviator trainees who have been through the Officer/Warrant Officer Rotary Wing Aviator Course and the Warrant Officer Candidate Course during the period 1 July 1968-31 December 1969. Specific regression analyses dealing with the prediction of student performance in training are furnished, and the methods used to obtain them are described. The equations allow the extrapolation of current training performance to a prediction of (1) the probability that the individual will pass the course, and (2) what his final end-of-course grade will be. A review of the most pertinent literature in the area is included as are frequency counts of a large volume of training data. (Author)

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Multivariate Extrapolation of Training Performance

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HUMAN RESOURCES RESEARCH ORGANIZATION
300 North Washington Street • Alexandria, Virginia 22314

June 1975

Prepared for

U.S. Army Research Institute for the
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1300 Wilson Boulevard
Arlington, Virginia 22209

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This report summarizes the techniques used in gathering and maintaining a data file on most of the Army aviator trainees who have been through the Officer/Warrant Officer Rotary Wing Aviator Course 2C-1981-B/2C-062B-B and the Warrant Officer Candidate Course 2C-062B-C during the period 1 July 1968-31 December 1969. Specific regression analyses dealing with the prediction of student performance in training are furnished, and the

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MILITARY PROBLEM

Flight training is one of the Army's most costly training programs, so the management of manpower and training resources is especially critical in aviation. An important aspect of this management concerns the handling of attrition during flight training. When an aviation trainee falters, and is nominated for possible expulsion from the program, the Army must decide whether further investment of training in this individual is warranted, considering his past performance, or whether he should be eliminated from the program, thereby avoiding any further expense in what may be an unsuccessful training investment.

In making this decision, the responsible military personnel, in the form of a Faculty Board, are required to evaluate a large quantity of information. This information comes to the Board in the student's grade folder, which contains standardized test information, demographic information, and all of the grades which the student has received in training up to the point of his nomination for possible expulsion. Reduced onto the PREDICT data file, this information contained over 100 separate data entries.

Understandably, it is difficult for the military decision maker, acting on his judgment alone, to use this large mass of information with maximum efficiency. Work Unit PREDICT was aimed at summarizing this information, through multiple regression techniques, in a manner to aid this decision process.

RESEARCH PROBLEM

The research goal of this effort was to produce a set of mathematical relationships based on multiple regression analyses, which could be used to extrapolate an individual's present and past performance into a prediction of his future performance in training. In doing this, standardized test information and demographic information were used in addition to training performance records.

METHOD

The collection and organization of data present major problems in an effort of this type. The exact number of data entries gathered varies from individual to individual. Some people received more graded flights than others; some information is not available on all people. However, it can safely be said that more than 100 separate data entries were gathered on most of the individuals considered in these analyses. These data included standardized test information where it was available, and demographic information such as marital status and number of children.

Standard multiple regression techniques were used to reduce this information to predictive equations for each of seven different points in time during the primary helicopter training program. These seven time periods were not evenly spaced throughout the training program. Rather, they represented the times which the Student Evaluation Review Council at Fort Wolters had indicated would be the most valuable for their utilization of the information.[1] Actually, the last of the seven equations is appropriate

[1] The bulk of this research was conducted during the period when the Primary Phase of the Initial Entry Rotary Wing (IERW) training was conducted by the U.S. Army Primary Helicopter School at Fort Wolters, Texas. As of 30 July 1973, that training was moved to Fort Rucker, Alabama, where it is conducted, along with the remainder of IERW training, by the U.S. Army Aviation School.

for a time approximately one-half of the way through the primary flight program. For the classes used in this research, almost all of the attrition had occurred by this point in the program.

Two criteria or dependent variables were examined. One of these was the pass/fail dichotomy. Since whether or not a man ultimately passes training or fails is the crux of the matter, the pass/fail issue was thought to be a suitable criterion. Later examination showed that, while it had value, there were certain problems associated with using pass/fail as a criterion. Therefore, a second criterion, final end-of-course grade or class standing, was also examined. Predictive equations were calculated for each of seven time periods during the Primary Helicopter training for each criterion.

RESULTS

The primary results of this effort are equations for predicting the performance of students in the Primary Phase of Army Initial Entry Rotary Wing flight training. The summarizing of these equations is best left to the main text of the report. However, a brief description of differences between the passing student and the failing student, and also the differences between the high-scoring and the low-scoring student, might be useful here. Separate descriptions are given for officer students and Warrant Officer Candidate students.

A verbal picture of the successful Warrant Officer Candidate (WOC) would include the fact that he has a slightly higher rank upon entry into the program than his peers, indicating that he was more likely to have been obtained from in-service sources. Correspondingly, he is slightly older than his peers. The more time he has in the service, the higher is his probability of successful training completion. On the other hand, his end-of-course standing is likely to be somewhat lower with more time in service. The successful Warrant Officer Candidate is better educated than his peers, and he is more likely to have had some flight training prior to entering the Army flight training program. His Flight Aptitude Selection Test (FAST) score is higher, while his General Technical (GT) score is of no consequence in determining whether he will pass or fail the course. If he is married and has children, his probability of passing is greater, but this factor has little effect on his final end-of-course grade. The successful aviation Warrant Officer Candidate scored well on the Armed Forces Qualification Test (AFQT). By definition, he does well on his Airmanship Examinations, his Warrant Officer Development Examinations, and his flight grades.

The officer aviator trainee who scores well in his end-of-course standings is also a little older than his peers. However, he generally has not been in the service as long as his contemporaries. He is somewhat above average in education, and he has had some previous flight training. He tends to score better if he is married and has children.

CONCLUSIONS

Statistically significant multiple correlations were obtained ranging from $R = .23$ to $R = .80$. As expected, the value of R increased over time as new predictors were added, but little increase in predictive efficiency resulted from the use of more than five predictor variables. Results were stable on cross validation.

In short, the predictive equations furnished in the text of this study can be used to summarize effectively for prediction purposes the information available on each trainee at each of seven points during the training program. These equations furnish an extrapolation of this available information in order to provide a predicted pass/fail probability and a predicted end-of-course grade for each individual. Further, the predicted end-of-course grade can be translated into a predicted end-of-course percentile class standing.

In addition to their use in faculty board decisions, these extrapolations of student performance could also be used in a student counselling program. The Training Advisor/Counselor (TAC) officer, or some other designated individual, could be provided a periodic posting of his students that not only would include a predicted probability of eventual success, and a predicted end-of-course grade, but also would provide the counsellor with some idea of the nature of the individual student's problem.

PREFACE

Work Unit PREDICT was initiated to develop a data system which could be used by the Army to make in-training predictions of ultimate training success for individuals in the Initial Entry Rotary Wing flight training program. This information was to be used to assist the U.S. Army Primary Helicopter School in making administrative decisions concerning the disposition of students who encountered flight, academic, or other difficulties. It was also anticipated that the data pool required for the prediction of student training performance would potentially be useful in the prediction of other training and post-training job performance criteria.

When the research was conceived and begun, Army primary helicopter training was given by the U.S. Army Primary Helicopter School, Fort Wolters, Texas. Students then went to the U.S. Army Aviation School at Fort Rucker, Alabama, for their advanced helicopter training. The PREDICT research was designed and data were gathered under this administrative organization. However, a major change occurred in FY 1974 when Fort Wolters was closed and primary training was moved to the U.S. Army Aviation School at Fort Rucker. This change and many others associated with it adversely affected the conduct of the PREDICT research and its utility as an operational system.

After the prediction equations were developed, experimental operation of the PREDICT system was begun at Fort Wolters. The closing of Fort Wolters occurred before the utilization of the system reached the desired level of effectiveness. After the move of primary training to Fort Rucker, attempts were made to utilize the system at the U.S. Army Aviation School. However, because of the various changes in the syllabus of instruction and administrative organization, those attempts were not particularly successful, although the predictive equations functioned as expected. The present report documents the methodology employed and can serve as a basis for future training management systems that are based on multiple predictor systems.

The research was conducted at HumRRO Central Division, Dothan Office (formerly Division No. 6). Dr. Wallace W. Prophet is Director of the HumRRO Central Division and Dr. Paul Caro is Dothan Office Director. The project was initiated, and the first regressions were obtained, under the leadership of Dr. Wiley R. Boyles. The second study, its cross validation, and the writing of this report were conducted under the leadership of Dr. James W. Dees. Other HumRRO personnel who have participated in the project are L. Paul Dufilho, H. Alton Boyd, James L. Wahlberg, and Peter R. Prunkl.

Military support was provided by the U.S. Army Research Institute Human Research Unit, Fort Rucker, Alabama. LTC Donald E. Youngpeter is the Chief of the Human Research Unit. During the conduct of the PREDICT work the Human Research Unit provided a total of four officers in support of the project: CPT Larry C. Marrs, CPT Robert N. Seigle, CPT Richard L. Campbell, and CW-3 Charles L. Phillips. Enlisted support was provided by a total of 26 enlisted personnel:

SP5 Joseph J. Baldwin
SP5 Alan Boerger
SP5 Calvin L. Branch
SP5 Hal W. Howington
SP5 Paul A. Kazmierczak
SP5 James H. McGinnis
SP5 David McTate
SP5 Gary L. Ridgway
SP5 Gary W. Seals
SP5 William R. Soldressen
SP5 John M. Stahura
SP5 Robert A. Tangney, Jr.
SP5 Peter C. Tomolonis
SP5 Eric Wagner

SP5 James L. Wahlberg
SP5 Curtis W. Waller
SP5 Merlin V. Widup
SP4 Gary D. Dotson
SP4 Kenneth P. Odom
SP4 Richard L. Oltmann
SP4 Daniel A. Polovina
PV2 Terry V. Bishop
PV2 Kenneth J. Bouma
PV2 Timothy Putka
PFC Richard A. Uhlar
PVT John M. Trezise, Jr.

The military support strength at peak loading was about one officer and seven enlisted personnel.

HumRRO research for the Department of the Army under Work Unit PREDICT was conducted under Army Contract DAHC19-73-C-0004. Training research is conducted under Army Project 2Q162106A723. The PREDICT work was conducted under the sponsorship of the U.S. Army Research Institute for the Behavioral and Social Sciences, with Dr. David Meister serving as the technical monitor.

Meredith P. Crawford
President
Human Resources Research Organization

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INTRODUCTION

BACKGROUND

The motivating stimulus for Work Unit PREDICT has been the Army's continuing concern with attrition in the aviation training program. As far back as 1963, the U.S. Army Aviation School, Fort Rucker, Alabama, requested specific assistance from HumRRO, in the form of Technical Advisory Service. concerning attrition rates in the aviation program. This concern with training attrition has been the stimulus for a large variety of different research programs. Under Work Unit ECHO, for example, it was determined that experience in certain types of simulators or training devices reduced attrition in the flight training program.[1]

It is likely that every major military flight training program has been concerned with the attrition problem. While the percentage of students who attrite in undergraduate pilot training (UPT) programs (i.e., the "washout rate") varies from one time to another and from one service or situation to another as a function of many complex factors, typically attrition rates of one student in five, or one in three, are cited as being likely. While this problem has always been of prime concern to the services, from the standpoint of training efficiency, the recent fuel crisis has added a dimension over and above that of cost effectiveness. The manpower and resource management aspects of flight trainee attrition will continue to be of concern.

Efforts to manage the attrition problem more effectively fall into three general categories: (a) efforts related to pretraining selection of trainees (primary selection); (b) efforts related to improved training methods designed to reduce attrition; and (c) efforts aimed at maximizing the likelihood, after training is started, that those trainees with high training success probabilities are retained in the program and those with unacceptable success probabilities are eliminated with the minimum investment of training resources (secondary selection). The PREDICT research effort falls into this third, or secondary selection, category.

In FY 1965, HumRRO initiated a study (Exploratory Research 38) dealing with the training, utilization, and retention of Warrant Officer aviators. This project developed a number of questionnaire items that showed some validity for predicting the retention of Warrant Officer aviators in the service.[2] The predictions of retention obtained in ER-38 stimulated an interest in the possible use of a similar approach to predict attrition in the aviation training program. It was reasoned that if a questionnaire could predict with fair accuracy whether or not a man would elect to remain in the service, a more comprehensive data pool should have considerably more predictive potential. This data pool would contain demographic information, standardized test scores, and available training data on each individual. The potential of such an approach was emphasized by the success of a similar approach for the Navy's aviation training program.[3]

[1] Paul W. Caro, Jr., Robert N. Isley, and Oran B. Jolley. *The Captive Helicopter as a Training Device: Experimental Evaluation of a Concept*, HumRRO Technical Report 68-9, June 1968.

[2] H. Alton Boyd, and Wiley R. Boyles. *Attitudes as Predictors of Retention for Army Pilots*, HumRRO Professional Paper 14-69, May 1969. AD-688 816

[3] Richard F. Booth, George M. Rickus, Jr., and Rosalie K. Ambler. *Predicting the Career Naval Flight Officer*, NAMI-1070, Naval Aerospace Medical Institute, Naval Aerospace Medical Center, Pensacola, Florida, May 1969. AD-690 896

A feasibility study of this multivariate approach was approved during the third quarter of FY 1968, under the designation of Exploratory Research 70. ER-70, which was completed in FY 1969, was the direct precursor of Work Unit PREDICT. It also produced the Background Activities Inventory (BAI).[1] This Inventory, further discussed by Prophet,[2] was a questionnaire containing items concerning the willingness of the individual to expose himself to the threat of physical harm. One concern in ER-70 was the utility of the BAI and similar instruments for predicting performance under stress as in pilot training or combat. The initial data looked promising, and the BAI was examined further under Work Unit PREDICT. In 1968, a plan to develop computerized multiple correlation predictor systems for use in the Army's aviation program was discussed.[3]

Work Unit PREDICT[4] began formally in the fourth quarter of FY 1969. The first two years of the program were spent in developing the system and gathering the data.[5] Since it took 40 weeks at that time for a man to go through the aviation training program, and since at least a six-month quota of students was required for statistical analyses, no analyses could be initiated until the beginning of the second quarter of FY 1970. In the interim, a number of small studies were conducted to explore the potential of many variables as predictors. Some of these studies are referred to in the next section.

EXPLORATION OF POTENTIAL PREDICTORS

Preliminary Research

The possibility of birth order as a predictor variable was explored, but no significant differences were found.[6]

The potential of a peer rating was examined.[7] The validity coefficients obtained indicated that the peer rating then in use in primary helicopter flight training would probably be an excellent predictor in the multivariate system. Unfortunately, the peer rating was changed, and became considerably less reliable. Therefore, it was not included in the predictive equations.

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[1] Wiley R. Boyles. *Measures of Reaction to Threat of Physical Harm as Predictors of Performance in Military Aviation Training*, HumRRO Professional Paper 15-69, May 1969. AD-688 817

[2] Wallace W. Prophet. *Human Factors in Aviation: Some Recurrent Problems and New Approaches*, HumRRO Professional Paper 30-67, June 1967. AD-656 971

[3] Wallace W. Prophet. *Prediction of Aviator Performance*, HumRRO Professional Paper 5-69, February 1969.

[4] All of the data reported in this document were gathered at the U.S. Army Primary Helicopter School (USAPHS) at Fort Wolters, Texas. On 30 July 1973, the USAPHS began closing and primary training was initiated at the U.S. Army Aviation School (USAAVNS), Fort Rucker, Alabama, with consequent changes in the syllabus and terminology. For example, the functions of the Student Evaluation Review Counsel (SERC) at Fort Wolters have been assumed by the Faculty Board at Fort Rucker. It should be kept in mind that the PREDICT research was based on data gathered during the time when USAPHS was in operation and is, therefore, tailored to the program and management structure that existed at that time. While many changes have resulted from the transfer of primary training, the general problems of trainee attrition and its relationship to trainee aptitudes, psychological and sociological factors, and performance probably are similar in the new training setting.

[5] See Appendix E for the original PREDICT technical plan developed during this period. This plan describes the general rationale and the detailed data collection procedures used.

[6] Peter R. Prunkl. *Factors in Predicting Army Aviator Performance: Birth Order and Participation in Dangerous Sports and Activities*, HumRRO Professional Paper 13-69, May 1969. AD-688 812

[7] J. L. Wahlberg, Wiley R. Boyles and H. Alton Boyd. *Peer Ratings as Predictors of Success in Military Aviation*, HumRRO Professional Paper 1-71, March 1971. AD-721 695

The Flight Aptitude Selection Test (FAST), while developed by Kaplan[1] as a primary selection instrument, was determined also to be a strong predictor of flight deficiency eliminations among students already in the program.[2] There are two separate FAST tests, one for the selection of Warrant Officer Candidate (WOC) students, and one for the selection of officer students.

Literature Review

The training literature was surveyed in order to identify types of variables that had been successful in previous attempts to predict trainee performance. Two studies published by the Naval Aerospace Research Laboratory demonstrated a correlation between procurement source and amount and type of attrition in Naval aviation training.[3] Wherry and Hutchins found that the use of procurement source in dichotomized form in the computation of the multiple prediction formulae resulted in increases in the formulae's validity for both officers and non-officers. Wherry also developed a procedure, known as the pseudovariable technique, for handling nominal data that might occur in classification (e.g., procurement source) in the multiple regression analyses.[4]

A number of prior studies have shown correlations between rank and age upon entry into flying training programs, and performance in those programs.[5] In the Kaplan study, which established the FAST battery for primary selection (i.e., selection of candidates for the aviation program), rank and age were negatively related to flight grades, but positively related to leadership evaluations. In that study, it was concluded that this variable would be ineffective for selection because of the reversal across flight grades and leadership evaluations. In general, the lower ranking and younger students tend to be better pilots while the higher ranking and older students tend to be better leaders. Kaplan argued that since the Army wishes to train people who will be both good leaders and good flyers, a restrictive policy on rank would lead to an increase on one performance measure but a decrease on another. Of course, lower ranking, younger officers become higher ranking, older officers. It would appear, therefore, that a good case could be made for restricting the upper age group.

[1] Harry Kaplan. *Prediction of Success in Army Aviation Training*, Technical Research Report 1142, U.S. Army Personnel Research Office, Washington, June 1965.

[2] Wiley R. Boyles, and James L. Wahlberg. *Prediction of Army Aviator Performance: Description of a Developing System*, HumRRO Professional Paper 5-71, April 1971. AD-721 696.

[3] R. J. Wherry, Jr., and C. W. Hutchins, Jr. *An Investigation of Unpredicted Differences in Attrition Rates Among Students From Different Procurement Sources*, U.S. Naval School of Aviation Medicine Report USAM-907, Pensacola, Florida, October 1964.

R. J. Wherry, Jr., and C. W. Hutchins, Jr. *The Use of Procurement Source as a Predictor of Success in Training*, Special Report 65-5, U.S. Naval School of Aviation Medicine, Pensacola, Florida, July 1965.

[4] R. A. Bottenberg and R.E. Christal. *An Interactive Technique for Clustering Criteria Which Retains Optimum Predictive Efficiency*, WADD-TN-61-30, Personnel Laboratory, Lackland AFB, Texas, 1961.

R. J. Wherry, Jr. *Toward an Optimum Method of Equating Subgroups Composed of Different Subjects*, Monograph 9, U.S. Naval School of Aviation Medicine, USAM Medical Center, Pensacola, Florida, August 1964.

[5] C. W. Hutchins, Jr. *Relationship Between the Rank of Incoming Officers and Success in Flight Training*, Report 911, U.S. Naval School of Aviation Medicine, Pensacola, Florida, November 1964.

Kaplan, *op. cit.*

In another investigation of the rank/age factor, Hutchins found that rank was a valid predictor variable for success in Naval aviation training.[1] In addition, he found that the higher ranking officers attrited more often by means of the DOR (Dropped on Request) category than did the lower ranking officers. In the Army situation, self-initiated elimination (SIE), which is comparable to the Navy's DOR category, has, at various points in time, been one of the major attrition problem areas.

In his 1965 study, Kaplan found that the presence or absence of previous flight training was related to the probability of an individual's passing the flight training course. In the same study he found low correlations between educational level and the various training performance criteria within the training program. In general, the correlations were positive with academic performance, and negative with flight and leadership performances.

Cognitive tests were found to be strong predictors of academic performance in the Warrant Officer Candidate helicopter training program.[2] Of those investigated by Kaplan, the General Technical (GT) score, which is a component of the Army Classification Battery (ACB) taken by all enlisted men at the time of their induction into the Army, had the highest single correlation with academic performance of all of the measures investigated in the FAST validation study. This score is derived from arithmetic reasoning and verbal scores of the ACB.

Academic courses in which success has been shown to be related to the probability of completion of the Navy flight training course were mathematics, physics, navigation, engineering, aerodynamics, and physiology.[3] The Army aviation academic examination program is not divided in terms of classic technical or academic subject matter areas, but some of the subject matter is identifiable at various points in the Airmanship (AME), Warrant Officer Development (WDE), and Rotary Wing Course (RWC) Examination series.[4] Table 1 provides examples of similarities between the Army and Navy academic programs. Also included are the point biserial correlations of the Navy test scores in these content areas with the complete/attrite criterion in the Navy program. These correlations can be found in the Shoenberger, Wherry, and Berkshire publication. In view of this, it was felt that the Army academic examination scores would be worthy of investigation as potential predictor variables.

Also, Shoenberger *et al.* determined that in the Navy, once flight grades are available, they become the strongest single predictor of future performance for non-officers and officers through the remainder of the training program. While the average grade for the previous phase of flight is the strongest predictor in each case, the flight grades for non-officers from the pre-solo period are significant contributors to prediction for every subsequent phase of the program.

Lane and Peterson[5] found that an individual's college major correlates well with success in the Navy aviation training program. Generally, individuals with engineering

[1] Hutchins, *op. cit.*

[2] Kaplan, *op. cit.*

[3] R. W. Shoenberger, R. J. Wherry, Jr., and J. R. Berkshire. *Predicting Success in Aviation Training*, Research Report Number 7, U.S. Naval School of Aviation Medicine, Pensacola, Florida, September 1963.

[4] The reader should keep in mind that some of this terminology and course organization may have changed as a result of the move from USAPHS to USAAVNS.

[5] Norman E. Lane and Floyd E. Peterson. *College Major Differences in Naval Flight Officer Training Performance*, Special Report 66-7, U.S. Naval Aerospace Medical Institute, U.S. Naval Aviation Medical Center, Pensacola, Florida, November 1966.

Table 1

Comparison of Army and Navy Academic Content Areas

Army Examinations[a]	Navy Content Area	Navy Point-Biserial Correlations With Complete/Attrite	
AME 1	Aerodynamics	Non-officers	.144
		Officers	.151
AME 2 and 3	Engineering	Non-officers	.124
		Officers	.168
AME 4, 5, 6, 7, 12, and 15	Physics	Non-officers	.105
		Officers	--
AME 16, 17	Math	Non-officers	.150
		Officers	.122
AME 11, 13, and 14; WDE 7 and 8; RWC 1, RWC 2	Navigation	Non-officers	.162
		Officers	.147

[a]AME, Airmanship; WDE, Warrant Officer Development; RWC, Rotary Wing Course.

backgrounds performed better than those with nontechnical backgrounds. Physical education majors performed significantly worse than the other majors. In another study, Rimland[1] determined that skill in sports bears no relationship, positive or negative, to officer performance and career motivation.

[1] Bernard Rimland. *The Relationship of Athletic Ability, Sports Knowledge and Physical Proficiency to Officer Performance and Career Motivation*, Technical Bulletin 61-12, Bureau of Naval Personnel, Washington, August 1961.

METHOD

SUBJECTS

The data bank used in this research included entries on virtually all trainees in the Warrant Officer Rotary Wing Aviator Course (WORWAC) Classes 69-05 through 70-49 and the Officer Rotary Wing Aviator Course (ORWAC)[1] Classes 69-06 through 70-50. The exception is a gap of approximately six months occurring the last half of FY 1969; specifically, WORWAC Classes 69-31 through 69-49, and ORWAC Classes 69-32 through 69-50 are missing.

The chronological class designations are based on the time of entry of a class. Forty weeks were required for the training program in 1969. In addition, six months of data were needed to obtain an adequate sample. Thus, even though the first class of the first sample began the program in September 1968, the data of the last class in that six-month sample were not available for analysis until December 1969.

These data were divided into three samples. The FY69 sample included Classes 69-05 through 69-29 for WORWACs. The ORWAC data for Classes 69-06 through 69-30 were not analyzed. Six months after completion of the FY69 data, additional data were gathered for cross-validation purposes. This FY70 sample included WORWAC Classes 70-01 through 70-23, and ORWAC Classes 70-02 through 70-24. The remaining data were gathered as insurance in case a third analysis was needed, but the third analysis was not necessary.

Summaries of the demographic data and the collapsed variables used in the analyses are given in Appendices A-D. A brief description of a few of the demographic characteristics of the warrant officer and officer students is given here so the reader will have an idea of the general characteristics of the student samples.

Warrant Officers. The FY69 Warrant Officer sample[2] contained 2,799 Warrant Officer Candidates (WOCs). The FY70 sample contained 1,826 WOC students. Based upon the 1969 sample, the ages of the entering Warrant Officer Candidate (WOC) ranged from 18 to 34 years, with a mean of 20.9, a median of 20, and a mode of 19. The mean education of the WOC was 12.9 years, the median was very close at 13 years of education, while the mode was 12 years. The mean for months of prior service was 13.7, while the median and mode were both two months. Thus, the majority of the Warrant Officer Candidates in the 1969 sample had been in the service only a short period of time. The mean FAST score was 310.4 with a median of 307. The mean AFQT was 83.4 with a median of 87. Roughly 30% of the WOCs were currently married, 2% were divorced, and 68% were single. Approximately 74% of the WOCs were obtained through the enlistment option program,[3] while 26% were obtained from in-service sources.

[1] The WORWAC and ORWAC courses are often referred to collectively as the Initial Entry Rotary Wing Course (IERW).

[2] Warrant Officer Candidate classes received odd number designations (e.g., 69-05, 69-07). and officer class designations were even numbers (e.g., 69-06, 69-08).

[3] The enlistment option program allowed an individual volunteering for the service to select the type of job in which he would serve, provided he could qualify. The Aviation Warrant Officer Program was a popular choice. Those individuals entering the aviation program in this manner received their basic combat training at Fort Polk, Louisiana, and then went immediately to Fort Wolters for flight training. A high school diploma was required.

Officers. The officer data were analyzed only on the FY70 sample, which consisted of Classes 70-02 through 70-24 and included a total of 1,206 officers. Based upon the 1970 sample, the age of the officers in the aviation program ranged from 19 years to 45 years, with a mean of 24.6, a median of 23, and a mode of 23. The officers had a mean of 14.5 years of education, a median of 15 years, and a mode of 16 years. The range of education was from 9 to 20 years. The mean for months of prior service was 29.9, the median was 19, and the mode was 52. The range of months of prior service was from zero to more than 143 months. Sixty-seven percent of the officers were currently married. Thirty-two percent were single, and less than one percent were divorced. (Further details on these demographic variables and all of the variables used in the PREDICT system for both officers and warrant officers are available in Appendices A-C).

DATA COLLECTION

All the results reported in this study were derived from data obtained from the U.S. Army Primary Helicopter School (USAPHS) at Fort Wolters, Texas.

In the early stages of the research effort, a system for the transfer of biographical and training information from Fort Wolters to HumRRO was established. These data were forwarded on printed reports and standardized forms which were then in use at USAPHS. The documents were: (a) initial data printout (biographical data and class assignment information), (b) the block form (standardized test scores), (c) individual flight resumes (daily flight grades), and (d) individual academic resumes (results of Airmanship and Warrant Officer Development Examinations).

As this information was received, the academic grades, biographical data, and class assignment information were re-recorded on a form designated as the PREDICT Individual Data Record (PIDR). This procedure was necessary in order to consolidate information from several sources onto one record for key-punching. A more detailed explanation of the original transfer of data is reported in Section 3 of the original PREDICT planning paper reproduced as Appendix E of this report.

This system for data collection and recording was in effect through all of the FY69 classes and was continued with FY70 Classes 70-01 through 70-26. Beginning with Class 70-27, the transfer of data became fully automated—the Management Information Systems Office (MISO) at Fort Wolters began to ship the 80-column IBM cards created at the Fort Wolters Electronic Data Processing Center directly to the HumRRO Computer Center. These cards contained the same type of information which had previously been received on the printed forms and documents. Under the new system, the procedure for transferring data from the original source document to the PIDR was eliminated. The exclusion of this step greatly reduced the processing time for deriving new regression equations, but also created a significant time lag in the quality control of the data.

One of the major areas of concern during the receiving and editing of data was that of routine syllabus changes which occurred occasionally in the academic and flight portions of training. These changes required constant monitoring, since the data from which a set of predictive equations were derived had to be compatible with the data generated by the classes being evaluated.

For the period of time covered by this report, there were two major syllabus changes. Tables 2 and 3 note the status of the syllabus which was in effect when the project began. Table 2 outlines the 20-week training syllabus for Warrant Officer Candidates, and Table 3 outlines the 18-week training syllabus for the officers. (In preflight, Warrant Officer Candidates received two additional weeks of training.) It should be noted that Table 2 shows AME 18 although this is appropriate only for Classes 70-41 through 71-22. These programs were in effect for Classes 69-01/02 through Classes 71-21/22.

Table 2

Primary Academic and Flight Syllabus, by Week and Day of Training: Warrant Officer Candidates, Classes 69-01 Through 71-21

	Preflight (Week)				Flight Training (Week)															
Curriculum	1	2	3	4	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Academics																				
		WDE		AME		AME				WDE		AME	AME				WDE	WDE		
Mon.		2		5		8				11		13	14				13	14		
Questions		20		20		20				20		20	20				20	20		
Points		20		20		20				20		20	20				20	20		
		WDE	AME	AME							AME			WDE		WDE				
Tues.		3	1	6							12			11		12				
Questions		20	20	20							20			20		20				
Points		20	20	20							20			20		20				
		WDE	AME								WDE			AME				AME		
Wed.		4	2								10			15				17		
Questions		20	20								20			20				20		
Points		20	20								20			20				20		
			AME	AME			WDE	AME							AME				AME	
Thurs.			3	7			7	10							16				18	
Questions			20	20			20	20							20				20	
Points			20	20			20	20							20				20	
	WDE	WDE	AME		WDE	AME		WDE	WDE											
Fri.	1	5	4		6	9		8	9											
Questions	20	20	20		20	20		20	20											
Points	20	20	20		20	20		20	20											
Flight Hours																				
Solo								3:25	4:35	4:35	4:35	2:50	5:00	7:45	3:00	6:15	6:15	6:15	5:30	0:00
Cum. Solo								3:25	8:00	12:35	17:10	20:00	25:00	32.45	35:45	42:00	48:15	54:30	60:00	60:00
Dual					5:00	5:00	5:00	4:00	3:25	2:55	2:55	1:45	3:15	2:20	4:10	2:45	2:30	2:30	1:00	1:30
Cum. Dual					5:00	10:00	15:00	19:00	22:25	25:20	28:15	30:00	33:15	35:35	39:45	42:30	45:00	47:30	48:30	50:00
Wk. Total					5:00	5:00	5:00	7:25	8:00	7:30	7:30	4:35	8:15	10:05	7:10	9:00	8:45	8:45	6:30	1:30
Cum. Total					5:00	10:00	15:00	22:25	30:25	37:55	45:25	50:00	58:15	68:20	75:30	84:30	93:15	102:00	108:30	110:00
								Pre-Solo Ck.Rd. 16 hrs.					Pri I Ck.Rd. 50 hrs.							

Mil. Dev. Eval. Rec.

Table 3

Primary Academic and Flight Syllabus, by Week and Day of Training: Officers, Classes 69-02 Through 71-22

	Preflight (Week)		Flight Training (Week)															
Curriculum	1	2	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Academics		AME		AME				AME		AME	AME							
Mon.		3		8				11		13	14							
Questions		20		20				20		20	20							
Points		20		20				20		20	20							
		AME							AME			ODE		ODE				
Tues.		4							12			9		10				
Questions		20							20			20		20				
Points		20							20			20		20				
		AME										AME				AME		
Wed.		5										15				17		
Questions		20										20				20		
Points		20										20				20		
	AME	AME	ODE			AME							AME				AME	
Thurs.	1	6	1			10							16				18	
Questions	20	20	20			20							20				20	
Points	20	20	20			20							20				20	
	AME	AME		AME														
Fri.	2	7		9														
Questions	20	20		20														
Points	20	20		20														
Flight Hours																		
Solo						3:25	4:35	4:35	4:35	2:50	5:00	7:45	3:00	6:15	6:15	6:15	5:30	0:00
Cum. Solo						3:25	8:00	12:35	17:10	20:00	25:00	32:45	35:45	42:00	48:15	54:30	60:00	60:00
Dual			5:00	5:00	5:00	4:00	3:25	2:55	2:55	1:45	3:15	2:20	4:10	2:45	2:30	2:30	1:00	1:30
Cum. Dual			5:00	10:00	15:00	19:00	22:25	25:20	28:15	30:00	33:15	35:35	39:45	42:30	45:00	47:30	48:30	50:00
Wk. Total			5:00	5:00	5:00	7:25	8:00	7:30	7:30	4:35	8:15	10:05	7:10	9:00	8:45	8:45	6:30	1:30
Cum. Total			5:00	10:00	15:00	22:25	30:25	37:55	45:25	50:00	58:15	68:20	75:30	84:30	93:15	102:00	108:30	110:00
						Pre-Solo Ck.Rd. 16 hrs.					PRI I Ck.Rd. 50 hrs.							

Mil. Dev. Eval. Rec.

Table 4

Primary Academic and Flight Syllabus, by Week and Day of Training: Warrant Officer Candidates, Classes 71-23 Through 71-49

	Preflight (Week)				Flight Training (Week)															
Curriculum	1	2	3	4	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Academics																				
Mon.										WDE 5							AME 7			
Questions										40							40			
Points										80							80			
Tues.		WDE 1		AME 1		AME 2														
Questions		40		40		40														
Points		80		80		80														
Wed.											AME 4								AME 9	
Questions											20								40	
Points											40								80	
Thurs.			WDE 3											AME 6						
Questions			20											40						
Points			80											80						
Fri.		WDE 2					AME 3	WDE 4				AME 5					AME 8			
Questions		40					40	20				20					20			
Points		80					80	80				40					40			
Flight Hours																				
Solo								3:25	4:35	4:35	4:35	2.50	5:00	7:45	3:00	6:15	6:15	6:15	5:30	0:00
Cum. Solo								3:25	8:00	12:35	17:10	20:00	25:00	32:45	35:45	42:00	48:15	54:30	60:00	60:00
Dual					5:00	5:00	5:00	4:00	3:25	2:55	2:55	1:45	3:15	2:20	4:10	2:45	2:30	2:30	1:00	1:30
Cum. Dual					5:00	10:00	15:00	19:00	22:25	25:20	28:15	30:00	33:15	35:35	39:45	42:30	45:00	47:30	48:30	50:00
Wk. Total					5:00	5:00	5:00	7:25	8:00	7:30	7:30	4:35	8:15	10:05	7:10	9:00	8:45	8:45	6:30	1:30
Cum. Total					5:00	10:00	15:00	22:25	30:25	37:55	45:25	50:00	58:15	68:20	75:30	84:30	93:15	102:00	108:30	110:00
								Pre-Solo Ck. Rd. 16 hrs.					Pri I Ck. Rd. 50 hrs.							

Mil. Dev. Eval. Rec.

Table 5

Primary Academic and Flight Syllabus, by Week and Day of Training: Officers, Classes 71-24 Through 71-50

Curriculum	Preflight (Week) 1	Preflight (Week) 2	Flight Training (Week) 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Academics								ODE							AME			
Mon.								3							7			
Questions								40							40			
Points								60							120			
		AME		AME														
Tues.		1		2														
Questions		40		40														
Points		120		120														
									AME								AME	
Wed.									4								9	
Questions									20								40	
Points									60								120	
			ODE									AME						
Thurs.			1									6						
Questions			20									40						
Points			0									120						
					AME	ODE				AME					AME			
Fri.					3	2				5					8			
Questions					40	20				20					20			
Points					120	40				60					60			
Flight Hours																		
Solo						3:25	4:35	4:35	4:35	2:50	5:00	7:45	3:00	6:15	6:15	6:15	5:30	0:00
Cum. Solo						3:25	8:00	12:35	17:10	20:00	25:00	32:45	35:45	42:00	48:15	54:30	60:00	60:00
Dual			5:00	5:00	5:00	4:00	3:25	2:55	2:55	1:45	3:15	2:20	4:10	2:45	2:30	2:30	1:00	1:30
Cum. Dual			5:00	10:00	15:00	19:00	22:25	25:20	28:15	30:00	33:15	35:35	39:45	42:30	45:00	47:30	48:30	50:00
Wk. Total			5:00	5:00	5:00	7:25	8:00	7:30	7:30	4:35	8:15	10:05	7:10	9:00	8:45	8:45	6:30	1:30
Cum. Total			5:00	10:00	15:00	22.25	30:25	37.55	45.25	50:00	58:15	68:20	75:30	84:30	93:15	102:00	108:30	110:00

Mil. Dev. Eval. Rec.

Table 6

Primary Academic and Flight Syllabus, by Week and Day of Training: Warrant Officer Candidates, Classes 72-03 Through Present Date

	Preflight (Week)				Flight Training (Week)													
Curriculum	1	2	3	4	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Academics																		
		WDE																
Mon.		1																
Questions		40																
Points		80																
				AME		AME				WDE								
Tues.				1		2				5								
Questions				40		40				40								
Points				80		80				80								
	Begin										AME			AME	AME			
Wed.	Train.										4			6	7			
Questions											20			40	40			
Points											70			80	80			
			WDE															
Thurs.			3															
Questions			20															
Points			80															
		WDE					AME	WDE				AME				AME		
Fri.		2					3	4				5				8		
Questions		40					40	20				20				20		
Points		80					80	80				70				60		
Flight Hours																		
Solo								5:00	5:45	5:45	5:45	5:45	5:45	5:45	6:00	5:45	5:45	3:00
Cum. Solo								5.00	10:45	16:30	22:15	28:00	33:45	39:30	45:30	51:15	57:00	60:00
Dual					5:00	5:00	5:00	2:30	2:30	2:30	2:30	2:30	2:30	2:15	2:15	2:15	2:15	1:00
Cum. Dual					5:00	10:00	15:00	17:30	20:00	22:30	25:00	27:30	30:00	32:15	34:30	36:45	39:00	40:00
Wk. Total					5:00	5:00	5:00	7:30	8:15	8:15	8:15	8:15	8:15	8:00	8:15	8:00	8:00	4:00
Cum. Total					5:00	10:00	15:00	22:30	30:45	39:00	47:15	55:30	63:45	71:45	80:00	88:00	96:00	100:00
								Pre-Solo Ck. Rd. 16 hrs.				Pri I Ck. Rd. 50 hrs.					Pri II Ck. Rd. 90 hrs.	

Mil. Dev. Eval. Rec.

Table 7

Primary Academic and Flight Syllabus, by Week and Day of Training: Officers, Classes 72-04 Through Present Date

	Preflight (Week)		Flight Training (Week)													
Curriculum	1	2	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Academics						ODE							AME			
Mon.						2							7			
Questions						20							40			
Points						40							120			
		AME		AME				ODE								
Tues.		1		2				3								
Questions		40		40				40								
Points		120		120				60								
									AME							
Wed.									4							
Questions									20							
Points									100							
			ODE									AME				
Thurs.			1									6				
Questions			20									40				
Points			0									120				
					AME					AME				AME		
Fri.					3					5				8		
Questions					40					20				20		
Points					120					100				120		
Flight Hours Solo						5:00	5:45	5:45	5:45	5:45	5:45	5:45	6:00	5:45	5:45	3:00
Cum. Solo						5:00	10:45	16:30	22:15	28:00	33:45	39:30	45:30	51:15	57:00	60:00
Dual			5:00	5:00	5:00	2:30	2:30	2:30	2:30	2:30	2:30	2:15	2:15	2:15	2:15	1:00
Cum. Dual			5:00	10:00	15:00	17:30	20:00	22:30	25:00	27:30	30:00	32:15	34:30	36:45	39:00	40:00
Wk. Total			5:00	5:00	5:00	7:30	8:15	8:15	8:15	8:15	8:15	8:00	8:15	8:00	8:00	4:00
Cum. Total			5:00	10:00	15:00	22.30	30:45	39:00	47:15	55:30	63:45	71:45	80:00	88:00	96:00	100:00

Mil. Dev. Eval. Rec.

Tables 4 and 5 outline for the WOCs and officers, respectively, the first program of instruction syllabus change which began with Classes 71-23/24 and continued through Classes 71-49/50. Tables 6 and 7 represent the same information for the second syllabus change covering the time period beginning with Classes 72-03/04.

Inspection of these tables, shows that the major syllabus changes included a reduction in the number of Airmanship Examinations, Warrant Officer Development Examinations, Officer Development Examinations, and the overall time in training. Also, it should be noted that the number of questions and the total contribution of points toward the final academic grade were modified considerably in the two syllabus changes.

SELECTION OF VARIABLES

A literature review and some small research projects contributed greatly to the selection of variables. These efforts were documented in the introduction to this report. Generally speaking, there were three primary criteria for the selection of variables for inclusion in the PREDICT data bank. First, similar studies, conducted principally by the Navy, have revealed a large number of variables which have predictive validity. These variables or their analogues were examined for their predictive potential in the Army aviation training system. Second, there were a number of potential predictors that seemed to have face validity; that is, they logically should have been predictors. Many of these were examined. Third, there were a large number of variables which were easily available from Army records, but about which no further information was known. A number of these were also examined.

Unfortunately, there were also some variables which were proven to be good predictors in the Navy system, but which were unavailable in the Army system. For example, the Navy uses a peer rating system initially administered prior to the ninth week of flight training. In the Navy's ninth and tenth week matrix, this produces a complete/attrite correlation of .195 using the point biserial correlation statistic.[1] The Army at one time had a peer rating which looked very promising.[2] Unfortunately, a change in that peer rating made it unusable during the period of this study.

In the process of selecting variables to be recorded for future analysis, a number of small studies were conducted to determine the predictive potential of some of them. Several of these studies were concerned with a Background Activities Inventory (BAI). This Inventory was developed at HumRRO Central Division (D) for the purpose of evaluating the predictive potential of certain demographic and attitude variables, such as history of willingness to participate in dangerous sports and expressed confidence in one's ability. The BAI did not add any predictive capability over other variables available without a special test administration.[3] The birth order variable was eliminated as a potential predictor on the basis of a study by Prunkl.[4] Thus, these two attempts to add apparently good predictors by administering psychological instruments to the students failed to produce anything worthy of inclusion. Since it was desired that no new administrative burden be placed on the Army in the form of administration of tests or development of data not already part of the normal Army system, and in view of the failure to come up with strong evidence to support their inclusion, it was decided that no variables or test scores would be included in the PREDICT system other than already pre-existing Army data.

[1] Shoenberger, Wherry, and Berkshire, *op. cit.*

[2] Wahlberg, Boyles, and Boyd, *op. cit.*

[3] Boyles, *op. cit.*

[4] Prunkl, *op. cit.*

One potential pre-existing predictor was not included. The Pilot Performance Description Record (PPDR) is a standardized performance rating scale given during checkrides at the Primary Helicopter School.[1] Unfortunately, not all of the students in the FY69 and FY70 classes were administered the PPDR because of the time required for its administration and the sudden and dramatic increase in the number of aviators being trained at that time. These pressures have been relieved, and future analyses could utilize PPDR data.

Many of the individual variables that were included in the data bank might be considered to be components of single, larger variables. For example, the mean of all of the flight grades prior to solo flight might be used in place of the individual grades. In view of the computational and data handling problems involved, and since predictions were required at seven different points during the course of training, means were taken that represented the student's progress to that point in each of the flight, academic, and Warrant Officer Development areas at the time that a given equation was computed.

All of the variables recorded in the data bank are shown in Appendices A-C. Of the larger number, some 36 variables were actually used in the equations at one point or another. These are given in Table 8. A comparison of the variables in this table with the variables listed in Appendices A-C will show that there are many that were neither used individually, nor collapsed and used collectively. The individual variables were examined for their predictive potential prior to inclusion in the multiple regression format. Those which, upon inspection, showed a low correlation with the criterion were excluded from the analysis. Most of these were nominal information. That is, they were simply classifications such as commission source (Academy, ROTC, etc.). This type of information often has a very low predictive power due to the insensitivity inherent in having only two or three categories into which everyone must be placed, and to the lack of any ordinal relationship among the categories. The possibility of the existence of suppressor variables was not treated in this analysis.

Where a nominal variable appeared promising, two choices were considered for the treatment of nominal data. The first choice uses data as modifier variables. Each category defines a separate subpopulation for which separate equations would be calculated. The disadvantage of this approach is that it fractionates the sample population and multiplies the number of equations necessary for adequate prediction of the entire population.

The second alternative, known as the "pseudovariable technique," avoids this problem.[2] In this technique, each of the categories of a nominal variable—such as hair color—is treated as a separate dichotomy. A zero or one is entered in each category for every subject; the zero indicates that the category is not correct for that subject while a one indicates that it is. In the example, if the sample is divided into blondes, brunettes, and red-heads, a red-headed subject would receive a one for that category (i.e., variable), and a zero for the other two categories. Each of the separate categories is then entered into the multiple regression format as a separate variable.

[1] George D. Greer Jr., Wayne D. Smith, and Jimmy L. Hatfield. *Improving Flight Proficiency Evaluation in Army Helicopter Pilot Training*, HumRRO Technical Report 77, May 1962. AD-276 115.

George D. Greer, Jr., Wayne D. Smith, Jimmy L. Hatfield, Carroll M. Colgan, and John O. Duffy. *PPDR Handbook: Use of Pilot Performance Description Record in Flight Training Quality Control*, HumRRO Research By-Product, December 1963.

John O. Duffy and Carroll M. Colgan. *A System of Flight Training Quality Control and its Application to Helicopter Training*, Consulting Report, June 1963. AD-419 081

[2] Bottenberg and Christal *op. cit*

Wherry, *op. cit.*

Table 8

Variables Used in Warrant Officer Regression Equations

Variable	Population and Criterion		
	FY 1969	FY 1970	FY 1970
	Pass/Fail	Pass/Fail	Class Standing
Rank (Enlisted Grade—E1 Through E9)	√	√	√
Age (Years)	√	√	√
Months Prior Service	√	√	√
Education (Years)	√	√	√
Prior Flight Training (Yes/No)	√	√	√
FAST Score (Actual Score)	√	√	√
GT Score (Actual Score)	√	√	√
Number of Dependents	√	√	√
AFQT (Actual Score)	√	√	√
Marital Status (Yes/No)	√	√	√
Procurement Source (In Service/Enlisted)	√	√	√
AME 1-7	√	√	√
AME 1-8	√	--	--
AME 1-9	√	--	--
AME 8-9	--	√	√
AME 8-10 ($\bar{X}$ of Actual Scores)	√	--	--
AME 8-12	√	--	--
AME 10	--	√	√
AME 11	--	√	√
AME 13-17	√	--	--
WDE 51-53	--	√	√
WDE 51-55	√	--	--
WDE 51-56	√	--	--
WDE 54-56	--	√	√
WDE 56-58 ($\bar{X}$ of Actual Scores)	√	--	--
WDE 56-60	√	--	--
WDE 57-59	--	√	√
WDE 61-64	√	--	--
Pre-solo Flights 3-5 ($\bar{X}$ of Flight Grades)	√	--	--
Pre-solo Flights 3-7 ($\bar{X}$ of Flight Grades)	√	√	√
Pre-solo Average	√	√	√
Pre-solo Hours (Total Minutes	--	√	√
Primary Flights 1-5 ($\bar{X}$ of Flight Grades)	√	√	√
Primary Average	√	√	√
Advanced Average	√	--	--
Primary I Checkride Grade	--	√	√

CRITERIA

Two criteria were used in this study. The first was pass/fail, the simple indication of whether or not an individual completed his helicopter training successfully through the advanced phase at Fort Rucker and was graduated.

The second criterion was class standing, or end-of-course grade. The final end-of-course grade was based on the weighted scale used by Fort Wolters training authorities to arrive at class standing for the students. That weighted scale consisted of 45% flight grades, 35% military development points, and 20% academic grades. Tables 9 and 10 provide the method by which these scores were obtained for WOCs and officers, respectively.

During primary helicopter training a student could earn a maximum of 1000 points. At the end of the primary phase these points are ranked from high to low for all members of a given class and a class standing rank is assigned sequentially from the highest to the lowest points earned. The first column of Table 9 shows the three major components from which these 1000 points are derived. The subject areas for which the student is graded are outlined in column 2. For the flight grades, column 3 outlines the factors for deriving the total overall points which can be earned for each of the subject areas listed in column 2. For the academic and military development evaluations, column 3 is a description of the examinations or evaluations and also lists the maximum overall points that can be awarded for each. Column 4 is the sum of the points available for each of the three major components of the overall available points. The procedure and weights for deriving the maximum points which are included in a student's end-of-course grade are outlined in the fifth column, while column 6 is the maximum points available for each of the three major areas.

STATISTICAL ANALYSES

The first step in the analysis was to determine the nature of the relationships among the various pairs of variables. That is, it was necessary to determine whether the variables should be entered in their raw form, or whether some transgeneration should be made in order to convert the relationship between a pair of variables from curvilinear to linear. In order to do this it was first necessary to obtain plots of each pair of variables. This was accomplished using the BMD05D program from the BioMedical series by Dixon.[1] The paired frequencies for the variables were then sampled by hand and analyzed for the best fit relationship for an exponential curve, a power curve, and a linear relationship. In no case was the correlation using a transgeneration found to be higher than with a simple linear relationship. However, it is suspected that if the simple correlations were higher among the same variables, a transgeneration might be of advantage.

Next, a stepwise multiple regression was conducted using a HumRRO-generated program. This program computes a sequence of multiple linear regression equations in a stepwise manner. At each step, one variable is added to the regression equation. The variable added is the one that makes the greatest reduction in the error sum of squares. When the addition of another variable will make no further reduction in the error sum of squares, the program automatically terminates. However, it was found that the overwhelming majority of the variance was accounted for by the first five or fewer variables in the stepwise program. Since a large number of equations would be used by

[1] W. J. Dixon, (ed.) *BMD Bio Medical Computer Programs*, University of California Press, Los Angeles, 1970.

Table 9

Outline for Deriving Overall End-of-Course Grade, Warrant Officer Candidates

Curriculum	Course Content	Point Distribution and/or Calculation by Course	Overall Points	Calculation of Points for Class Standing	Maximum Points
Flight	Pre-Solo	(Instructor Pilot Evaluation [%] X 105) + (Checkride Evaluation [%] X 45)=150 pts		1. (Points earned) ÷ (Overall points) = Percent of overall points	
	Primary I	(Instructor Pilot Evaluation [%] X 175) + (Checkride Evaluation [%] X 75)=250 pts		2. (Percent of overall points) X 450 = Maximum possible points	
	Primary II	(Instructor Pilot Evaluation [%] X 175) + (Checkride Evaluation [%] X 75)=250 pts	650 pts		450
Academic	Warrant Officer Development	Sum of grades for five examinations on military related subjects = 400 pts		1. Same as flight	
	Airmanship	Sum of grades for eight examinations on flight related subjects = 600 pts	1000 pts	2. (Percent of overall points) X 200 = Maximum possible points	200
Military Development	Obtain and Maintain Military Standards	Weekly evaluation by training advisor/counsel (TAC) based on performance observations during a given week of training = 750 pts		1. Same as flight	
	Performance of Duty	Points awarded to student by TAC officer for performance of duty factors as they apply to a chain of command position = 250 pts	1000 pts	2. (Percent of overall points) X 350 = Maximum possible points	350

Sample Calculation

Flight Grades

Step 1.	Pre-Solo	IP average	= 89	(.89 X 105) + (.92 X 45)	=	134.8
		CK grade	= 92			
	Pri. I	IP average	= 82	(.82 X 175) + (.80 X 75)	=	203.5
		CK grade	= 80			
	Pri. II	IP average	= 87	(.87 X 175) + (.87 X 75)	=	214.50
		CK grade	= 87	Total		552.8

Step 2. 552.8 ÷ 650 = .85

Step 3. .85 X 450 = 382.5

Total Flight Component = 382.5

Academic Grades

1. WOE exams = 360 pts
   AME exams = 535 pts
   Total Aca 895 pts
2. 895 ÷ 1000 = .89
3. .89 X 200 = 178

Total Academic Component = 178

Military Development Grades

1. MD = 735
   CPR = 210
   Total 945
2. 945 ÷ 1000 = .94
3. .94 X 350 = 329

Total Mil. Dev. Component = 329

Total Grade

Flight component	382.5
Academic component	178.0
Mil. Dev. component	329.0
End-of-course grade	889.5

Table 10

Outline for Deriving Overall End-of-Course Grade, Officers

Curriculum	Course Content	Point Distribution and/or Calculation by Course	Overall Points	Calculation of Points for Class Standing	Maximum Points
Flight	Pre-Solo	(Instructor Pilot Evaluation [%] X 105) + (Checkride Evaluation [%] X 45)=150 pts		1. (Points earned) ÷ (Overall points) = Percent of overall points	
	Primary I	(Instructor Pilot Evaluation [%] X 175) + (Checkride Evaluation [%] X 75)=250 pts		2. (Percent of overall points) X 450 = Maximum possible points	
	Primary II	(Instructor Pilot Evaluation [%] X 175 + (Checkride Evaluation [%] X 75)=250 pts	650		650
Academic	Officer Development	Sum of grades for three examinations on military-related subjects = 100 pts		1. Same as flight	
	Airmanship	Sum of grades for eight examinations on flight-related subjects = 900 pts	1000	2. (Percent of overall points) X 350 = Maximum possible points	350

Sample Calculation

Flight Grades

Step 1.	Pre-Solo	IP average = 89	(.89 X 105) + (.92 X 45)	= 134.8
		CK grade = 92		
	Pri. I	IP average = 82	(.82 X 175) + (.80 X 75)	= 203.5
		CK grade = 80		
	Pri. II	IP average = 87	(.87 X 175) + (.87 X 75)	= 214.50
		CK grade = 87	Total	552.8

Step 2. 552.8 ÷ 650 = .85

Step 3. .85 X 650 = 492.5

Total Flight Component = 492.5

Academic Grades

1. ODE Exams = 90
   AME Exams = 850
   Total Aca 940

2. 940 ÷ 1000 = .94

3. .94 X 350 = 329

Total Academic Component = 329

Total Grade

Flight component	492.5
Academic component	329.0
End-of-course grade	821.5

the training personnel, it was decided to make the length of the equations uniform in order to avoid confusion. The best five predictor variables were used in every case, even though, in some cases, one or more of those five made a negligible contribution.

In order to provide as up-to-date a prediction as possible, at the most likely points in training where predictions could be used, the analyses were conducted at each of seven points during training for the total population, and at each of three points for the population of students nominated for possible expulsion (the SERC population). The seven points are given in Table 11 for the total population analyses and in Table 12 for the SERC population analyses. Only three equation periods were used in the analysis of the SERC population because the smaller population could not reasonably be further subdivided. It should be noted that the officer syllabus has only two weeks of preflight while the WOC has four. There was also a syllabus change, reducing both overall programs by two weeks.

Table 11

Relationships Between Regression Equations and Time in Training

Equation Number and Name	WORWAC 20-Week Syllabus ORWAC 18-Week Syllabus	WORWAC 18-Week Syllabus ORWAC 16-Week Syllabus
1. Start Preflight	First Week Preflight	First Week Preflight
2. End Preflight	Fourth Week Preflight (WORWAC)	Fourth Week Preflight (WORWAC)
3. End 5th Graded Pre-Solo Flight	Second Week Flight Training	Second Week Flight Training
4. End 7th Graded Pre-Solo Flight	Second Week Flight Training	Second Week Flight Training
5. End Pre-Solo	Fourth Week Flight Training	Fourth Week Flight Training
6. End 5th Primary Flight	Sixth Week Flight Training	Sixth Week Flight Training
7. End Primary I Flight	Ninth Week Flight Training	Eighth Week Flight Training

Table 12

Relationships Between Regression Equations and Time in Training—SERC Study

Equation Number and Name	WORWAC 20-Week Syllabus
1. End Preflight	First Week Preflight
2. End 5th Graded Pre-Solo Flight	Second Week Flight Training
3. End 5th Primary Flight	Sixth Week Flight Training

The seven time periods are not evenly spread throughout the training program. Originally only three equations were furnished. Four others were added at times indicated by the SERC as being more important. This resulted in several equations being very close to one another in time.

RESULTS

WARRANT OFFICERS

Pass/Fail Criterion—Warrant Officers

FY69 Sample—Total Population. Over 100 separate data entries were stored on each of the WOCs who completed training in the 1969 sample. An exact number cannot be given because some students received more grades than others, especially daily flight grades. Included among these 100 plus variables were a large number that were part of sequence of grades. For example, each of the Warrant Officer Development Examinations and each of the Airmanship Examinations was included as a separate entry. When the individual components of a given sequence were combined in such a way as to provide a single index for that sequence, such as the mean pre-solo flight grade, the number of variables was reduced. Twenty-five variables are listed in Table 13. However, no more than 21 were used in any one analysis.

The collapsing of variables by summing them, or taking their average, rather than using the total number of variables individually has at least two advantages, and at least one disadvantage. One advantage is purely statistical. The fewer variables you examine with the same size population, the more reliable your multiple correlation coefficient will be because fewer degrees of freedom are used. The second advantage is also statistical in nature, but is more easily grasped intuitively. As measures which are basically very similar in nature are combined (e.g., by taking their mean), the reliability of the combined index increases, since the mean of several measures is more reliable than the individual measures would be. The primary disadvantage is the danger that some indices which are really very different from one another will be combined simply because they happen to fall in superficially similar categories. In any event, all of those indices which appeared to be multiple measures of the same type of behavior were combined into single measures.

Table 14 provides the attrition of the 1969 sample by equation periods. The attrition data are also provided for the end of the Primary Phase of training and the end of the Advanced Phase of training even though no equations were provided for these times.[1] Looking at Table 14, it can be seen that a total of 518 students (18.5%) were attrited from the flight program by the end of their Primary Phase of training. Only 10

[1] The reader should be aware of a confusion in Army flight program terminology that existed for many years. For reference, training given at Fort Wolters was referred to as the *Primary Phase*, while that given at Fort Rucker was often referred to as the *Advanced Phase*. The Rucker training was actually subdivided into an *Advanced Instrument Phase* and an *Advanced Contact and Tactics Phase*. This distinction between *Primary* and *Advanced* was often confused by the fact that the Primary Flight Training Phase, as conducted at Fort Wolters, consisted of what was called a "primary" and an "advanced" portion. At the end of the "primary" portion (about the 13th week), a checkride was given. Upon passing this checkride, the individual proceeded to the "advanced" portion of his Primary Flight Training Phase. He then had to pass a second checkride to successfully complete the "advanced" portion of his Primary Flight Training Phase at Fort Wolters. Upon passing this second checkride, the individual proceeded to Advanced Flight Training Phase at Fort Rucker. To reduce the confusion resulting from the use of the terms "primary" and "advanced" within the Primary Phase, these portions of Fort Wolters training will be referred to as Primary I and Primary II, respectively.

Table 13

Variables Submitted for Analysis, FY69 Warrant Officer Sample
(Total Population)

Variable	Mean	Standard Deviation	Range of Values or Scores
Rank (Enlisted Grade—E1 Through E9)	2.1	1.5	1–9
Age (Years)	20.9	2.7	18–34
Months Prior Service	13.7	28.2	1–134
Education (Years)	12.9	1.2	9–19
Prior Flight Training (Yes/No)	0.2	0.4	1 or 0
FAST Score (Actual Score)	310.4	36.8	230–439
GT Score (Actual Score)	122.3	7.2	99–152
Number of Dependents	0.6	1.0	0–7
AFQT (Actual Score)	83.5	11.2	20–103
Marital Status (Yes/No)	0.3	0.4	1 or 0
Procurement Source (In Service/Enlisted)	1.7	0.4	1 or 2
AME 1-7 (X̄ of Actual Scores)	17.0	1.2	0–20
AME 1-8 (X̄ of Actual Scores)	17.1	1.2	0–20
AME 1-9 (X̄ of Actual Scores)	17.2	1.1	0–20
AME 8-10 (X̄ of Actual Scores)	17.6	1.2	0–20
AME 8-12 (X̄ of Actual Scores)	17.6	1.1	0–20
WDE 51-55 (X̄ of Actual Scores)	16.4	1.3	0–20
WDE 51-56 (X̄ of Actual Scores)	16.5	1.3	0–20
WDE 56-58 (X̄ of Actual Scores)	16.7	1.6	0–20
WDE 56-60 (X̄ of Actual Scores)	16.8	1.4	0–20
Pre-Solo Flights 3-5 (X̄ of Flight Grades)	2.4	0.6	1–4
Pre-Solo Flights 3-7	2.4	0.6	1–4
Pre-Solo Flight Average	2.5	0.5	1–4
Primary Flights 1-5	2.6	0.4	1–4
Primary Flight Average	2.7	0.3	1–4

additional individuals were attrited during the Fort Rucker Advanced Phase of their training. For this reason, the PREDICT effort concentrated on Primary rather than Advanced flight training.

Table 14 indicates that attrition was spread very unevenly throughout the program, with the bulk of it occurring early in the program (as it should for economic reasons). Remember that the "primary" flights are completed by the end of the 13th week in a 20-week Primary Phase program. At this time the student is given a checkride. If he passes the checkride, he begins the second portion of his Primary Phase flight training.

During FY69, the Primary Phase training program lasted for 20 weeks. Seven equations were provided to the Student Evaluation Review Council. These equations took advantage of all of the information available at these seven points in time in order to provide the SERC with as current an estimate of a student's predicted performance as possible.

Table 15 provides an accounting of the examination and usage of the collapsed variables in the "total population" analyses of the FY69 sample. The term "total population" refers to the fact that everyone in the FY69 sample was included in the

Table 14

Population Sizes and Attrition of FY69 Sample—Total Population, by Equation Period

Population	Equation Period								
	Preflight		Pre-Solo			Primary Flights			USAAVNS Fort Rucker
	Start Preflight	End Preflight	End of 5th Graded Pre-Solo Flight	End of 7th Graded Pre-Solo Flight	End Pre-Solo	End of 5th Graded Primary Flights	End Primary I	End Primary II	Advanced
Total Student Population Within Each Period	2799	2799	2762	2676	2655	2444	2405	2341	2281
Total Student Population Completing Training Within Each Period	2799	2762	2676	2655	2444	2405	2431	2281	2271
Total Student Population Eliminated From Training Within Each Period	0	37	86	21	211	39	64	60	10
Cumulative Total Eliminated From Training at End of Each Period	0	37	123	144	355	394	458	518	528
Percent of Population Eliminated From Training Within Each Period	0.00	1.32	3.11	0.78	7.94	1.59	2.66	2.56	0.43
Cummulative Percent Eliminated From Training at Each Point (N = 2,799)	0.00	1.32	4.39	5.14	12.68	14.08	16.36	18.50	18.86

equations, whether or not he was at that time nominated to appear before the Student Evaluation Review Council. A later portion of the Results Section will deal with a special study that used a subsample consisting solely of those individuals who were nominated to appear before the SERC. In Table 15, the numbers indicate the order of importance of the variables actually used in the equation; checkmarks indicate the other variables examined. Examination of Table 15 reveals that the demographic information that is available early in training tended to be used only until actual flight and academic records became available. As in previous research, early flight information is the best predictor of later flight performance.

Table 16 provides the regression coefficients and constants, the variable means and standard deviations, the standard errors of the estimate, the goodness-of-fit F ratios and degrees of freedom, and the multiple correlation coefficients for each of the seven equations. Since these equations are based on the pass/fail criterion, their application results in an estimate of the probability of a given individual's successfully completing his helicopter training through graduation at Fort Rucker.

Comparing Table 16 with Table 14, it can be seen that the multiple correlation coefficient tends to rise and fall with the proportion of individuals being attrited at any given time. This is a statistical artifact due to the decreasing proportion of individuals in the population who eventually fail as the students proceed through the later portions of training. However, looking at the standard errors of the estimate, it can be seen that even though the multiple correlation coefficient first increases with the time in the program, then decreases as attrition drops off, the standard errors of the estimate continue to decrease throughout the duration of the program. This suggests that the primary reason for the drop-off in the multiple correlation coefficient is statistical (i.e., due to the decreasing number of individuals being attrited), rather than to a drop in the inherent validity of the predictors.

The standard errors of the estimate, especially for the early equations, are relatively large. It is believed that this is due primarily to the fact that attrition from the program has less to do with overall flight and grade averages than with the occurrence of critical incidents. While individuals are often attrited for low academic or flight averages, more are probably attrited for failures on checkrides, for disciplinary reasons, or other critical incidents. Thus, while these equations were useful, their limitations were quite clear, and it was necessary to take measures to increase the predictive capabilities. The first such measure taken was the analysis of the subpopulation of individuals who were nominated to come before the Student Evaluation Review Council.

Utilization of 1969 WOC Pass/Fail Regression Equations. The regression coefficients given in Table 16 are weights which, when multiplied by the scores to which they pertain, furnish the predictive contribution of these particular variables. For example, utilizing the regression coefficients given for equation four, and utilizing scores for the "average man" for the five predictor variables required in that equation (i.e., Months Prior Service = 13.96, Marital Status = .31, etc.), it can be determined that the probability that the "average man" will pass the course is .85.[1]

FY69—SERC Subsample. Of the 2,799 Warrant Officer Candidates in the FY69 sample, excluding medical and self-initiated eliminations, a total of 715 individuals were nominated to appear before the Student Evaluation Review Council for possible expulsion from the program. Two sets of equations were developed on this population. First, equations were developed predicting the probability of successful completion of the course for the students prior to the Council's action. Thus, these equations predict both

[1] Reference to Table 14 reveals that 2,444 students entered the period of training subsequent to Equation No. 4 and that 374 of them (i.e., 211 + 39 + 64 + 60) subsequently attrited at Fort Wolters. This is 15% of the total and compares with the pair probability of .85 computed above.

Table 15

Examination and Usage of Variables in Analyses of FY69 Sample—Total Population

Equation	Rank	Age	Months Prior Service	Education	Prior Flight Training	FAST Score	GT Score	Number of Dependents	AFQT	Marital Status	Procurement Source	AME 1-7	AME 1-8	AME 1-9	AME 8-10	AME 8-12	WDE 51-55	WDE 51-56	WDE 56-58	WDE 56-60	Pre-Solo Flights 3-5	Pre-Solo Flights 3-7	Pre-Solo Flight Average	Primary Flights 1-5	Primary Flight Average
	Variable[a]																								
1. Start Preflight	√	√	√	4	3	1	√	√	5	2	√														
2. End Preflight	√	√	√	√	4	2	√	√	√	3	√	1					5								
3. End 5th Graded Pre-Solo Flight	√	√	5	√	√	√	√	√	√	3	√		2					4			1				
4. End 7th Graded Pre-Solo Flight	√	√	5	√	√	√	√	√	√	3	√		2					4				1			
5. End Pre-Solo	√	√	√	√	√	√	√	√	√	√	5			1				3				4	2		
6. End 5th Graded Primary Flight	√	√	√	√	√	√	√	√	√	√	5	√			4		√		1			√	3	2	
7. End Primary I Flights	√	√	√	√	√	√	√	√	√	√	√	√				1	5			3		2	√		4
Frequency of Variable Examination	8	8	8	8	8	8	8	8	8	8	8	4	2	1	1	2	3	3	1	1	1	4	3	1	1
Frequency of Selection as Predictor	0	0	2	1	2	2	0	0	1	4	2	1	2	1	1	1	2	3	1	1	1	3	2	1	1

[a]The numbers in the table opposite the seven equations indicate the order in which the first five variables appear in the stepwise multiple regression analyses. The checkmarks indicate the other variables included in that analysis.

Table 16

Regression Equations, FY69 Sample—Total Population

Equation Number and Name	Variables in Multiple	Mean	Standard Deviation	Coefficient	Constant	Standard Error of Estimate	*F* Ratio	*df*	*R*
1. Start Preflight	Education	12.93	1.18	0.0134	0.0509	0.766	26.12	5,2793	0.211
	Prior Flight Training	.22	.41	0.0518					
	FAST Score	310.42	38.61	0.0014					
	AFQT Score	83.48	11.20	0.0012					
	Marital Status	.30	.45	0.0889					
2. End Preflight	Prior Flight Training	.22	.41	0.0454	−0.5180	0.738	41.81	5,2756	0.266
	FAST Score	310.43	36.89	0.0010					
	Marital Status	.30	.45	0.0706					
	AME 1-7	17.04	1.25	0.0456					
	WDE 51-56	16.45	1.33	0.0132					
3. End 5th Graded Pre-Solo Flight	Months Prior Service	13.92	28.48	−0.0006	−0.4724	0.672	74.20	5,2670	0.349
	FAST Score	310.82	36.89	0.0005					
	Marital Status	.31	.46	0.0514					
	AME 1-8	17.10	1.19	0.0468					
	3rd-5th Pre-Solo Flights	2.41	.59	0.1499					
4. End 7th Graded Pre-Solo Flight	Months Prior Service	13.96	28.56	−0.0006	−0.4914	0.654	83.71	5,2649	0.369
	Marital Status	.31	.41	0.0590					
	AME 1-8	17.11	2.75	0.0368					
	WDE 51-56	16.47	1.28	0.0160					
	3rd-7th Pre-Solo Flights	2.38	0.55	0.1871					
5. End Pre-Solo	Procurement Source	1.73	0.44	0.0167	0.1198	0.503	21.28	5,2438	0.204
	AME 1-9	17.21	1.11	0.0264					
	WDE 51-56	16.50	1.24	0.0090					
	3rd-7th Pre-Solo Flights	2.54	0.48	0.0198					
	Pre-Solo Flight Average	2.49	0.50	0.0514					

(Continued)

Table 16 *(Continued)*

Regression Equations, FY69 Sample—Total Population

Equation Number and Name	Variables in Multiple	Mean	Standard Deviation	Coefficient	Constant	Standard Error of Estimate	*F* Ratio	*df*	*R*
6. End 5th Graded Primary Flight	Procurement Source	1.73	0.44	0.0182	0.1589	0.446	30.12	5,2399	0.243
	Pre-Solo Flight Average	2.50	0.49	0.0230					
	AME 8-10	17.64	1.20	0.0082					
	WDE 56-58	16.70	1.57	0.0211					
	First 5 Primary Flights	2.64	0.39	0.0758					
7. End Primary I Flights	AME 8-12	17.61	1.12	0.0169	0.4574	0.335	17.30	5,2335	0.189
	WDE 51-56	16.53	1.27	-0.0046					
	WDE 56-60	16.81	1.35	0.0106					
	3rd-7th Pre-Solo Flights	2.54	.47	0.0190					
	Primary Flight Average	2.71	.32	0.0234					

the current action of the Council, and its future action upon setbacks. The second set of equations was computed on those individuals who were set back (i.e., not eliminated from the program by the current action of the Council). This set of equations predicted the performance of those individuals who are given a second chance. Only three equation periods were used instead of the seven used in the total population sample because the smaller number of individuals in this sample required their combination into larger units in order to make the results more reliable.

Tables 17 and 18 provide the regression coefficients and constants, the variable means and standard deviations, the standard errors of the estimate, the goodness-of-fit F ratios and degrees of freedom, and the multiple correlation coefficients for each of the three equations for the "before SERC" and "after SERC" groups, respectively. The three time periods used in the equations are given as headings in Tables 17 and 18.

A comparison of Tables 17 and 18 with Table 16 reveals little statistical improvement in the equations. The multiple correlation coefficients are about the same. However, the SERC equations are based specifically on the populations in which there is a greater interest, namely the population of individuals who have been nominated to appear before the Review Council. Therefore, in spite of the fact that little improvement was shown statistically, the Student Evaluation Review Council reported a greater satisfaction in using the SERC equations as compared to the total population equations.

Cross Validation of FY69 Sample. It was originally planned to cross validate the FY69 sample on the FY70 sample. However, the large number of syllabus changes occurring between FY69 and FY70 dictated that the FY69 sample not be cross validated, but rather that a new sample be gathered in FY70, and that this new sample be subjected to concurrent cross validation.

FY70 Sample—Total Population. The total population of 1,826 WOC students in the FY70 sample was divided into two equal groups of 913 students for concurrent cross-validation purposes. The attrition data for one of these two half-samples are given in Table 19. Stepwise regressions were performed on the first of these two groups. The results of these analyses are given in Table 20. Two equation 7s are shown in Table 20, one excluding and one including the Primary I checkride as a predictor. The checkride grade was not available on everyone in the sample.

Comparing the results of these analyses with those of the FY69 sample, it can be seen that there is a worthwhile improvement in the multiple correlation coefficients. In addition, it can be seen that the standard errors of the estimate show the same consistently decreasing trend as in the 1969 sample. However, in spite of the improvement in the multiple correlation coefficients, greater predictive accuracy was desired. For this reason, a new criterion—class standing—was introduced into the analyses of the 1970 sample. These analyses are given in a later section.

Cross Validation of FY70—Total Population Analyses. The regression equations given in Table 20, and based upon half of the 1970 sample, were used to generate predicted probabilities of passing for the other half of the 1970 sample. Table 21 provides a comparison of the original multiple correlation coefficients with the correlation between the predicted probability and the actual pass/fail record of the second half of the 1970 sample. None of the differences between the correlations is significant at the $p < .05$ level. In addition, there was very little shrinkage[1] in the cross validation correlation coefficient.

[1] A cross validation correlation coefficient is obtained by computing the correlation of the weighted sums of the predictors with the criterion in a new sample. The difference between this correlation and the original correlation is called shrinkage. (C.I. Mosier. "Problems and Designs of Cross-Validation," *Journal of Educational and Psychological Measurement*; vol. 11, 1951, pp. 5-11).

Table 17

Regression Equations, FY69 Sample—Before SERC Subsample

Equation Number and Name	Variables in Multiple	Mean	Standard Deviation	Coefficient	Constant	Standard Error of Estimate	*F* Ratio	*df*	*R*
1. Start Preflight	Months Prior Service	16.54	32.21	0.0032	0.1988	0.849	3.83	5,203	0.294
	Education	12.70	1.16	0.0164					
	Prior Flight Training	0.17	0.37	-0.0659					
	FAST Score	297.25	33.59	-0.0007					
	Marital Status	0.28	0.48	0.0709					
2. End 5th Graded Pre-Solo Flight	Months Prior Service	14.11	29.66	-0.0017	-0.7610	0.958	4.14	5,406	0.220
	Prior Flight Training	0.09	0.29	-0.1216					
	Marital Status	0.28	0.50	0.0980					
	AME 1-8	16.57	1.30	0.0509					
	3rd-5th Pre-Solo Flights	2.47	0.47	0.1270					
3. End 5th Graded Primary Flight	Prior Flight Training	0.17	0.37	0.1316	-0.5021	0.954	4.93	5,188	0.340
	AME 1-7	16.60	1.30	-0.0529					
	3rd-7th Pre-Solo Flights	2.53	0.39	-0.1478					
	AME 8-10	17.23	1.19	0.0486					
	WDE 56-58	15.96	1.82	0.0890					

Table 18

Regression Equations, FY69 Sample—After SERC Subsample

Equation Number and Name	Variables in Multiple	Mean	Standard Deviation	Coefficient	Constant	Standard Error of Estimate	*F* Ratio	*df*	*R*
1. Start Preflight	Age	21.57	3.34	−0.0393	1.8491	0.871	2.49	5,70	0.389
	Months Prior Service	23.82	39.27	0.0048					
	Prior Flight Training	0.16	0.37	−0.2032					
	FAST Score	295.88	32.74	−0.0014					
	Number Dependents	0.60	1.01	0.0679					
2. End 5th Graded Pre-Solo Flight	Months Prior Service	16.08	32.08	−0.0027	0.2736	0.881	2.86	5,216	0.249
	Prior Flight Training	0.10	0.29	−0.1696					
	GT Score	122.43	7.89	−0.0040					
	AME 1-8	16.74	1.14	0.0409					
	3rd-5th Pre-Solo Flights	2.52	0.45	0.1221					
3. End 5th Graded Primary Flight	Age	21.03	3.01	−0.0228	0.0652	0.688	4.08	5,115	0.374
	AME 1-7	16.68	1.25	−0.0434					
	3rd-7th Pre-Solo Flights	2.52	0.38	−0.1452					
	AME 8-10	17.31	1.08	0.0930					
	WDE 56-58	16.32	1.72	0.0451					

Table 19

Warrant Officer Candidate Sample Size, FY70, by Equation Period

	Equation Period						
	Preflight		Pre-Solo			Primary I Flights	
Population	Start Preflight	End Preflight	End 5th Graded Pre-Solo Flight	End 7th Graded Pre-Solo Flight	End Pre-Solo	End 5th Graded Primary Flight	End Primary I Flights
One-half Student Population Within Each Equation Period	913	890	848	845	741	709	500
One-half Student Population Passed at Each Equation Period	636	626	634	635	643	640	475
One-half Student Population Failing Within Each Equation Period	277	264	214	210	98	69	25

Class Standing Criterion—Warrant Officers

As has been noted, one of the purposes of PREDICT was to aid agencies such as the SERC in integrating the information pertinent to pass/fail decisions for individual students. While the multiple correlations obtained were quite respectable for a secondary selection process, it was obvious that higher accuracy in predicting the criterion would be desirable. Another factor of concern was the nature of the criterion being predicted. Reference has already been made to some of the problems with the pass/fail criterion, such as the great influence of critical incidents and the effect that the pass/fail ratio can have on the multiple correlation and, hence, the accuracy of prediction. In addition, there were administrative problems in connection with the SERC's ability to use the predictions, since virtually all students appearing before the SERC would have pass/fail probabilities in excess of .50. Statistically, this was correct, but conceptually the SERC was uncomfortable with a system that predicted the students whom they were washing out had substantial probability of passing.

For these reasons, a predictive criterion that did not suffer these problems was sought. It was thought the prediction of percentile ranking of all of the individuals in the course would be such a criterion. It is a criterion that is easy to interpret. Unfortunately, percentile class ranking is not a criterion that is easy to work with mathematically, as it lacks the characteristics necessary for parametric statistical computations. However, final end-of-course grade does have the desired mathematical characteristics, and the percentile class standing can be computed from the distribution of final end-of-course grades. Therefore, equations were developed to predict this variable. A conversion graph is used to obtain the percentile class standing.

Table 22 provides the regression coefficients and constants, the variable means and standard deviations, the standard errors of the estimate, the goodness-of-fit F ratios and degrees of freedom, and the multiple correlation coefficients for the equation at each of the seven time periods. Comparing the data in Table 22 with those in Tables 16, 17, 18,

Table 20

Regression Equations, FY70 WOC Population, Pass/Fail

Equation Number and Name	Variables in Multiple	Mean	Standard Deviation	Coefficient	Constant	Standard Error of Estimate	*F* Ratio	*df*	*R*
1. Start Preflight	Rank	2.22	1.52	0.0375	-0.1431	0.447	9.91	5,908	0.227
	FAST Score	312.84	36.56	0.0021					
	Number Dependents	0.65	1.03	-0.0496					
	Marital Status	0.37	0.48	0.1682					
	Procurement Source	1.74	0.44	0.0521					
2. End Preflight	Prior Flight Training	0.16	0.37	0.0779	-1.1019	0.433	21.03	5,884	0.326
	FAST Score	312.02	35.70	0.0015					
	Number Dependents	0.67	1.08	-0.0509					
	Marital Status	0.37	0.48	0.2222					
	AME 01-07	17.57	1.19	0.0731					
3. End 5th Graded Pre-Solo Flight	Age	21.38	3.06	-0.0075	-1,3262	0.390	35.44	5,842	0.417
	FAST Score	313.22	35.68	0.0012					
	Marital Status	0.39	0.48	0.1270					
	AME 01-07	17.58	1.17	0.0600					
	3rd-5th Week Flights	2.71	0.43	0.2849					
4. End 7th Graded Pre-Solo Flight	FAST Score	312.84	35.58	0.0007	-0.9675	0.391	38.12	5,839	0.430
	GT Score	122.39	7.24	-0.0029					
	Marital Status	0.38	0.48	0.0962					
	AME 01-07	17.62	1.16	0.0529					
	3rd-7th Week Flights	2.58	0.45	0.3382					
5. End Pre-Solo	Marital Status	0.39	0.49	0.0633	-0.6657	0.328	23.00	5,736	0.368
	AME 01-07	17.67	1.15	0.0329					
	3rd-7th Week Flights	2.64	0.42	0.0875					
	WDE 57-59	16.77	1.67	0.0206					
	Pre-Solo Average	2.41	0.51	0.1401					

(Continued)

Table 20 *(Continued)*

Regression Equations, FY70 WOC Population, Pass/Fail

Equation Number and Name	Variables in Multiple	Mean	Standard Deviation	Coefficient	Constant	Standard Error of Estimate	*F* Ratio	*df*	*R*
6. End 5th Graded Primary Flight	Marital Status	0.40	0.49	0.0451	-0.2581	0.283	14.88	5,703	0.309
	AME 01-07	17.68	1.11	0.0263					
	3rd-7th Week Flights	2.65	0.41	0.0786					
	AME 08-09	17.56	1.53	0.0101					
	Primary 1-5	2.40	0.43	0.1217					
7. End Primary I Flights	AME 01-07	17.74	1.09	0.0167	0.2893	0.210	6.26	5,662	0.213
	WDE 51-53	17.52	1.33	0.0124					
	3rd-7th Week Flights	2.67	0.41	0.0454					
	Pre-Solo Average	2.48	0.49	0.0322					
	PS 04-PS 15 hrs	880.72	236.89	-0.0001					
7. End Primary I Flights, including checkride grade information	Education	17.82	1.05	-0.0177	0.2295	0.208	11.46	5,494	0.322
	WDE 57-59	17.54	1.37	0.0144					
	Pre-Solo Average	2.72	0.38	0.0554					
	PS 04-PS 15 hrs	2.51	0.48	-0.0001					
	PPDR	874.96	260.04	0.0079					

Table 21

Comparison of Multiple and Cross-Validation Correlation Coefficients for Pass/Fail Criterion, FY70 Warrant Officer Candidates Sample

Equation	Multiple Correlation Coefficient	Cross-Validation Correlation Coefficient
1. Start Preflight	.23	.22
2. End Preflight	.33	.28
3. End 5th Graded Pre-Solo Flight	.42	.39
4. End 7th Graded Pre-Solo Flight	.43	.48
5. End Pre-Solo Flight	.37	.35
6. End 5th Graded Primary Flight	.31	.22
7. End Primary I Flights	.21	.17

and 20, that deal with the pass/fail criterion, it can be seen that multiple correlation coefficients for the end-of-course grade criterion are considerably higher (R = .38 to .80) than those for the pass/fail criterion (R = .17 to .48).

Figure 1 provides a graphic display of the relationship between end-of-course grades and percentile ranking within the class. It can be seen from Figure 1 that an individual with a score of 83.25 would be at the 50th percentile of his class, while an individual with a predicted score of 90.5 would be at the 99th percentile of his class, and an individual with a score of 75.75 would be at the first percentile of his class.

Another feature of this graph is the ability to calculate probability limits. For example, if you wished to calculate the 90% confidence limits within which a given individual who has a specific predicted end-of-course grade will actually fall, you would first consult a table of the normal distribution to determine how many standard deviation units above and below the mean will encompass 90% of the population. This number is 1.65. Using, for example, equation four (end 7th Graded Pre-Solo Flight), the standard error of the estimate is equal to 1.974. This multiplied by the constant of 1.65 given a 90% boundary range equal to the predicted score ±3.26. Again using an example, suppose the individual's predicted end-of-course grade is 80. The range within which his actual grade should fall, at the 90% level of confidence, would then be from 76.74 to 83.26. Consulting Figure 1, it can be seen that his most probable actual percentile position would be at the 16th percentile, with his 90% probability range extending from the second percentile to the 50th percentile. Thus, you could say with some assurance that this individual will not complete the course with an end-of-course grade in the upper half of his class.

Cross Validation of the Class Standing Criterion. Table 23 presents the multiple correlation coefficients for the seven regression equations along with the correlation between the predicted end-of-course grade for the second half of the 1970 population and the actual end-of-course grade. The predicted end-of-course grade was based upon the equations derived from the first half of the 1970 sample. Thus, the correlation between the predicted and actual scores represents in this case a cross-validation correlation coefficient. A glance at Table 23 reveals that there was comparatively little shrinkage[1] in

[1] Mosier, *op. cit.*

Table 22

Regression Equations, FY70 WOC Population, Class Standing

Equation Number and Name	Variables in Multiple	Mean	Standard Deviation	Coefficient	Constant	Standard Error of Estimate	*F* Ratio	*df*	*R*
1. Start Preflight	Rank	2.31	1.55	0.0911	69.0813	2.576	21.90	5,634	0.384
	Education	13.06	1.25	0.2427					
	Prior Flight Training	0.18	0.38	0.8939					
	FAST Score	315.92	36.19	0.0199					
	GT Score	122.35	7.32	0.0384					
2. End Preflight	Prior Flight Training	0.18	0.38	1.0035	51.3525	2.157	85.28	5,634	0.634
	FAST Score	315.92	36.19	0.0109					
	Procurement Source	1.75	0.43	0.4117					
	AME 01-07	17.75	1.06	1.1432					
	WDE 51-53	17.53	1.30	0.4357					
3. End 5th Graded Pre-Solo Flight	FAST Score	315.92	36.19	0.0105	46.8270	2.040	110.24	5,634	0.682
	AME 01-07	17.75	1.06	0.9338					
	WDE 51-53	17.53	1.30	0.3244					
	WDE 54-56	16.76	1.53	0.3602					
	3rd-5th Week Flights	2.79	0.38	1.8560					
4. End 7th Graded Pre-Solo Flight	FAST Score	315.92	36.19	0.0096	46.660	1.974	126.47	5,634	0.707
	AME 01-07	17.75	1.06	0.9294					
	WDE 51-53	17.53	1.30	0.3199					
	WDE 54-56	16.76	1.53	0.3542					
	3rd-7th Week Flights	2.69	0.40	2.1889					
5. End Pre-Solo	AME 01-07	17.75	1.06	0.8362	46.2905	1.817	171.89	5,634	0.759
	WDE 51-53	17.53	1.30	0.2986					
	AME 08-09	17.61	1.49	0.2896					
	WDE 57-59	16.83	1.63	0.3991					
	Pre-Solo Average	2.50	0.48	2.1729					

(Continued)

Table 22 *(Continued)*

Regression Equations, FY70 WOC Population, Class Standing

Equation Number and Name	Variables in Multiple	Mean	Standard Deviation	Coefficient	Constant	Standard Error of Estimate	*F* Ratio	*df*	*R*
6. End 5th Graded Primary Flight	AME 01-07	17.75	1.06	0.9258	44.2142	1.746	196.65	5,634	0.780
	WDE 51-53	17.53	1.30	0.3732					
	WDE 57-59	16.83	1.63	0.4206					
	Pre-Solo Average	2.50	0.48	1.6071					
	Primary 1-5	2.71	0.36	1.9677					
7. End Primary I Flights	AME 01-07	17.75	1.06	0.9188	41.0621	1.664	229.61	5,634	0.803
	WDE 51-53	17.53	1.30	0.3864					
	WDE 57-59	16.83	1.63	0.4135					
	Pre-Solo Average	2.50	0.48	1.4145					
	Primary Average	2.75	0.28	2,2677					

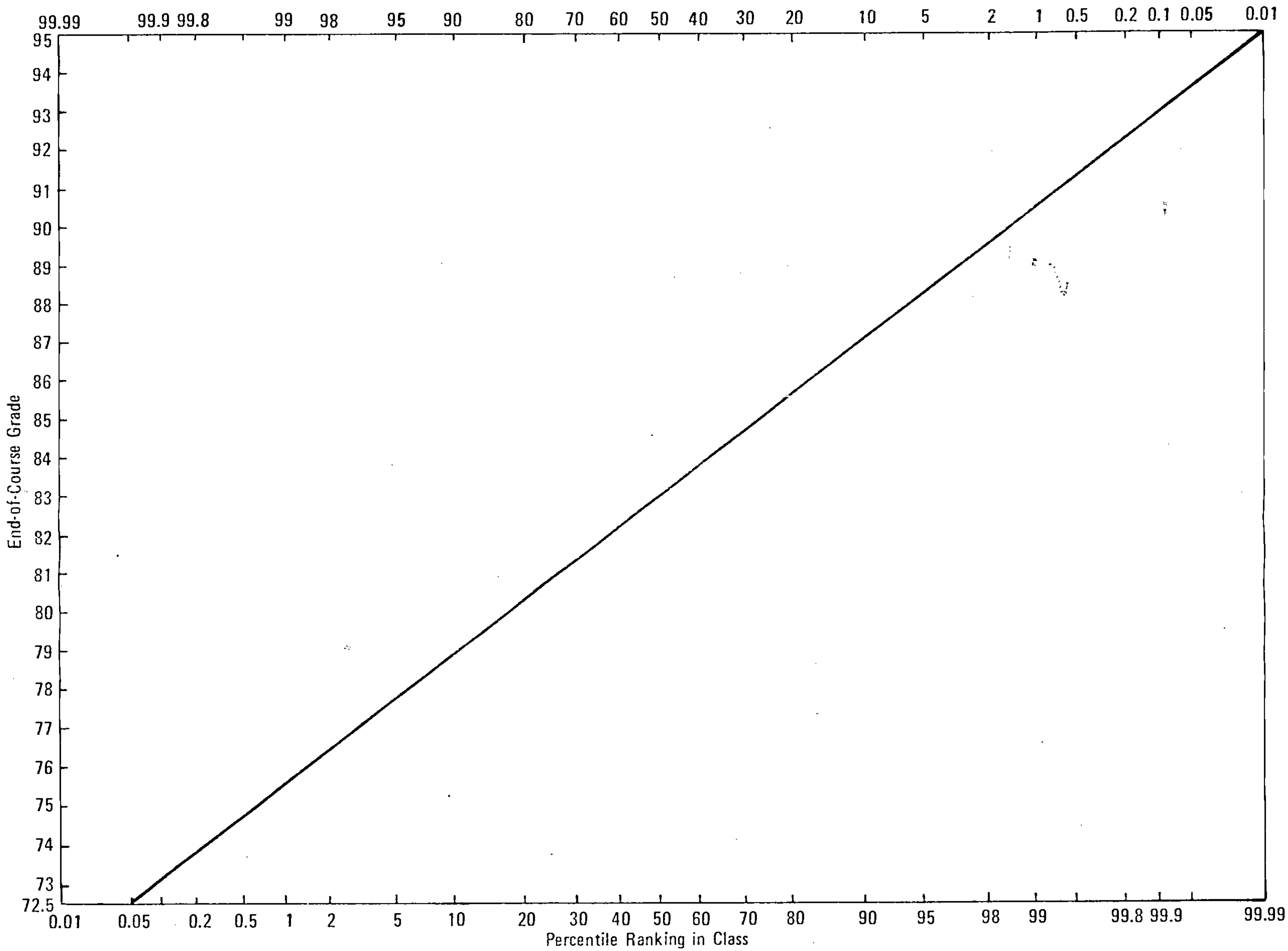

Figure 1 – **Relationship of End-of-Course Grades to Percentile Ranking, FY70 WOC Population**

Table 23

Comparison of Multiple and Cross-Validation Correlation Coefficients, FY70 Warrant Officer Candidates Sample, Class Standing Criterion

Equation	Multiple Correlation Coefficient	Cross-Validation Correlation Coefficient
1. Start Preflight	.38	.33
2. End Preflight	.63	.55
3. End 5th Graded Pre-Solo Flight	.68	.61
4. End 7th Graded Pre-Solo Flight	.71	.63
5. End Pre-Solo	.73	.69
6. End 5th Graded Primary Flight	.78	.69
7. End Primary I Flights	.80	.67[a]

[a]Differences between original and cross-validation correlation coefficient significant at $p < .05$.

the cross-validation correlation coefficient. Among the seven pairs of correlation coefficients tested, only one pair, that for equation seven, tested significantly different at the .05 level.

Verbal Description of Successful Warrant Officer Candidate

The successful aviation Warrant Officer Candidate has a slightly higher rank than his peers, indicating that he was obtained from in-service sources. Similarly, he is slightly older than his peers. If he has more time in service, his probability of successful completion is higher. On the other hand, his end-of-course standing is likely to be lower with more time in service. The successful Warrant Officer Candidate is better educated than his peers. He probably received some flight training prior to entering the Primary Helicopter School course. His FAST score is higher, but his GT score is of no consequence in determining whether he will pass or fail the course. If he is married and has children, his probability of passing is greater, but this has little effect on his final end-of-course grade. The successful aviation Warrant Officer Candidate scores well on the AFQT. By definition, he does well on his Airmanship Examinations, Warrant Officer Development Examination, and flight grades.

OFFICERS

Pass/Fail Criterion—Officers

The same type of data were stored on the officers as on the Warrant Officer Candidates, with a few exceptions. No FAST scores were available on the officers without using the facilities of the Armed Forces Records Center at St. Louis, Missouri. Since this retrieval would have been manual, and would have required more manpower resources than were available, this variable[1] was not retrieved for the officers.

[1]Table 15 shows that the FAST variable appeared only in the first two predictive equations (i.e., "Start Preflight" and "End Preflight"). for the Warrant Officer Candidates. After that point it was no longer an effective predictor. Since the officers do not receive the same Preflight training phase as do the WOCs, one may surmise that little was lost for the officers through the omission of the FAST.

Since the officer population (because of their previous officer training) does not need the military development that Warrant Officer Candidates require, the Officer Development Examinations which they receive during their aviation training are not as frequent, as long, or rated as important as the Warrant Officer Development Examinations which the Warrant Officer Candidates receive. The Airmanship Examinations were identical in content, but were scored differently using a different weighting for officers as compared to Warrant Officer Candidates. The scores of officers and Warrant Officer Candidates on these examinations cannot be compared without taking this different weighting into account.

The officers' records also lack the standardized tests that are given to enlisted men as they are inducted into the service. These include the AFQT and the GT. After the available variables were collapsed for the officer population in the same manner as for the Warrant Officer Candidate population, the number of variables for use in the regression analyses was reduced to the 18 listed in Table 24.

Table 24

Variables Used in FY70 Officer Regression Equations

Age (Years)
Months Prior Service
Education (Years)
Prior Flight Training (Yes/No)
Number of Dependents
Marital Status (Yes/No)
AME 1-7 ($\overline{X}$ of Actual Scores)
AME 8-9 ($\overline{X}$ of Actual Scores)
AME 10
AME 11
ODE 9-10 ($\overline{X}$ of Actual Scores)
Pre-Solo Flights 3-5 ($\overline{X}$ of Flight Grades)
Pre-Solo Flights 3-7 ($\overline{X}$ of Flight Grades)
Pre-Solo Average
Pre-Solo 04-15 Hours (Total Minutes)
Primary Flights 1-5 ($\overline{X}$ of Primary Flights)
Primary Average
Primary I Checkride Grade

Table 25 provides the attrition data for the officers in the 1970 sample by equation periods. Looking at the first and last figures of row 1 of Table 25, it can be seen that only 80 students (6.6%) were attrited from the officer population by the end of their Fort Wolters training. Many were failed during a given period only to be reinstated and eventually passed so that, in net, only 80 failed. With an attrition rate this low, the PREDICT equations have relatively little utility for secondary selection. On the other hand, there is an increasing interest in counselling students during training to assist them in gaining the maximum from the training program. The regression equations on the officer sample could be of value in such an application.

Table 26 provides the regression coefficients and constants, the variable means and standard deviations, the standard errors of the estimate, the goodness-of-fit F ratios and degrees of freedom, and the multiple correlation coefficients for each of the seven equations. The rise and fall of the multiple correlation coefficients with time in the program is not as noticeable for the officer sample as it was for the warrant officer sample. This is true in part because the attrition in the officer sample, although it is less than the Warrant Officer Candidate sample, is spread more evenly throughout the training program. The standard errors of the estimate show the same general decline from the beginning to the end of the program as they did with the Warrant Officer Candidate program, except for one reversal on the fourth equation. The pass/fail equations have the same problems for the officer population as they did for the warrant officer population.

Cross Validation of Officer Pass/Fail Analysis

Table 27 presents the multiple correlation coefficients for the regression equations along with the cross-validation correlation coefficients. The predicted pass/fail probability was based upon only one-half of the 1970 sample. Using the regression equations

Table 25

Officer Sample Size, FY70, by Equation Period

Population	Equation Period[a]						
	Preflight		Pre-Solo			Primary I Flights	
	Start Preflight	End Preflight	End 5th Graded Pre-Solo Flight	End 7th Graded Pre-Solo Flight	End Pre-Solo	End 5th Graded Primary Flight	End Primary I Flights
Total Student Population Within Each Equation Period	1206	1165	1225	1156	1162	1162	1126
Total Student Population Passed at Each Equation Period	1094	1056	1105	1059	1105	1105	1105
Total Student Population Failing Within Each Equation Period	112	109	120	97	57	57	21
Percent Failing Within Each Equation Period	9.3	9.4	9.8	8.4	4.9	4.9	1.9

[a]The total number of students reported for each equation period includes only those students for whom the necessary data, specific to that equation, were available. It does not reflect the total student population at that time in training. Thus, the column totals cannot be manipulated to derive percentages, cumulative totals, etc. Many students who failed in one period were later reinstated and eventually passed, accounting for much of the discrepancy in this table.

computed on the first half of the sample, predicted probabilities of successful completion were computed for the individuals in the second half of the sample. The cross-validation correlation coefficient represents the correlation between this predicted probability of successful completion and the actual pass/fail record of the second half of the officer population. With a pass/fail split as poor as is found in the officer population, you would not normally expect either a high correlation, or a very reliable correlation with this criterion.

The cross-validation correlation coefficient is significantly different from the original correlation coefficient ($p < .95$) for both the first and the last equations. Equations three through six are considerably more reliable. Even so, it is worth noting that the highest correlation of .315 accounts for only about 10% of the variance. Thus, any predictions based upon the pass/fail criterion should be used cautiously.

Class Standing Criterion—Officers

The sample examined and the general techniques used in examining them were the same for the class standing criterion as for the officer pass/fail criterion. Table 28 provides the regression coefficients and constants, the variable means and standard deviations, standard errors of the estimate, goodness-of-fit F ratios and degrees of freedom, and the multiple correlation coefficients for each of the seven equations.

Table 26

Regression Equations, FY70 Officer Population, Pass/Fail

Equation Number and Name	Variables in Multiple	Mean	Standard Deviation	Coefficient	Constant	Standard Error of Estimate	*F* Ratio	*df*	*R*
1. Start Preflight	Age	24.59	3.32	0.0101	0.6919	0.273	1.84	5,597	0.123
	Education	14.51	1.76	-0.0018					
	Prior Flight Training	0.22	0.41	0.0379					
	Marital Status	0.68	0.46	0.0089					
	Number Dependents	1.27	1.33	-0.0069					
2. End Preflight	Age	24.53	3.40	0.0021	0.4574	0.269	1.72	5,577	0.121
	Months Prior Service	29.81	33.20	0.0004					
	Education	14.53	1.79	-0.0070					
	Prior Flight Training	0.23	0.41	0.0194					
	AME 01-07	18.56	0.88	0.0269					
3. End 5th Graded Pre-Solo Flight	Age	24.57	3.36	-0.0027	0.5010	0.266	10.58	5,607	0.283
	Education	14.52	1.76	-0.0047					
	Months Prior Service	30.04	34.18	0.0002					
	Number Dependents	1.26	1.28	-0.0087					
	3-5 Week Flights	2.84	0.40	0.1963					
4. End 7th Graded Pre-Solo Flight	Months Prior Service	28.57	32.99	-0.0003	0.6576	0.271	9.84	5,572	0.281
	Education	14.58	1.79	-0.0147					
	Marital Status	0.69	0.46	0.0211					
	Number Dependents	1.22	1.22	-0.0147					
	3-7 Week Flights	2.74	0.44	0.1763					
5. End Pre-Solo	AME 01-07	18.59	0.88	0.0134	-0.0036	0.215	7.56	5,575	0.248
	3-7 Week Flights	2.78	0.42	0.0604					
	Pre-Solo Average	2.60	0.50	0.0510					
	PS 04-PS 15 Hours	5.61	1.18	0.0182					
	AME 08-09	18.49	1.23	0.0162					

(Continued)

Table 26 *(Continued)*

Regression Equations, FY70 Officer Population, Pass/Fail

Equation Number and Name	Variables in Multiple	Mean	Standard Deviation	Coefficient	Constant	Standard Error of Estimate	*F* Ratio	*df*	*R*
6. End 5th Graded Primary Flight	Pre-Solo Average	2.60	0.50	0.0391	-0.3249	0.211	12.67	5,575	0.315
	Pre-Solo 04-PS 15 Hours	5.61	1.18	0.0265					
	AME 08-09	18.49	1.23	0.0139					
	AME 10	19.09	1.38	0.0208					
	Primary 1-5	2.77	0.36	0.1335					
7. End Primary I Flights	Prior Flight Training	0.22	0.41	−0.0312	0.4470	0.115	8.25	5,557	0.263
	3rd-7th Week Flights	2.79	0.40	0.0283					
	PS 04-PS 15 Hours	5.60	1.17	−0.0056					
	AME 10	19.13	1.08	0.0217					
	PPDR	79.99	8.08	0.0010					

Table 27

Comparison of Multiple and Cross-Validation Correlation Coefficients for Officer Pass/Fail Criterion of FY70 Sample—Total Population

Equation	Multiple Correlation Coefficient	Cross Validation Correlation Coefficient
1. Start Preflight	.12	.00[a]
2. End Preflight	.12	.08
3. End 5th Graded Pre-Solo Flight	.28	.33
4. End 7th Graded Pre-Solo Flight	.28	.30
5. End Pre-Solo	.25	.28
6. End 5th Graded Primary Flight	.32	.30
7. End Primary I Flights	.26	.35[a]

[a]Differences between original and cross validation correlation coefficients significant at $p < .05$.

The application of a regression equation results in an estimate of the final end-of-course grade for a given student. The highest correlation with the class standing criterion accounts for 73% of the variance as compared to about 10% of the variance for the highest correlation using the pass/fail criterion. This correlation of .86 is achieved in equation seven which occurs at the end of the Primary I flights, or at approximately the halfway point in the Fort Wolters training program. The prediction here represents an extrapolation of future performance based upon the five best indices available approximately halfway through the training program.

Figure 2 allows for translating the predicted end-of-course grade to a predicted end-of-course percentile class standing. The method for making this conversion is the same as that outlined for the Warrant Officer sample.

Cross Validation of Class Standing Criterion—Officers

The concurrent cross validation was conducted for the class standing criterion in the same manner as for the pass/fail criterion. Table 29 provides a comparison of the original multiple correlation coefficients with the cross-validation correlation coefficients, and provides the standard errors of the estimate as well. The shrinkage[1] of the multiple correlation coefficient was not excessive. None of the shrunken multiple *R*s differed from the original multiple *R*s by an amount sufficient to reach significance at the .05 level.

Verbal Description of the Successful Officer Aviator Trainee

Compared to the Warrant Officer Candidate, little personal information is available on the officer aviation trainee. However, it can be said that the officer aviator trainee who scores well in his end-of-course standings is also a little older than his peers.

[1]Mosier, *op. cit.*

Table 28

Regression Equations, FY70 Officer Population, Class Standing

Equation Number and Name	Variables in Multiple	Mean	Standard Deviation	Coefficient	Constant	Standard Error of Estimate	*F* Ratio	*df*	*R*
1. Start Preflight	Age	24.49	3.15	0.0448	81.0480	2.791	9.15	5,547	0.278
	Months Prior Service	30.77	34.95	-0.0040					
	Education	14.50	1.73	0.1580					
	Prior Flight Training	0.20	0.40	1.5560					
	Number Dependents	1.26	1.26	0.1952					
2. End Preflight	Age	24.49	3.15	0.0259	49.1611	2.238	74.97	5,547	0.639
	Months Prior Service	30.77	34.95	-0.0051					
	Prior Flight Training	0.20	0.40	1.1915					
	Number Dependents	1.26	1.26	0.0940					
	AME 01-07	18.56	0.88	1.9329					
3. End 5th Graded Pre-Solo Flight	Months Prior Service	30.77	34.95	-0.0043	46.2649	2.047	111.01	5,547	0.710
	Prior Flight Training	0.20	0.40	0.6867					
	Marital Status	0.69	0.46	0.2172					
	AME 01-07	18.56	0.88	1.7498					
	3-5 Week Flight Grade	2.87	0.39	2.4296					
4. End 7th Graded Pre-Solo Flight	Age	24.49	3.15	-0.0510	47.1770	1.940	135.92	5,547	0.744
	Prior Flight Training	0.20	0.40	0.4956					
	Marital Status	0.69	0.46	0.2265					
	AME 01-07	18.56	0.88	1.7144					
	3-7 Week Flight Grade	2.77	0.42	2.8352					
5. End Pre-Solo	AME 01-07	18.56	0.88	1.3699	46.3705	1.737	196.65	5,547	0.802
	3-7 Week Flights	2.77	0.42	1.7611					
	Pre-Solo Average	2.64	0.51	1.3533					
	PS 04-PS 15 Hours	5.64	1.12	-0.3420					
	AME 08-09	18.45	1.26	0.4094					

(Continued)

Table 28 *(Continued)*

Regression Equations, FY70 Officer Population, Class Standing

Equation Number and Name	Variables in Multiple	Mean	Standard Deviation	Coefficient	Constant	Standard Error of Estimate	*F* Ratio	*df*	*R*
6. End 5th Graded Primary Flight	AME 01-07	18.56	0.88	1.3933	41.0453	1.713	205.15	5,547	0.808
	3-7 Week Flights	2.77	0.42	1.5504					
	Pre-Solo Average	2.64	0.51	1.2091					
	AME 08-09	18.45	1.26	0.3742					
	Primary 1-5	2.80	0.33	1.6314					
7. End Primary I Flights	AME 01-07	18.56	0.88	1.4019	32,1328	1.502	299.88	5,547	0.856
	3-7 Week Flights	2.77	0.42	1.4265					
	Primary Average	2.85	0.27	3.6936					
	PPDR	79.90	7.69	0.0864					
	AME 11	18.53	1.49	0.3417					

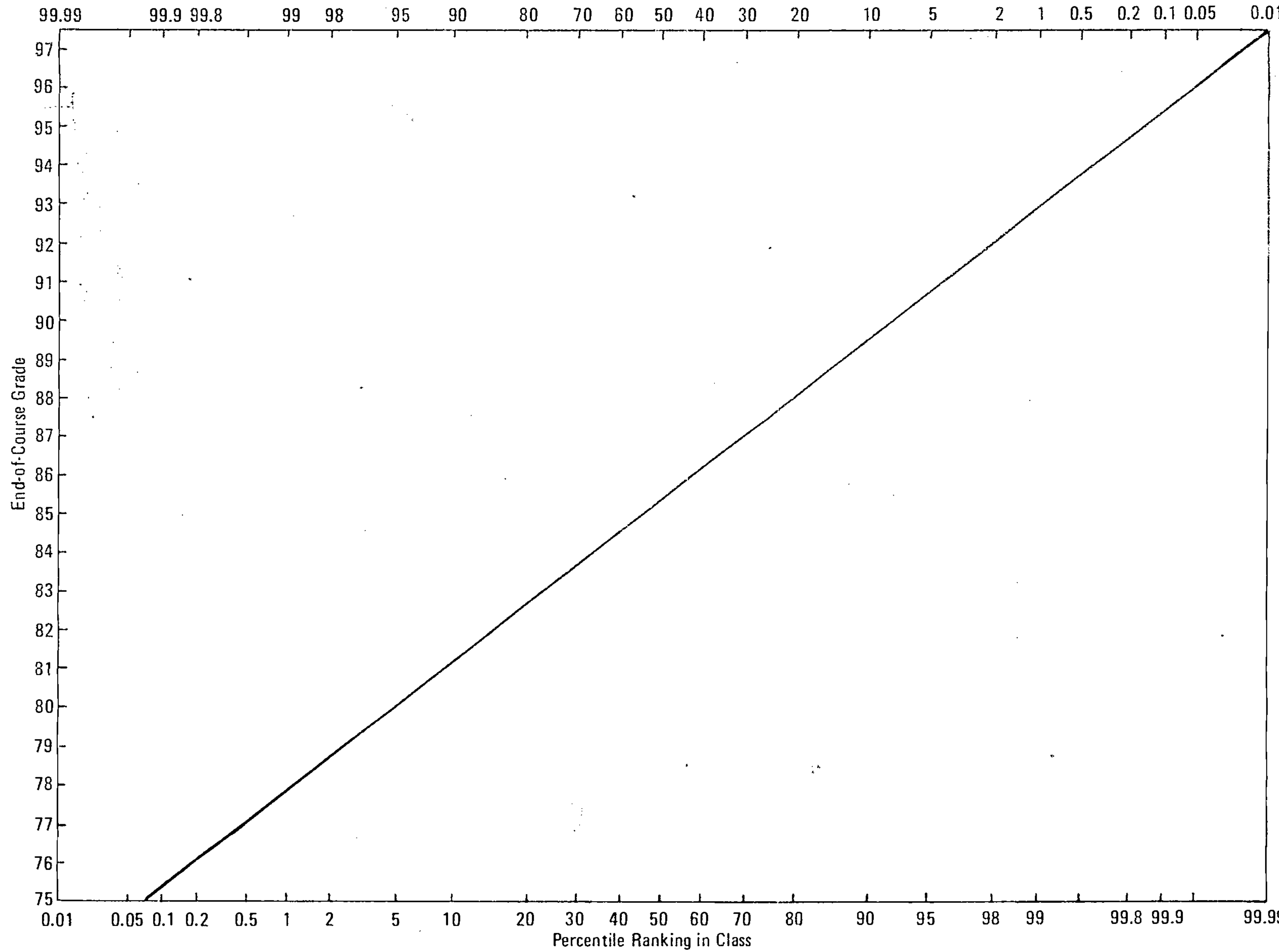

Figure 2 — **Relationship of End-of-Course Grades to Percentile Ranking, FY70 Officer Population**

Table 29

Comparison of Multiple and Cross-Validation Correlation Coefficients, FY70 Officer Sample, Class Standing Criterion

Equation	Multiple Correlation Coefficient	Cross-Validation Correlation Coefficient
1. Start Preflight	.28	.31
2. End Preflight	.64	.56
3. End 5th Graded Pre-Solo Flight	.71	.64
4. End 7th Graded Pre-Solo Flight	.74	.69
5. End Pre-Solo	.80	.77
6. End 5th Graded Primary Flight	.81	.76
7. End Primary I Flights	.86	.83

However, he generally has not been in the service as long as his contemporaries. He is somewhat above average in education, and has had some previous flight training. It is to his advantage to be married and to have children.

SUPPORTING RAW DATA

Appendices A-D of this report contain much of the raw data for the analyses (both officer and warrant officer for all criteria), along with descriptive statistics, intercorrelation matrices, and the listing of the regression equations.

DISCUSSION

The correlation coefficients which were obtained in this study are quite respectable. However, a few comments on their interpretation are probably worthwhile.

Those equations dealing with the pass/fail criterion have a number of limitations. First, and perhaps foremost, to the extent that they are used they will become a self-fulfilling prophecy. The pass/fail equations predict the action of the Student Evaluation Review Council (SERC) or, more currently, the Faculty Board. When a student is nominated for possible expulsion, he comes before a Board for action. If the Board sets him back to another class, his chances of eventually passing are about the same as for students who never appeared before the Board. If the Board refuses to set him back, he has failed by definition. If the Board were to take the pass/fail prediction, establish a cut-off point, and base its decisions exclusively on this prediction, the effective correlation of the equations with the action of the Board would become perfect. While this would have no effect upon the utility of the first set of equations derived, it would make it impossible to provide a realistic updating of those equations based upon new information, since that new information would be interactive with the previous regression equation.

The situation is not as routine as described in the preceding paragraph. The Board does not use the pass/fail prediction as an exclusive guide to their actions. Most individuals are nominated for expulsion because of critical incidents such as a failed checkride. In addition, the equations are based not only on those individuals who are nominated to appear before the Board, but rather on all individuals in flight training. This further dilutes the tendency toward a self-fulfilling prophecy. However, the fact remains that this tendency is built into the pass/fail criterion. Therefore, the pass/fail equations should not be used to nominate a candidate for expulsion.

A second limitation of the pass/fail criterion concerns the effect of changing attrition rates. Predictive equations based upon an overall attrition of 15% will yield unrealistic predictions of probable student success when the attrition rate changes (e.g., to 30%.) The relative position of the students should be the same, but a scalar shift is required for the predicted probability of successful completion for all of the students. Such a scalar shift can only be accomplished empirically, using new data. It is more efficient and accurate to generate a new set of equations based upon the data generated with the new attrition rate.

Another problem with the pass/fail criterion concerns the effect of a changing pass/fail split. During the course of training, the proportion of individuals ultimately failing decreases as a given class progresses through the training program. In the final week of training, it is not unusual to have no failures. Thus, the equations used early in training and based on the entire population may have a pass/fail split of 65/35. This is adequate for statistical purposes. Late in the program, an equation may be based upon a pass/fail split of 99.5/0.5. Such an extreme split greatly reduces the reliability of the correlation coefficients obtained.

It should also be noted that many of the individuals who are nominated for possible expulsion receive this nomination on the basis of a critical incident rather than a low overall average. For example, a Warrant Officer Candidate might be doing extremely well in both the academic and the flight portions of his training, but have a severe disciplinary incident with his TAC officer and be nominated for expulsion. Critical incidents such as these, while they may be justified, do not fit well into a multiple correlation format. Although a variety of information is entered into the regression analysis, training grades are the best predictors. The pass/fail prediction is simply a second order reflection of an individual's overall class standing. Thus, critical incidents, reflecting attitudes and motivations, are not predicted well.

There is also, as previously noted, a practical user problem relative to the predicted probabilities of success. Since a large number of those nominated for expulsion because of some critical incident have good academic and flight records, their predicted probability of passing is quite high. As stated earlier, experience has shown that the actual probability of passing is very high once a man gets past his first Board action without being eliminated. In fact, his chances are about as good as they would be if he had never been boarded. Unfortunately, because the predicted probability is bound to be quite high, especially late in the program, the users of the pass/fail equations are often placed in the uncomfortable position of having to pass judgment on men, all of whom are predicted to have an extremely high probability of eventual success.

The class standing criterion circumvents a number of the shortcomings of the pass/fail criterion. Since the actual criterion predicted is end-of-course grade, changes in attrition affect the equation very little. There are no statistical problems with a lopsided pass/fail split, since it does not use one. It is not affected by the use of critical incidents to nominate the individual for possible expulsion. Since the class standing criterion is independent of Council action, there is no danger that it might become a self-fulfilling prophecy. There is also no embarrassment at having to fail a man who is predicted to pass. Rather, the Board can concern itself with the predicted quality of the student whom they are considering. For example, with two individuals nominated for possible expulsion for the same reasons, they may decide to keep one because he is predicted to perform well in the future, and to expel the other because he is predicted to perform less well, even though he may also be predicted to pass.

The value of these equations can be changed by the frequency with which sizeable changes are made in the training syllabus. For example, for the 1969 sample, the primary helicopter training program lasted for 20 weeks, and contained 17 Airmanship Examinations and 14 Warrant Officer Development Examinations. The program at the time of the writing of this report lasts for 14 weeks, and has eight Airmanship Examinations and five Warrant Officer Development Examinations. Accommodations are necessary to equate the old system with the new when such syllabus changes occur, and these accommodations are less than perfect. In order to be maximally effective, equations should be updated frequently, based on data as close to the current classes as possible. This will greatly reduce the effect of syllabus changes on the accuracy of the predicted equations.

There is a second area where these equations could be used with considerable value. The equations were originally intended for use in the decision-making process concerning whether a student who has been identified as having a problem should be expelled from the program or retained. The equations could also be used to identify students early in the program who look as if they will drop below a satisfactory level in their average performance. Although many students are expelled for critical incidents rather than a poor overall performance, it is still true that a large proportion of the failures are attrited for flight and academic deficiencies. These equations might be used to identify students who are developing problems in the flight and academic areas before these problems become acute. In this area, both the pass/fail and the class standing criteria would be valuable. The class standing equations would provide an early extrapolation of an individual student's tendency to perform poorly in the training program. The pass/fail equations would provide an index of the eventual seriousness of the problem.

The primary virtue of the PREDICT system is its ability to produce an optimal summary of the information available on a single individual at any time during the training program. The mass of information which the PREDICT system summarizes is so voluminous and detailed as to defy an accurate and reliable interpretation without first determining the relative importance of the various types of information and developing a mechanism for trading off poor performance on one indicator as compared to good performance on another indicator. The PREDICT system provides both an indication of the relative importance of the available information and a mechanism for summarizing the information from the several indicators.

At the beginning of this report the distinction was made between primary and secondary selection. Such distinctions, while perhaps an administrative necessity, often distort our view of the requirement that selection and training must exist in an integrated personnel system if the services are to utilize manpower resources with maximum efficiency. Neither selection nor training can be viewed as independent of or segregated from other aspects of the total personnel system. Therefore, primary selection programs and secondary selection procedures such as that described here must be placed into the larger system context. Several aspects of the PREDICT program that did not fit well with the training system (e.g., operational use of the pass/fail prediction criterion) have been described. However, adjustments in those areas would be possible in future implementations of the system. The basic methodology involved in multivariate extrapolation of aviator performance offers considerable potential for effective application, both in training and in other areas of performance.

The prediction of future performance is probably one of the most important functions of management. Wherever a prediction of the future training performance of students currently enrolled in the training program would be valuable, the PREDICT system would be valuable. This would include not only the current uses, but also student counselling and training program management. The same data pool gathered for the purpose of predicting student performance might also be useful in predicting performance after graduation.

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Appendix A

SUMMARY OF DEMOGRAPHIC DATA AND THE COLLAPSED VARIABLES USED IN THE REGRESSION EQUATIONS, WARRANT OFFICER CANDIDATES 1969 SAMPLE

Table A-1

Frequency Counts for Variables Used in Analyses, WOC 1969 Sample

Rank			Age			Months Prior Service			Education			Prior Flight Training			FAST		
Value	f	%	Value	f	%	Value	f	%	Value	f	%	Value[a]	f	%	Value	f	%
E1	1342	48.4	18	311	11.2	1-7	2153	77.6	9	4	.1	0	2175	78.5	230-240	5	.2
E2	766	27.6	19	666	24.0	8-14	170	6.1	10	13	.5	1	15	.5	241-251	48	1.8
E3	187	6.7	20	625	22.5	15-21	38	1.4	11	20	.7	2	1	.0	252-262	215	7.9
E4	156	5.6	21	395	14.2	22-28	34	1.2	12	1305	47.0	3	337	12.2	263-273	238	8.7
E5	142	5.1	22	232	8.4	29-35	32	1.2	13	644	23.2	4	159	5.7	274-284	285	10.4
E6	154	5.6	23	140	5.0	36-42	58	2.1	14	490	17.6	5	62	2.2	285-295	268	9.8
E7	27	1.0	24	93	3.4	43-49	41	1.5	15	196	7.1	6	19	.7	296-306	288	10.5
E8	0	.0	25	87	3.1	50-56	21	.8	16	88	3.2	7	2	.1	307-317	286	10.5
E9	1	.0	26	70	2.5	57-63	15	.5	17	14	.5	8	1	.0	318-328	257	9.4
$\overline{X}$	2.1		27	43	1.6	64-70	16	.6	18	1	.0	$\overline{X}$	.2		329-339	225	8.2
Mdn	E2		28	36	1.3	71-77	21	.8	19	1	.0	Mdn	.0		340-350	181	6.6
σ	1.5		29	38	1.4	78-84	27	1.0	$\overline{X}$	12.9		σ	1.5		351-361	134	4.9
Min.	E1		30	18	.6	85-91	20	.7	Mdn	13.0		Min.	.0		362-372	137	5.0
Max.	E9		31	9	.3	92-98	20	.7	σ	1.2		Max.	8.0		373-383	67	2.4
Range	8		32	4	.1	99-105	18	.6	Min.	9.0		Range	8.0		384-394	57	2.1
N	2775	99.1	33	4	.1	106-112	11	.4	Max.	19.0		N	2771	99.0	395-405	26	1.0
Missing									Range	10.0		Missing					
Data	24	.9	34	5		113-119	21	.8				Data	28	1.0	406-416	11	.4
			$\overline{X}$	20.9		120-126	7	.2	N	2776	99.2				417-427	1	.0
			Mdn	20.0		127-133	21	.8	Missing								
			σ	2.7		134 +	30	1.1	Data	23	.8	Binary[b]			428-438	1	.0
			Min.	18.0		$\overline{X}$	13.73					0	2175	78.5	439 +	2	.1
			Max.	34.0		Mdn	2.00					1	596	21.5	$\overline{X}$	310.35	
			Range	16.0		σ	28.38								Mdn	307.00	
			N	2776	99.2	Min.	1.00								σ	37.33	
			Missing												Min.	230	
			Data	23	.8	Max.	143								Max.	452	
						Range	142								Range	222	
						N	2774	99.1							N	2732	97.6
						Missing									Missing		
						Data	25	.9							Data	67	2.4

(Continued)

Table A-1 *(Continued)*

Frequency Counts for Variables Used In Analyses, WOC 1969 Sample

Criterion

Value[c]	f	%
1	528	18.9
3	2271	81.1
$\bar{X}$	2.6	
Mdn	3.0	
σ	.8	
Min.	N/A	
Max.	N/A	
Range	N/A	
N	2799	100.0
Missing Data	0	.0

GT Score

Value	f	%
99-101	2	.1
102-104	6	.2
105-107	5	.2
108-110	73	2.6
111-113	219	8.0
114-116	341	12.4
117-119	409	14.8
120-122	407	14.8
123-125	419	15.2
126-128	419	15.2
129-131	207	7.5
132-134	68	2.5
135-137	76	2.8
138-140	45	1.6
141-143	36	1.3
144-146	14	.5
147-149	7	.2
150-152	1	.0
$\bar{X}$	122.3	
Mdn	122	
σ	7.4	
Min.	99.0	
Max.	152.0	
Range	53	
N	2745	98.4
Missing Data	45	1.6

No. Dependents

Value	f	%
0	1928	69.6
1	433	15.6
2	209	7.6
3	131	4.7
4	50	1.8
5	13	.5
6	3	.1
7	1	.0
$\bar{X}$	.6	
Mdn	0.0	
σ	1.0	
Min.	0.0	
Max.	7.0	
Range	7	
N	2768	98.9
Missing Data	31	1.2

AFQT

Value	f	%
20-23	1	.0
24-27	2	.1
28-31	0	.0
32-35	4	.2
36-39	6	.2
40-43	4	.2
44-47	9	.4
48-51	30	1.2
52-55	15	.6
56-59	44	1.8
60-63	96	3.8
64-67	60	2.4
68-71	85	3.4
72-75	170	6.8
76-79	137	5.5
80-83	422	16.8
84-87	283	11.3
88-91	506	20.2
92-95	406	16.2
96-99	223	8.9
100-103	6	.2
$\bar{X}$	83.4	
Mdn	87.0	
σ	11.8	
Min.	20	
Max.	100	
Range	80	
N	2509	
Missing Data	290	

Marital Status

Value	f	%
D	50	1.8
M	814	29.9
S	1858	68.3
$\bar{X}$	.3	
Mdn		
σ	.5	
Min.	N/A	
Max.	N/A	
Range	N/A	
N	2722	97.2
Missing Data	77	2.8

Procurement Source

Value[d]	f	%
1	724	26.1
2	2051	73.9
$\bar{X}$	1.7	
Mdn	2.0	
σ	.4	
Min.	N/A	
Max.	N/A	
Range	N/A	
N	2775	99.1
Missing Data	24	.9

[a]0 - No prior flight experience
1 - AROTC flight training—not completed
2 - AROTC flight training—completed
3 - Limited fixed wing (other than 1)
4 - Fixed wing—private license
5 - Fixed wing—commercial license
6 - Limited rotary wing experience
7 - Rotary wing—private license
8 - Rotary wing—commercial license

[b]Binary Codes:
0 - No previous flight experience
1 - Prior flight experience

[c]1 = Fail; 3 = Pass

[d]1 = In service when entered flight training program
2 = Enlisted for flight program

Table A-2

Frequency Counts for Variables Used in Analyses, WOC 1969 Sample: Fort Wolters' Flights

Flight Number	Grade				$\overline{X}$	Mdn	σ	N	Missing Data
	1.0	2.0	3.0	4.0					
PS 04	21	214	2070	93	2.9	3	.4	2398	401
PS 05	81	391	1809	72	2.8	3	.5	2354	445
PS 06	173	691	1427	70	2.6	3	.7	2361	438
PS 07	388	684	1199	79	2.4	3	.8	2350	449
PS 08	465	717	1077	81	2.3	2	.8	2340	459
PS 09	521	676	1048	74	2.3	2	.8	2319	480
PS 10	528	700	1004	56	2.3	2	.8	2288	511
PS 11	516	688	965	57	2.2	2	.8	2226	573
PS 12	455	644	958	32	2.3	2	.8	2089	710
PS 13	375	573	856	25	2.3	2	.8	1829	970
PS 14	324	472	802	40	2.3	3	.8	1638	1161
PS 15	203	320	481	14	2.3	2	.8	1018	1781
PS 16	26	193	390	15	2.6	3	.6	624	2175
P 01[a]	8	517	1636	53	2.8	3	.5	2214	585
P 02S	0	0	0	0	0	0	0	0	2799
P 03	0	1	2	0	2.7	3	.6	3	2796
P 04	126	507	1497	48	2.7	3	.6	2178	621
P 05	2	0	9	0	2.6	3	.8	11	2788
P 06	165	550	1416	40	2.6	3	.6	2171	628
P 07	0	6	4	0	2.4	2	.5	10	2789
P 08	197	583	1323	51	2.6	3	.7	2154	645
P 09	1	4	10	0	2.6	3	.6	15	2784
P 10	174	586	1324	45	2.6	3	.7	2129	670
P 11	51	134	298	11	2.6	3	.7	494	2305
P 12	98	308	685	26	2.6	3	.7	1117	1682
P 13	82	293	663	31	2.6	3	.7	1069	1730
P 14	65	225	502	20	2.6	3	.7	812	1987
P 15	99	280	715	29	2.6	3	.7	1123	1676
P 16	49	216	511	24	2.6	3	.6	800	1999
P 17	66	237	736	36	2.7	3	.6	1075	1724
P 18	47	171	531	42	2.7	3	.6	791	2008
P 19	52	215	704	36	2.7	3	.6	1007	1792
P 20	47	177	710	38	2.8	3	.6	972	1827
P 21	29	144	598	31	2.8	3	.6	802	1997
P 22	21	162	730	49	2.8	3	.5	962	1837
P 23	20	129	571	45	2.8	3	.6	765	765
P 24	17	137	719	50	2.8	3	.5	923	1876
P 25	9	84	534	38	2.9	3	.5	665	2134
P 26	15	94	599	49	2.9	3	.5	757	2042
P 27	10	53	512	41	3.0	3	.5	616	2183
P 28	10	40	354	51	3.0	3	.5	455	2344
P 29	3	36	347	37	3.0	3	.4	423	2376

(Continued)

Table A-2 *(Continued)*

Frequency Counts for Variables Used in Analyses, WOC 1969 Sample: Fort Wolters Flights

Flight Number	Grade				$\overline{X}$	Mdn	σ	N	Missing Data
	1.0	2.0	3.0	4.0					
P 30	3	16	253	28	3.0	3	.4	300	2499
P 31	3	13	212	34	3.1	3	.5	262	2537
P 32	2	11	162	23	3.0	3	.5	198	2601
P 34[b]	0	8	105	15	3.0	3	.4	128	2671
P 35	0	6	73	11	3.1	3	.4	90	2709
P 36	0	2	42	6	3.1	3	.4	50	2749
P 37	1	1	27	8	3.1	3	.6	37	2762
P 38	0	1	11	3	3.1	3	.5	15	2784
P 39	0	0	21	3	3.1	3	.3	24	2775

[a]P 02S - Second Supervised Solo

[b]P 34 - Syllabus lessons P 34 through P 39 were used to award additional flight time to students who did not successfully complete P 32 (checkride). P 33 not assigned.

Table A-3

Frequency Counts for Variables Used in Analyses, WOC 1969 Sample: Airmanship Examinations (AMEs)

Exam	Scores																				$\overline{X}$	Mdn	σ	N	Missing Data
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20					
AME 1	2	0	0	0	0	2	1	2	2	6	8	25	50	98	199	311	416	595	598	373	17.5	18	2.0	2676	83
AME 2	0	0	0	1	0	0	2	0	3	12	28	33	61	121	189	355	460	566	586	289	17.3	18	2.1	2706	56
AME 3	0	0	1	1	0	0	2	1	2	6	14	28	51	91	196	339	509	583	599	290	17.4	18	1.9	2713	49
AME 4	0	0	0	1	0	0	0	0	0	3	8	15	20	81	109	270	471	622	722	402	17.8	18	1.7	2724	38
AME 5	0	0	0	0	0	0	0	0	1	9	12	30	82	154	299	432	543	560	428	177	16.9	17	1.9	2727	35
AME 6	0	0	0	0	0	1	0	7	4	12	34	74	141	214	352	475	518	461	299	124	16.4	17	2.1	2716	46
AME 7	0	0	0	0	0	3	4	4	22	34	83	134	201	270	325	388	409	360	328	156	16.0	16	2.6	2721	41
AME 8	1	0	0	0	1	0	0	2	0	4	10	22	54	122	212	305	498	612	512	251	17.3	18	1.9	2606	49
AME 9	0	0	0	0	0	0	0	1	0	0	3	21	42	98	170	308	469	613	541	341	17.6	18	1.8	2607	48
AME 10	0	0	0	0	0	0	0	0	1	1	2	4	29	43	139	262	392	564	612	380	17.9	18	1.6	2429	226
AME 11	0	0	0	0	0	0	0	1	4	1	5	16	24	53	126	211	394	489	609	364	17.8	18	1.8	2297	358
AME 12	0	0	0	0	0	1	1	1	4	22	33	53	74	123	167	255	340	418	428	346	17.2	18	2.4	2266	389
AME 13	0	0	0	0	0	0	3	3	2	7	20	29	56	100	146	223	303	411	495	473	17.6	18	2.2	2271	384
AME 14	0	0	0	0	0	0	0	0	1	13	27	32	85	178	246	306	382	367	315	191	16.8	17	2.2	2143	512
AME 15	0	0	0	0	1	0	0	3	14	27	58	113	135	245	251	358	338	284	246	159	16.0	16	2.5	2232	423
AME 16	0	0	0	0	0	1	0	0	1	2	2	9	17	63	125	243	388	473	540	340	17.8	18	1.7	2204	451
AME 17	0	1	0	0	1	0	2	1	1	5	10	34	62	132	236	365	400	427	321	193	16.9	17	2.0	2191	464

Table A-4

Frequency Counts for Variables Used in Analyses, WOC 1969 Sample: Warrant Officer Development Examinations (WDEs)

Exam	Scores																				$\overline{X}$	Mdn	σ	N	Missing Data
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20					
WDE 1	0	0	0	0	1	1	4	14	16	45	71	111	183	250	333	401	396	440	301	149	16.0	16	2.6	2716	46
WDE 2	0	0	0	1	3	1	1	2	7	9	37	84	125	229	331	467	510	460	316	127	16.4	17	2.2	2710	52
WDE 3	0	1	0	0	0	0	1	2	2	14	22	53	103	202	334	403	536	534	342	160	16.6	17	2.1	2709	53
WDE 4	1	0	0	0	0	2	1	3	15	35	56	82	130	272	395	509	494	431	226	60	16.0	16	2.2	2712	50
WDE 5	0	0	0	0	1	0	0	0	2	5	10	16	58	121	223	378	555	621	516	196	17.2	17	1.8	2702	60
WDE 6	0	0	0	0	1	0	0	1	5	16	29	66	118	209	286	470	533	457	277	131	16.5	17	2.1	2599	56
WDE 7	0	0	0	0	0	0	0	1	6	15	18	49	95	140	266	351	444	525	431	205	16.9	17	2.1	2546	109
WDE 8	0	0	0	0	0	0	2	14	11	31	59	86	123	192	219	333	395	416	416	230	16.6	17	2.6	2527	128
WDE 9	1	0	0	0	0	0	1	2	6	16	26	65	92	165	261	322	393	453	403	189	16.8	17	2.3	2395	260
WDE 10	0	0	0	0	0	0	0	1	2	1	5	30	57	115	248	330	466	483	356	163	17.0	17	1.9	2257	398
WDE 11	0	0	0	1	1	3	8	19	24	56	105	158	209	268	272	292	312	241	199	67	15.2	15	2.7	2235	420
WDE 12	0	0	1	0	1	2	2	5	11	27	36	73	103	167	255	318	394	388	301	148	16.4	17	2.4	2232	423
WDE 13	0	0	0	0	1	0	1	6	2	7	23	47	94	152	253	264	367	397	293	128	16.6	17	2.2	2035	620
WDE 14	0	0	0	0	1	1	3	3	3	12	19	55	78	165	239	304	338	380	368	212	16.8	17	2.3	2181	474

Appendix B

SUMMARY OF DEMOGRAPHIC DATA AND THE COLLAPSED VARIABLES USED IN THE REGRESSION EQUATIONS, WARRANT OFFICER CANDIDATES 1970 SAMPLE

Table B-1

Frequency Counts for Variables Used in Analyses, WOC 1970 Sample

Rank			Age			Months Prior Service			Education			Prior Flight Training			FAST		
Value	f	%	Value	f	%	Value	f	%	Value	f	%	Value[a]	f	%	Value	f	%
E1	372	37.3	18	89	8.9	1 -7	763	76.8	10	1	.1	0	785	78.9	230-239	1	.1
E2	383	38.4	19	174	17.4	8 -14	39	3.9	11	3	.3	1	210	21.1	240-249	0	.0
E3	47	4.7	20	244	24.4	15-21	24	2.4	12	409	41.0	$\overline{X}$			250-259	49	5.2
E4	55	5.5	21	151	15.1	22-28	18	1.8	13	236	23.6	Mdn	0.0		260-269	62	6.6
E5	85	8.5	22	102	10.2	29-35	15	1.5	14	233	23.4	σ			270-279	65	6.9
E6	44	4.4	23	67	6.7	36-42	26	2.6	15	69	6.9	Min.	0		280-289	77	8.2
E7	10	1.0	24	45	4.5	43-49	14	1.4	16	38	3.8	Max.	1		290-299	78	8.3
E8	1	.1	25	40	4.0	50-56	16	1.6	17	6	.6	Range	1		300-309	90	9.5
E9	0	0	26	23	2.3	57-63	9	.9	18	2	.2	N	995		310-319	88	9.3
$\overline{X}$	2.3		27	18	1.8	64-70	6	.6	19	1	.1	Missing			320-329	85	9.0
Mdn	E2		28	15	1.5	71-77	9	.9	$\overline{X}$	13.1		Data			330-339	70	7.4
σ			29	11	1.1	78-84	3	.3	Mdn	13.0					340-349	85	9.0
Min.	E1		30	5	.5	85-91	9	.9	σ	1.2					350-359	58	6.2
Max.	E9		31	9	.9	92-98	4	.4	Min.	10					360-369	56	5.9
Range	8		32	1	.1	99-105	8	.8	Max.	19					370-379	25	2.6
N	997	99.7	33	3	.3	106-112	3	.3	Range	9					380-389	22	2.3
Missing			34	0	0	113-119	6	.6	N	998					390-399	18	1.9
Data	3	.3	35	0	0	120-126	2	.2	Missing						400-409	6	.64
			36	1	.1	127-133	7	.7	Data	7					410-419	8	.8
			37+	1	.1	134+	12	1.2							$\overline{X}$	316.9	
			$\overline{X}$	21.3		$\overline{X}$	14.4								Mdn	315.0	
			Mdn	20.0		Mdn	3								σ	37.8	
			σ	2.8		σ	28.0								Min.	237.0	
			Min.	18		Min.	1								Max.	419	
			Max.	39		Max.	143								Range	182	
			Range	21		Range	142								N	943	
			N	999		N	993								Missing		
			Missing			Missing									Data	57	
			Data	1		Data	7										

Continued

Table B-1 *(Continued)*

Frequency Counts for Variables Used in Analyses, WOC 1970 Sample

GT Score			No. Dependents			AFQT			Marital Status			Enlistment Option			Criterion		
Value	*f*	%	Value	*f*	%	Value	*f*	%	Value[b]	*f*	%	Value[c]	*f*	%	Value[d]	*f*	%
100-104	4	.4	0	609	61.2	30-34	3	.3	D	18	1.8	1	239	24.07	0	42	4.2
105-109	9	.9	1	209	21.0	35-39	6	.6	M	362	36.8	2	754	75.93	1	958	95.8
110-114	137	13.8	2	109	10.9	40-44	3	.3	S	604	61.4	$\overline{X}$	1.8		$\overline{X}$	1.0	
115-119	214	21.6	3	47	4.7	45-49	7	.8	$\overline{X}$	.4		Mdn	2		Mdn	1	
120-124	245	24.8	4	18	1.8	50-54	14	1.5	Mdn			σ	.4		σ	.2	
125-129	236	23.8	5	4	.4	55-59	18	1.9	σ			Min.	1		Min.	0.0	
130-134	82	8.3	$\overline{X}$	.7		60-64	42	4.5	Min.	Not Applicable		Max.	2		Max.	1.0	
135-139	37	3.7	Mdn	0.0		65-69	34	3.6	Max.	Not Applicable		Range	1		Range	1	
140-144	18	1.8	σ	1.0		70-74	90	9.7	Range	Not Applicable		N	993		N	1000	
145-149	7	.7	Min.	0		75-79	58	6.2	N	984		Missing Data	7		Missing Data	0	
150+	1	.1	Max.	5		80-84	131	14.1	Missing Data	16							
$\overline{X}$	122.4		Range	5		85-89	157	16.8									
Mdn	122.0		N	996		90-94	231	24.8									
σ	7.5		Missing Data	4		95-99	136	14.6									
Min.	100.0					100+	2	.2									
Max.	151.0					$\overline{X}$	82.9										
Range	51					Mdn	87.0										
N	990					σ	12.8										
Missing Data	10					Min.	30.0										
						Max.	100.0										
						Range	70										
						N	932										
						Missing Data	68										

[a] 0 - No previous flight experience
1 - Prior flight experience

[b] D - Divorced
M - Married
S - Single

[c] 1 = In service when entered flight training program
2 = Enlisted for flight program

[d] 0 - Fail
1 - Pass

Table B-2

Frequency Counts for Variables Used in Analyses, WOC 1970 Sample: Fort Wolters Flights

Flight Number	Grade				$\bar{X}$	Mdn	σ	N	Missing Data
	1.0	2.0	3.0	4.0					
PS 04	15	187	1576	39	2.9	3	.4	1817	311
PS 05	68	363	1303	38	2.7	3	.6	1772	356
PS 06	167	520	1078	38	2.6	3	.7	1803	325
PS 07	297	512	927	33	2.4	3	.8	1769	359
PS 08	381	490	819	24	2.3	2	.8	1714	414
PS 09	389	507	776	33	2.3	2	.8	1705	423
PS 10	384	513	719	9	2.2	2	.8	1625	503
PS 11	347	513	652	20	2.2	2	.8	1532	596
PS 12	331	441	566	8	2.2	2	.8	1346	782
PS 13	283	363	430	6	2.2	2	.8	1082	1046
PS 14	239	239	278	5	2.1	2	.8	761	1367
PS 15	151	114	120	1	1.9	2	.8	386	1742
PS 16	18	221	903	52	2.8	3	.5	1194	934
P 01	13	320	1161	31	2.8	3	.5	1525	603
P 02	57	194	731	19	2.7	3	.6	1001	1127
P 03	81	204	671	19	2.6	3	.7	975	1153
P 04	118	301	1017	13	2.6	3	.6	1449	679
P 05	86	193	695	29	2.7	3	.7	1003	1125
P 06	43	183	1098	51	2.8	3	.5	1375	753
P 07	0	4	7	1	2.8	3	.6	12	2116
P 08	50	148	266	7	2.5	3	.7	471	1657
P 09	1	1	5	0	2.6	3	.8	7	2121
P 10	44	147	264	6	2.5	3	.7	461	1667
P 11	16	48	91	1	2.5	3	.7	156	1972
P 12	28	95	160	7	2.5	3	.7	290	1838
P 13	20	68	145	4	2.6	3	.7	237	1891
P 14	13	53	120	3	2.6	3	.6	189	1939
P 15	23	64	171	5	2.6	3	.7	263	1865
P 16	18	62	107	2	2.5	3	.7	189	1939
P 17	20	66	163	6	2.6	3	.7	255	1873
P 18	14	63	114	0	2.5	3	.6	191	1937
P 19	11	54	152	5	2.7	3	.6	222	1906
P 20	11	53	166	4	2.7	3	.6	234	1894
P 21	11	55	162	6	2.7	3	.6	234	1894
P 22	6	47	132	5	2.7	3	.6	190	1938
P 23	2	52	141	6	2.8	3	.5	201	1927
P 24	4	34	159	8	2.8	3	.5	205	1923
P 25	3	26	135	5	2.8	3	.5	169	1959
P 26	1	28	137	8	2.9	3	.5	174	1954
P 27	1	17	126	7	2.9	3	.4	151	1977

(Continued)

Table B-2 *(Continued)*

Frequency Counts for Variables Used in Analyses, WOC 1970 Sample: Fort Wolters Flights

Flight Number	Grade 1.0	2.0	3.0	4.0	X̄	Mdn	σ	N	Missing Data
P 28	1	14	95	4	2.9	3	.4	114	2014
P 29	2	5	94	6	3.0	3	.4	107	2021
P 30	0	8	65	9	3.0	3	.5	82	2046
P 31	0	4	51	3	3.0	3	.4	58	2070
P 32	0	9	58	9	3.0	3	.5	76	2052
P 34[a]	0	3	24	0	2.9	3	.3	27	2101
P 35	0	2	16	1	3.0	3	.4	19	2109
P 36	0	0	13	0	3.0	3	0	13	2115
P 37	0	0	8	0	3.0	3	0	8	2120
P 38	0	0	3	0	3.0	3	0	3	2125
P 39	0	0	3	0	3.0	3	0	3	2125

[a]P 34 - Syllabus lessons P 34 through P 39 were used to award additional flight time to students who did not successfully complete P 32 (checkride). P 33 was not assigned.

Table B-3

Frequency Counts for Variables Used in Analyses, WOC 1970 Sample: Airmanship Examinations (AMEs)

Exam	Scores																				$\overline{X}$	Mdn	σ	N	Missing Data
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20					
AME 1	0	0	0	0	0	0	0	0	0	1	1	1	7	6	23	46	121	181	277	328	18.6	19	1.5	992	8
AME 2	0	0	0	0	0	0	0	0	2	1	8	6	10	29	84	116	161	231	205	139	17.6	18	1.9	992	8
AME 3	0	0	0	0	0	1	0	1	0	0	1	2	6	10	25	62	131	235	303	217	18.3	19	1.5	994	6
AME 4	0	0	0	0	0	0	0	0	0	2	0	6	6	16	27	60	129	179	274	293	18.4	19	1.6	992	8
AME 5	0	0	0	0	2	13	1	1	0	0	0	2	3	17	47	77	140	214	285	194	17.9	18	2.2	996	4
AME 6	0	0	0	0	0	0	0	1	1	14	8	18	53	88	127	154	164	153	144	65	16.5	17	2.2	990	10
AME 7	0	0	0	0	0	0	0	1	1	2	4	17	36	62	83	136	175	178	181	117	17.1	17	2.1	993	7
AME 8	0	0	0	0	0	0	0	3	0	1	2	8	23	35	81	121	182	228	206	107	17.4	18	1.9	997	3
AME 9	0	0	0	0	0	0	0	0	0	0	1	4	16	23	48	78	133	195	274	225	18.1	19	1.7	997	3
AME 10	0	0	0	0	0	1	0	0	0	0	2	2	8	18	33	67	135	215	292	220	18.2	19	1.6	993	7
AME 11	0	0	0	0	0	0	0	1	0	2	7	7	9	33	55	110	141	206	254	143	17.7	18	1.9	968	32

Table B-4

Frequency Counts for Variables Used in Analyses, WOC 1970 Sample: Warrant Officer Development Examinations (WDEs)

Exam	Scores																				$\overline{X}$	Mdn	σ	N	Missing Data
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20					
WDE 51	0	1	0	0	1	0	0	2	2	6	12	26	50	78	114	145	181	192	119	66	16.5	17	2.3	995	5
WDE 52	0	0	0	0	0	0	0	0	0	2	5	10	20	32	49	101	162	196	259	161	17.7	18	1.9	997	3
WDE 53	0	0	0	0	0	0	0	1	0	0	0	1	2	19	27	76	116	231	286	235	18.3	19	1.5	994	6
WDE 54	0	0	.0	0	1	1	1	0	6	11	22	41	55	94	130	153	142	167	123	43	16.1	16	2.4	990	10
WDE 55	0	1	0	0	0	0	0	0	1	5	9	11	24	66	87	145	169	212	156	92	17.0	17	2.1	978	22
WDE 56	0	0	0	1	0	0	0	0	0	1	5	7	24	40	98	145	186	218	183	84	17.2	17	1.9	997	3
WDE 57	0	0	0	0	0	0	0	2	1	2	3	16	26	71	84	136	173	200	192	88	17.1	17	2.0	994	6
WDE 58	0	0	0	0	1	0	0	0	5	11	26	33	46	82	101	112	155	173	164	89	16.6	17	2.5	998	2
WDE 59	0	0	0	0	0	0	0	0	1	5	7	12	35	95	98	147	191	183	125	71	16.7	17	2.0	970	30

Appendix C

SUMMARY OF DEMOGRAPHIC DATA AND THE COLLAPSED VARIABLES USED IN THE REGRESSION EQUATIONS, OFFICER 1970 SAMPLE

Table C-1

Frequency Counts for Variables Used in Analyses, Officer 1970 Sample

Rank			Age			Months Prior Service			Education		
Value	*f*	%	Value	*f*	%	Value	*f*	%	Value	*f*	%
01	666	60.3	19	8	.7	0-6	305	28.2	09	3	.3
02	167	15.1	20	21	1.9	7-13	124	11.5	10	1	.1
03	214	19.4	21	83	7.6	14-20	214	19.8	11	0	0.0
04	1	.1	22	183	16.7	21-27	57	5.3	12	239	21.8
05	0	0	23	241	22.0	28-34	46	4.3	13	109	1.0
06	4	.4	24	162	14.8	35-41	76	7.0	14	146	13.4
07	1	.1	25	111	10.1	42-48	75	6.9	15	81	7.4
W1	24	2.2	26	80	7.3	49-55	28	2.6	16	449	41.0
W2	24	2.2	27	49	4.5	56-62	10	.9	17	57	5.2
W3	2	.2	28	35	3.2	63-69	14	1.3	18	7	.6
W4	1	.1	29	29	2.6	70-76	22	2.0	19	1	.1
$\bar{X}$			30	30	2.7	77-83	13	1.2	20	1	.1
Mdn			31	18	1.6	84-90	8	.7	$\bar{X}$	14.5	
σ			32	13	1.2	91-97	10	.9	Mdn	15.0	
Min.			33	11	1.0	98-104	16	1.5	σ	1.8	
Max.			34	7	.6	105-111	10	.9	Min.	9	
Range			35	4	.4	112-118	6	.6	Max.	20	
N	1104		36	0	0	119-125	2	.2	Range	11	
Missing Data	1		37	4	.4	126-132	4	.4	N	1094	
			38+	8	.7	133+	40	3.7	Missing Data	11	
			$\bar{X}$	24.5		$\bar{X}$	29.5				
			Mdn	24		Mdn	16				
			σ	3.3		σ	34.1				
			Min.	19		Min.	0.0				
			Max.	45		Max.	143				
			Range	26		Range	143				
			N	1097		N	1080				
			Missing Data	8		Missing Data	25				

(Continued)

Table C-1 *(Continued)*

Frequency Counts for Variables Used in Analyses, Officer 1970 Sample

Prior Flight Training			Number of Dependents			Marital Status			Primary I Checkride		
Value[b]	*f*	%	Value	*f*	%	Value[c]	*f*	%	Value	*f*	%
0	845	78 5	0	350	32.0	D	4	.4	60-61	125	11.2
1	45	4.2	1	388	35.5	M	733	67.7	62-63	0	0.0
2	95	8.8	2	211	19.3	S	345	31.9	64-65	0	0.0
3	69	6.4	3	86	7.9	N	1082		66-67	0	0.0
4	14	1.3	4	32	2.9	Missing			68-69	0	0.0
5	8	.7	5	15	1.4	Data	23		70-71	22	2.0
6	0	0.0	6	8	.7				72-73	22	2.0
7	0	0.0	7	0	0				74-75	49	4.4
8	1	.1	8	1	.1				76-77	72	6.5
$\overline{X}$	.5		9	1	.1				78-79	84	7.6
Mdn	0.0		$\overline{X}$	1.2					80-81	168	15.1
σ	1.1		Mdn	1.0					82-83	164	14.8
Min.	0		σ	1.2					84-85	174	15.6
Max.	8		Min.	0					86-87	124	11.2
Range	8		Max.	9					88-89	46	4.1
N	1077		Range	9					90-91	50	4.5
Missing			N	1092					92-93	8	.7
Data	28		Missing						94-95	3	.3
			Data	13					96	1	.1
									$\overline{X}$	75.6	
									Mdn	82	
									σ	8.3	
									Min.	60	
									Max.	96	
									Range	36	
									N	1112	
									Missing		
									Data	94	

[a]01 - 2LT 03 - CPT 05 - LTC 07 - BG W2 - CWO 2 W4 - CWO 4
02 - 1LT 04 - MAJ 06 - COL W1 - WO 1 W3 - CWO 3

[b]0 - No prior flight experience
1 - AROTC flight training—not completed
2 - AROTC flight training—completed
3 - Limited fixed wing (other than 1)
4 - Fixed wing—private license
5 - Fixed wing—commercial license
6 - Limited rotary wing experience
7 - Rotary wing—private license
8 - Rotary wing—commercial license

[c]D - Divorced; M - Married; S - Single

Table C-2

Frequency of Occurrence of Pre-Solo and Primary Flight Grades, Officer 1970 Sample

Flight Number	Grade 1	2	3	4	$\overline{X}$	Mdn	σ	N	Missing Data
PS 04	3	62	1051	52	3.0	3	.3	1168	57
PS 05	35	191	889	62	2.8	3	.6	1177	48
PS 06	63	245	762	46	2.7	3	.6	1116	109
PS 07	145	278	651	51	2.5	3	.8	1125	100
PS 08	154	265	649	38	2.5	3	.8	1106	119
PS 09	128	261	631	51	2.6	3	.8	1071	154
PS 10	119	267	617	41	2.6	3	.7	1044	181
PS 11	107	247	564	30	2.6	3	.7	948	277
PS 12	104	228	463	12	2.5	3	.7	807	418
PS 13	70	162	335	16	2.5	3	.7	583	642
PS 14	40	94	176	7	2.5	3	.7	317	908
PS 15	29	30	73	5	2.4	3	.9	137	1088
PS 16	2	137	725	62	2.9	3	.5	926	299
P 01	5	170	920	37	2.9	3	.4	1132	93
P 02	27	108	657	25	2.8	3	.5	817	408
P 03	32	128	638	24	2.8	3	.6	822	403
P 04	35	211	813	28	2.8	3	.5	1087	138
P 05	34	130	668	41	2.8	3	.6	873	352
P 06	22	71	897	95	3.0	3	.5	1085	140
P 07	2	2	10	1	2.7	3	.8	15	1210
P 08	21	66	178	5	2.6	3	.7	270	955
P 09	2	2	8	2	2.7	3	.9	14	1211
P 10	20	62	173	9	2.6	3	.7	264	961
P 11	11	32	67	7	2.6	3	.7	117	1108
P 12	9	43	96	4	2.6	3	.6	152	1073
P 13	11	24	99	8	2.7	3	.7	142	1083

Table C-3

Frequency Counts for Variables Used in Analyses, Officer 1970 Sample: Airmanship Examinations

Exam	Scores																				$\overline{X}$	Mdn	σ	N	Missing Data
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20					
AME 1	0	0	0	0	0	0	2	1	1	0	0	0	0	7	4	17	45	125	313	557	19.2	20	1.3	1072	33
AME 2	0	0	1	0	0	0	0	0	0	1	2	2	4	10	29	53	129	205	341	289	18.5	19	1.6	1066	39
AME 3	0	0	0	0	0	0	1	0	1	0	1	1	2	12	25	35	89	217	328	372	18.7	19	1.4	1084	21
AME 4	0	0	0	0	0	0	0	0	0	0	0	0	2	8	13	55	89	180	351	396	18.8	19	1.3	1094	11
AME 5	0	0	0	0	0	2	0	0	0	0	0	0	4	8	9	26	104	202	346	377	18.8	19	1.4	1078	27
AME 6	0	0	0	0	0	1	0	0	0	2	0	4	10	21	34	83	125	209	315	268	18.2	19	1.7	1072	33
AME 7	0	0	0	0	0	0	0	0	0	2	4	9	12	21	65	94	152	193	278	246	18.0	18	1.9	1077	28
AME 8	0	0	0	0	0	0	0	0	0	0	2	5	5	17	44	84	146	237	301	248	18.2	19	1.6	1089	16
AME 9	0	0	0	0	0	0	0	0	0	0	3	1	2	7	15	47	87	159	316	442	18.8	19	1.4	1079	26
AME 10	0	0	0	0	1	0	0	0	0	0	0	0	2	0	5	24	52	129	332	533	19.2	19	1.1	1078	27
AME 11	0	0	0	0	0	0	0	1	1	1	0	1	3	13	25	49	92	200	301	327	18.6	19	1.5	1014	91

Table C-4

Frequency Counts for Variables Used in Analyses, Officer 1970 Sample: Officer Development Examinations

Exam	Scores																				$\overline{X}$	Mdn	σ	N	Missing Data
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20					
ODE 89	--	--	--	--	--	1	4	4	13	15	32	44	53	74	100	125	129	183	191	135	16.56	17	2.83	1104	1
ODE 90	--	--	--	--	1	1	4	2	2	5	5	11	36	50	85	116	158	232	210	183	17.40	18	2.52	1102	3

Appendix D

INTERCORRELATION MATRICES FY69 AND FY70 SAMPLES

Table D-1

WORWAC 1969 Sample, Total Population

(N=2281)

Variable	No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Rank	1	–																					
Age	2	.598	–																				
Months Prior Service	3	.772	.721	–																			
Education	4	-.217	.115	-.260	–																		
Prior Flight Training	5	-.099	.014	-.083	.091	–																	
FAST Score	6	-.028	.054	-.027	.132	.246	–																
GT Score	7	-.059	-.001	-.118	.262	-.052	.251	–															
Number of Dependents	8	.497	.653	.627	-.171	.005	.015	-.070	–														
AFQT	9	-.190	-.083	-.175	.135	.026	.332	.374	-.097	–													
Marital Status	10	.391	.464	.431	-.061	.017	.037	-.073	.727	-.085	–												
Procurement Source	11	-.741	-.397	-.511	.121	.089	.016	-.014	-.319	.189	-.270	–											
AME 1-7	12	.034	.080	-.007	.180	.174	.340	.242	.021	.226	.031	.016	–										
AME 8-12	13	.030	.124	.017	.191	.139	.315	.231	.029	.156	.032	-.020	.562	–									
AME 13-17	14	.039	.101	.008	.193	.115	.276	.254	.011	.159	.009	-.009	.502	.579	–								
WDE 51-55	15	.051	.113	.037	.177	-.058	.183	.350	.042	.162	.047	-.021	.515	.461	.447	–							
WDE 56-60	16	.073	.130	.040	.204	.004	.289	.348	.044	.243	.051	-.043	.524	.561	.570	.525	–						
WDE 61-64	17	.086	.110	.043	.192	-.040	.175	.285	.057	.128	.081	-.072	.319	.440	.404	.383	.455	–					
3rd–7th Wolters Pre-solo Flights	18	.001	-.030	-.020	-.004	.258	.211	-.010	-.009	.018	.009	-.011	.156	.164	.099	.017	.034	.035	–				
Pre-solo Flight Average	19	.002	-.010	-.004	.013	.197	.174	-.013	-.016	.014	-.021	-.019	.138	.131	.067	.002	.041	.044	.591	–			
Primary Flight Average	20	.010	-.024	-.015	-.012	.172	.177	.017	.008	.022	.017	-.021	.127	.137	.098	.025	.084	.082	.440	.478	–		
Advanced Flight Average	21	-.037	-.032	-.043	.004	.152	.170	.025	.017	.020	.034	.030	.121	.134	.119	.028	.090	.074	.299	.260	.340	–	
Criterion Pass/Fail	22	.015	-.003	.008	.009	.005	.037	.005	.006	.010	.013	-.010	.005	.021	.014	-.036	.012	-.028	.076	.032	.058	.057	–

Table D-2

WORWAC 1970 Sample, First-Half Sample, Pass/Fail Criterion With PPDR

(N=500)

Variable	No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Rank	1	--																							
Age	2	.598	--																						
Months Prior Service	3	.674	.712	--																					
Education	4	-0.156	.128	-0.229	--																				
Prior Flight Training	5	.026	.153	.053	-0.032	--																			
FAST Score	6	-0.029	.103	.017	.168	.173	--																		
GT Score	7	-0.074	.055	-0.075	.247	-0.077	.205	--																	
Number of Dependents	8	.484	.615	.656	-0.148	.031	-0.024	.005	--																
AFQT	9	-0.108	.011	-0.091	.154	.009	.363	443	-0.061	--															
Marital Status	10	.331	.435	.391	-0.010	.017	0.006	0.001	.736	0.041	--														
Procurement Source	11	-0.657	-0.344	-0.365	.073	.001	029	014	-0.307	.120	-0.213	--													
AME 1-7	12	.064	.193	.075	.178	.132	.349	340	.098	.299	.103	.002	--												
WDE 51-53	13	-0.079	-0.061	-0.082	.154	-0.084	.206	.406	-0.038	.176	.005	.060	428	--											
WDE 54-56	14	.097	.186	.116	.146	-0.017	.159	.329	.155	.157	.203	0.049	.500	.510	--										
3rd–7th Wolters Flights	15	.130	.088	.083	-0.074	241	187	0.012	.078	.024	.041	0.119	.069	0.066	-0.051	--									
AME 8-9	16	.001	.085	-0.048	.153	.057	.233	.198	.005	.238	.062	.042	.434	.308	.340	.115	--								
WDE 57-59	17	.033	.111	.040	.190	.029	.296	.375	.005	.384	0.013	.000	.481	.299	.347	.080	.304	--							
Pre-solo Average	18	.081	.050	.098	-0.096	.130	.170	0.064	080	-0.059	.079	0.024	.103	017	050	.495	.071	.091	--						
PS4–PS 15 hours	19	-0.065	0.057	.006	-0.093	-0.072	-0.100	-0.011	0.042	-0.011	-0.100	-0.013	0.079	-0.065	-0.045	-0.200	-0.220	-0.070	-0.222	--					
AME 10	20	.020	.123	.005	.090	.042	.108	.232	0.003	.099	.004	-0.007	.353	.238	.267	.010	.259	309	032	-0.045	--				
Primary Average	21	.065	.003	.017	-0.079	.167	.128	0.097	.030	0.013	.024	-0.093	-0.006	0.100	-0.017	.308	.040	061	.351	-0.141	.012	--			
AME 11	22	.098	.164	.053	.102	.156	.142	.105	.054	.215	.019	-0.073	.308	.126	.224	.019	.148	358	.012	067	.149	.031	--		
Primary I Checkride	23	.013	-0.014	-0.024	.089	.107	.069	-0.027	-0.025	-0.023	-0.018	-0.003	.132	.060	.033	.109	126	.079	.138	-0.193	.123	.221	.066	--	
Criterion Pass/Fail	24	.010	.015	.052	-0.062	.047	.099	020	.028	-0.008	.070	.038	.134	.032	.087	.086	.111	.121	.191	-0.171	.116	.080	.081	.226	--

Table D-3

WORWAC 1970 Sample, First-Half Sample, Class Standing Criterion

(N=640)

Variable	No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Rank	1	--																						
Age	2	.636	--																					
Months Prior Service	3	.748	736	--																				
Education	4	-0.186	.112	-0.253	--																			
Prior Flight Training	5	.019	.099	.016	.055	--																		
FAST Score	6	-0.013	.104	-0.018	.186	.215	--																	
GT Score	7	-0.071	003	0.014	.261	-0.034	.233	--																
Number of Dependents	8	.462	.587	.573	-0.157	.024	-0.035	-0.094	--															
AFQT	9	-0.165	-0.028	-0.171	.159	-0.000	0.361	.385	-0.091	--														
Marital Status	10	286	.442	356	0.038	-0.038	-0.030	-0.023	.746	-0.046	--													
Procurement Source	11	-0.648	0.378	-0.430	.112	.049	-0.013	-0.036	-0.257	.109	-0.144	--												
AMI 1-7	12	.106	.159	0.068	.159	.061	.299	.272	.049	.207	.046	-0.025	--											
WD 51-53	13	.013	.015	-0.012	140	-0.078	.139	.343	.010	.153	.042	-0.013	.407	--										
WD 54-56	14	.174	.262	.161	.158	-0.031	.103	.252	.176	.167	216	-0.039	.491	.457	--									
3r - 7th Wolters [illegible]ghts	15	089	.047	.019	-0.031	.275	.182	-0.029	.064	.058	.042	-0.026	.063	-0.035	-0.004	--								
AME 8-9	16	.019	078	0.026	.153	.089	.236	.146	0.012	.122	.046	.018	.368	.261	.308	.180	--							
WDE 57-59	17	.040	.095	0.018	.227	.023	.287	.295	.011	.329	054	-0.031	.495	.345	.430	.077	.263	--						
PS Average	18	.059	.044	0.016	-0.012	.167	.141	-0.001	.002	.067	.043	.019	.053	0.003	.022	.526	.082	.087	--					
PS 4 Hours	19	-0.008	0.057	0.003	-0.022	-0.109	-0.096	.009	.059	-0.025	.014	-0.053	-0.011	.038	0.009	-0.110	-0.120	-0.008	-0.149	--				
AME 10	20	0.037	-0.010	-0.088	.136	.078	.198	.240	-0.070	.166	-0.026	.033	.369	.311	.305	.016	.310	.299	.047	-0.008	--			
Primary Average	21	-0.026	0.014	-0.075	0.021	.160	.109	-0.070	-0.047	-0.018	-0.026	.065	.035	-0.051	-0.002	.344	.053	.051	.425	-0.119	-0.005	--		
AME 11	22	.014	.089	.010	.122	.098	.130	.138	.045	.135	.040	-0.025	.286	.133	.240	-0.005	.123	.319	.036	.110	.177	.027	--	
Criterion Class Standing	23	.022	0.045	-0.036	.182	.182	.329	.183	-0.018	.161	.021	.055	.568	.389	.449	.354	.406	.516	.421	-0.181	.344	.449	.294	--

Table D-4

Officer 1970 Sample, First-Half Sample, Pass/Fail Criterion

(N=563)

Variable	No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Age	1	--																
Months Prior Service	2	.496	--															
Education	3	-0.154	-0.414	--														
Prior Flight Training	4	-0.011	-0.182	.292	--													
Number of Dependents	5	.506	.366	-0.257	.016	--												
Marital Status	6	.252	.181	-0.127	.061	.631	--											
AME 1-7	7	.049	-0.047	.233	.165	.079	.098	--										
3rd–7th Wolters Flights	8	.129	-0.049	.057	.288	.132	.136	.228	--									
ODE 9-10	9	-0.032	-0.092	.125	.054	-0.078	-0.027	.172	.032	--								
Pre-solo Average	10	.000	-0.054	.014	.189	.074	.113	.144	.466	.039	--							
PS4-PS 15 Hours	11	-0.038	.008	-0.009	-0.279	-0.041	-0.061	-0.113	-0.361	.008	-0.308	--						
AME 8-9	12	.038	-0.016	.182	.146	.022	.052	.403	.144	.190	.132	-0.086	--					
AME 10	13	.065	-0.066	.160	.044	.023	.045	.301	.053	.249	.079	-0.076	.208	--				
Primary Average	14	.050	.009	.002	.204	.106	.141	.182	.516	.069	.444	-0.402	.195	.080	--			
Primary I Checkride	15	-0.016	-0.038	.032	.178	.014	.021	.086	.270	-0.064	.239	-0.203	.093	.051	.263	--		
AME 11	16	.122	-0.008	.140	.163	.079	.030	.403	.168	.158	.124	-0.137	.293	.274	.152	.038	--	
Criterion Pass/Fail	17	.000	.017	.024	-0.044	.005	.027	.052	.115	.016	.087	-0.089	.055	.207	.089	.098	.043	--

Table D-5

First-Half Officer 1970 Sample, Class Standing Criterion

(N=553)

Variable	No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Age	1	--																
Months Prior Service	2	.526	--															
Education	3	-0.196	-0.394	--														
Prior Flight Training	4	-0.093	-0.193	.341	--													
Number of Dependents	5	.587	.390	-0.271	-0.064	--												
Marital Status	6	.283	.231	-0.134	0.000	.645	--											
AME 1-7	7	.052	-0.009	.177	.128	.056	.061	--										
3rd–7th Wolters Flights	8	.144	-0.034	.052	.256	.074	.019	.202	--									
ODE 9-10	9	-0.074	-0.088	.121	.017	-0.076	-0.069	.196	.081	--								
Pre-solo Average	10	.046	-0.029	.026	.145	.076	.058	.225	.493	.091	--							
PS4-PS15 Hours	11	-0.082	-0.012	.010	-0.121	-0.068	-0.050	-0.087	-0.311	-0.008	-0.255	--						
AME 8-9	12	.010	.049	.166	.134	.009	.011	.445	.165	.178	.197	-0.108	--					
AME 10	13	.068	-0.030	.161	.049	.005	.003	.290	.041	.166	.111	-0.034	.219	--				
Primary Average	14	-0.031	-0.055	.011	.117	.050	.060	.169	.481	.158	.454	-0.373	.224	.071	--			
Primary I Checkride	15	-0.048	-0.012	-0.014	.093	-0.002	.010	.069	.175	-0.012	.189	-0.114	.108	.027	.257	--		
AME 11	16	.147	.002	.162	.134	.056	.066	.401	.173	.170	.174	-0.032	.221	.258	.083	.020	--	
Criterion Class Standing	17	.035	-0.068	.154	.246	.056	.060	.612	.529	.274	.527	-0.329	.466	.257	.587	.387	.416	--

Appendix E

ANNEX I TO WORK UNIT PREDICT PROGRAM PAPER

HumRRO Division No. 6 (Aviation)
Fort Rucker, Alabama

WORK UNIT PREDICT PROGRAM PAPER

11 May 1970

Annex I

Technical research plan for the development of (1) an operational predictor system for rotary wing initial flight training, and (2) a method of selection for helicopter gunnery training.

(PREDICT I)

INTRODUCTION

The objective of this Annex to the PREDICT Work Unit Program Paper are to provide:

1. A list of variables to be included in initial correlation matrices. Regression equations derived from these matrices will predict the success or failure of individual trainees in the initial entry Officer Rotary Wing Aviation Course (ORWAC) and Warrant Officer Rotary Wing Aviator Course (WORWAC). The list includes sources of the variables.

2. A rationale for inclusion in the matrices for each variable listed.

3. A description of the method for collection, coding and computer storage of information for each variable.

4. A brief rationale for the method of analysis.

5. A description of the implementation system for the predictor equations to be developed.

6. An exposition of plans for experimental evaluation of additional variables not included in the original matrices.

7. A description of the application of data compiled in paragraphs 1 and 6 above to the prediction of performance of students in helicopter gunnery training.

Section 1

VARIABLES TO BE INCLUDED IN INITIAL MATRICES

A. Identification variables.

For FY 69 classes, the primary source for these variables was the "Initial Data Printout" (IDP), a personnel management roster used for trainee control at the U. S. Army Primary Helicopter School (USAPHS), Fort Wolters, Texas. It contains identification, demographic, biographical, and assignment information and selection test scores. Some of this information is transcribed from the primary enlisted and officer personnel records, Forms 20 and 66 respectively, during the first week of ORWAC and WORWAC. Other portions of the information are obtained from the student. The combined data are compiled for IBM cards punching on a summary personnel document informally titled "the Block Form" (BF). The IDP is generated from the BF cards. For FY 70 classes, USAPHS transmits the IBM cards containing BF information directly to the HumRRO Computer Center (HCC). The identification variables are:

1. Class Number. This is the number assigned a flight class by USAPHS. This four-digit hyphenated number contains the fiscal year of the flight class as the first two digits and the sequential number of the class within that fiscal year as the last two digits. Classes are numbered within the year from 01, with odd integers assigned to WORWAC and even numbers assigned to ORWAC classes. For example, class 69-05 WORWAC was the fifth flight class to begin at Fort Wolters during fiscal year 1969. (Because of the odd-even alternation, it was the third aviation Warrant Officer Candidate (WOC) class to begin during that fiscal year.)

2. Class roster number. A within-class identification number is assigned to students in alphabetical order. It varies from one to three digits with categories of personnel identified by specific series of numbers. An explanation of these categories is included in Appendix 1.

3. Social Security Account number. This nine-digit number has replaced the Army serial number.

B. Demographic and biographical variables.

With the exception of marital status, values for these variables are obtained from the IDP.

1. Procurement source. A one-digit code categorizes the WOC as flight training enlistment option (EO) or in service (IS). EO candidates come into the aviation training program from civilain status while IS personnel come from enlisted active duty assignments. For officer students, procurement source reflects the source of commission or warrant, i.e., OCS, direct appointment, ROTC, or Academy.

2. Rank. This variable, in the case of WOCs, shows enlisted rank prior to entering the flight program. While the ranks of WOCs do not change during training, the ranks of officers may change. For matrix purposes, rank at time of entry into the Rotary Wing Aviator Course will be used for officers.

3. Age. This variable reflects the student's age in years at last birthday before entering the flight program.

4. Branch. For commissioned officer students this designates occupational categories such as infantry, artillery, and engineers. All warrant officers attending ORWAC are members of the Aviation Warrant Officer Branch. This variable will not appear in the matrices for WOCs.

5. Flight training. Flight training received prior to entry into the Army's aviation training program is reflected by this variable. The categories used are described in Appendix 1.

6. Marital status. This information is obtained from the Form 20 for WOCs and from the Form 66 for officers. Students are categorized as single, married, or divorced.

7. Educational level. This information is categorized in terms of years of formal civilian education completed. GED equivalents are not differentiated.

8. Months of prior service. These data consist of months of federal military service accumulated by the student prior to entry into aviation training.

9. Number of dependents. Number of dependents claimed by the student at the time of entry into ORWAC/WORWAC is reflected by this variable.

C. Actions.

1. Progress category. This variable reflects administrative progress actions applied to students. Examples are eliminations and setbacks. A complete list of categories is included in Appendix 1. These actions are shown on the Corrected Initial Roster (CIR) which is prepared at each of the training centers upon graduation of a flight class.

2. Location of advanced flight training. This variable designates the location at which the student receives advanced rotary wing training. At the completion of the primary phase at Fort Wolters, some students report to Fort Stewart-Hunter Army Air Field, Georgia, and others to the U. S. Army Aviation School (USAAVNS) at Fort Rucker, Alabama. The assignment of students to these locations is indicated on the USAPHS Final Class Standing Roster. For officer students, all USAPHS training is designated as Phase I. For WOCs the four-week preflight period is termed Phase I

and flight training is designated Phase II. Thus, the initial phase of advanced training (i.e., at Rucker or Hunter-Stewart) is Phase III for WOCs but Phase II for officer students.

D. Pretraining information.

1. Flight Aptitude Selection Tests (FAST) Composite Score. This information, obtained from the IDP, is the student's overall score on the primary selection battery, the Flight Aptitude Selection Tests, constructed and monitored by the U. S. Army Behavioral Science Research Laboratory. The minimum score for selection is 250 for the Warrant Officer Rotary Wing Aviator Battery and 155 for the Officer Rotary Wing Aviator Battery.

2. Armed Forces Qualification Test (AFQT) Score. This information, applicable to WOCs only, is taken from Form 20s for WOCs. It reflects the numerical score on the Armed Forces Qualification Test.

3. General Technical (GT) Aptitude Area Score. This score, applicable to WOCs only, is obtained from the IDP and is derived from the verbal and arithmetic aptitude subtests of the Armed Forces Qualification Test (AFQT) or the Army Classification Battery (ACB).

E. Primary academic variables.

1. Fort Wolters academics. Presently, 17 academic examinations in airmanship are administered. On each, the maximum score is 20 and the minimum passing score 14. The content areas covered by these examinations are as follows:

a. Airmanship Examination (AME)-1. The development of the helicopter, rotary wing aerodynamics and aircraft orientation, hardware, structures, wear factors, and safetying procedures.

b. AME-2. Helicopter airframe, technical publications, rotor performance, main rotor/tail rotor system, and helicopter vibrations.

c. AME-3. Flight controls, aviation fuels, powerplants, and aviation lubricants.

d. AME-4. Powertrains, electrical systems, instruments, helicopter systems review, and aircraft systems checks.

e. AME-5. Preflight-postflight procedure, cockpit procedures, ground handling, parking and mooring, communication procedures and radio phraseology, and clouds.

f. AME-6. Frontal weather, aircraft forms and records, aircraft inspection, and aircraft accident procedures.

g. AME-7 Flight line practical exercise in preflight and cockpit procedures, pressure, winds, air circulation, air masses, teletype sequence reports, and surface weather maps.

h. AME-8 Local area orientation, straight and level flight, a flight line practical exercise in preflight and cockpit procedures, a flight line orientation, climbs, turns, and descents, ground track maneuvers, normal take-off and landing, autorotations, and auto-simulated forced landing.

i. AME-9 Deceleration and quick stops, emergency procedures, auto-simulated forced landings, and human factors.

j. AME-10 Emergency procedures, human factors, helicopter limitations, and steep approach and maximum take-off.

k. AME-11. Take-off, land to ground, deceleration and quick stops, aero chart symbols, and distance and direction.

l. AME-12. Winds aloft, wind direction and speed, variation and deviation, and a navigational practical exercise.

m. AME-13. The use of the navigation computer.

n. AME-14. Flight plans, a navigational practical exercise, density altitude, adverse weather, performance data charts, low level navigation, and slopes and confined areas.

o. AME-15. Mountain circulation, pinnacle approaches, fog, icing, thunderstorms, and terminal and area forecasts.

p. AME-16 The weather depiction chart, human factors, radar summary charts, a weather flight planning practical exercise, aircraft accident prevention, administrative responsibilities, and aircraft accident investigation.

q. AME-17. Air mass weather in Southeast Asia, weight and balance, and visual search.

The Airmanship Examinations listed above are administered to both officers and WOCs. The scores are collected from academic examination printouts for FY 69 classes and from IBM punched cards for FY 70 classes.

2. Warrant Officer Development Examinations. These examinations are designed to test the student's progress in acquiring knowledge of military subjects. They include:

a. Warrant Officer Development Examination (WDE)-1. The organization of the Army

b. WDE-2. Problem solving and unit programs.

c. WDE-3 Leadership

d. WDE-4 Pay and allowances, checking accounts, budgets and savings, and survivor's benefits.

e. WDE-5. Unit administration and military justice.

f. WDE-6. Uniforms, the Honor Code, intelligence, safeguarding defense information, and customs and courtesies.

g WDE-7 Map symbols and marginal information, location and coordinates, and distance and map scales

h. WDE-8 Terrain features, elevation, directions, azimuth plotting, intersections, resections, and polar coordinates.

i. WDE-9 Aerial photography and military symbols.

j. WDE-10 Internal defense and development, and command and staff subjects.

k. WDE-11 Effective writing I

l WDE-12. Effective writing II.

m. WDE-13. The Officer Efficiency Report, mess and sanitation, personnel action, and nuclear effects.

n. WDE-14 Military instruction and unit supply.

3. Officer Development Examinations (ODE). These examinations are given in ORWAC. Officer students originally took 10 tests with content virtually identical to WDE examinations, but the number has now been reduced to three:

a. ODE-1 Map reading.

b ODE-9 Effective writing.

c. ODE-10 Effective writing.

4. Development examinations also have maxima of 20 points with a passing score of 14. Data are derived from academic printouts for FY 69 classes and from IBM punched cards for FY 70 classes.

F Fort Wolters Flight Grades

Letter grades for completed dual flights are compiled and recorded from a cumulative computer-printed listing prepared by USAPHS. Letter grades are awarded on a four-point scale and recorded in descending order of quality or performance as Above Average (AA), Average (A), Below Average (BA), and Unsatisfactory (U). There are approximately 75 graded flights at Fort Wolters. (Also compiled as a matter of convenience for future analysis but not for inclusion in original matrices are the identification number of the instructor pilot on the flight; the identification number of the lesson, which in turn will allow determination of the instructional content; and the time of day during which the flight occurred.)

G. Fort Rucker or Hunter-Stewart flight grades.

For advanced training grades on completed dual flights are recorded for Basic Instrument, Advanced Instrument, and Transition training stages. In addition, checkride grades for each stage of training are recorded. These grades are manually transcribed from original hand-written records made by flight instructors.

H. Fort Rucker WORWAC Phase III--ORWAC Phase II academic grades.

All Fort Rucker academic examinations are graded on a per cent correct basis.

For those students who receive advanced flight training at Fort Rucker, scores on the following academic tests are recorded:

a. RWC-1. Basic instruments (ADF, OMNI, RMI) and basic flight.

b. RWC-2. Flight regulations (Radar and ATC) and instrument landing.

c. FW-1. Fixed Wing tactical flight procedures and the dead reckoning computer.

d. FW-2. Fixed Wing IFR flying and navigation.

e. DOMT-1. UH-1 systems and maintenance.

I. Fort Rucker WORWAC Phase IV--ORWAC Phase III academic grades.

Scores on the following examinations during this phase of training will be recorded.

a. TAC-1. Communications and flares.

b. TAC-2. Gunnery

c. TAC-3. General subjects.

d. TAC-4. Experience in escape and evasion.

e. TAC-6. Aircraft gunnery.

f. TAC-7 Artillery subjects.

Fort Rucker academic grades are on a per cent scale.

J. Hunter-Stewart WORWAC Phase III--ORWAC Phase II academic grades.

For those students who attend advanced flight training at Fort Hunter-Stewart, the following academic grades will be recorded:

a. AHT-1 Instrument operation, VFR, IFR, traffic control, dead reckoning

b. AHT-2 ADF procedures, OMNI, navigation aids, radar and instrument landings.

c. AHT-3 FAA procedures, charts, navigation aids.

d. AHT-4 Maps, weather.

e. AHT-5 Powerplant, weight and balance, maintenance records.

f. AHT-6. Fuel and oil systems, rotor systems, tracking, electrical systems, hydraulic and flight control systems, heating ventilating and defrosting systems.

K. Hunter-Stewart WORWAC Phase IV--ORWAC Phase III academic grades.

a. TAC-1 Communications and flares

b. TAC-2 Loads and gunnery.

c. TAC-3 General subjects (landing areas, airmobile operations, ATC, med-evac).

d. TAC-4 Survival, escape and evasion.

e. TAC-6. Tactical flight missions

f. TAC-7 Artillery

Section 2

RATIONALE FOR INCLUSION OF VARIABLES IN THE STUDY

Variables are considered in the same order as in the Section 1 listing.

A. Identification variables.

Variables A1 (Class number), A2 (Class roster number), and A3 (Social Security number) serve as individual identifiers for the purposes of modification and expansion of subject files.

B. Demographic and biographical variables.

1. Procurement source. Two studies published by the Naval Aeromedical Institute have shown the relation between procurement source and amount and type of attrition in Naval aviation training (1, 2). Wherry and Hutchins (1) found that the use of procurement sources in dichotomized form in the computation of the multiple prediction formulae used to predict success in Naval flight training resulted in increases in the validity of the formulae for both officers and non-officers. In our initial matrices for WOCs, procurement source is a dichotomous predictor variable. The two categories are EO and IS. For comparison of accuracy of prediction, separate matrices will also be computed at each point in training for EO and IS candidates. In these matrices, of course, procurement source will not appear as a variable.

Procurement source for officers will indicate the source of the officer's commission. These sources are (1) direct, (2) academy, (3) OCS, and (4) ROTC. During analysis, procurement sources will be treated as if they were four separate dichotomous variables. An individual will receive a score of one on the variable which describes his procurement most accurately and a zero on each of the other four variables. This dichotomizing procedure, described previously by Bottenberg and Christal (3) and Wherry, Jr. (4), will be used with several categorical variables and will be referred to hereafter as the pseudovariable technique (4).

2. Rank. A number of studies have shown correlations between rank upon entry to flying training programs, and performance in those programs (5, 6). In the study which established the FAST battery for primary selection, rank was negatively related to flight grades, but positively related to leadership evaluations (5). In that study, it was concluded that this variable and age would be ineffective selector variables because of their reversal across these criteria. In general, younger, and lower ranking students tended to be better pilots, while older students were more often better leaders. Since the Army wishes to train people who are both good leaders and good fliers, a restrictive policy on these variables would lead to an increase on one performance measure but a decrease on

another. However, in secondary selection, it is possible to take advantage of these differential relationships. That is, one can consider students against flying criteria after they have completed the leadership portion of the course.

In a 1964 study Hutchins found that rank was a valid predictor variable for Naval aviation training (6). Officers in pay grade 0-1 had a significantly lower rate of attrition than officers in higher rank. Also, higher ranking officers attrited more often by means of the DOR (Dropped on Request) category. In the present Army situation, self-initiated elimination, which is comparable to the Navy's DOR category, is one of the major attrition problems. Therefore, rank will be included in the initial matrices for both WOCs and officers.

3. Age. As related in paragraph B2, age has previously been shown to relate to multiple criteria in the Army training program in a conflicting manner, so that older students as a group are rated higher during preflight, but lower during flight training. However, the present sample is much younger than that for the earlier Army study. A decrease in flying performance with age is less likely in a younger population. Especially among EO candidates, where there will be no variation in rank, age is seen as potential contributing variable in predicting performance.

4. Branch. This variable is applicable only to officer trainees, who are assigned to the aviation training program by their branch headquarters. Different selection methods used by the various branches may result in differential probabilities of success in the program for those selected. Branch will be treated by the pseudovariable technique.

5. Previous flight training. This variable was shown to be related to several criteria in the Kaplan study (5). The correlation with pass/fail during the flying portion of the program was substantial. This will also be treated as a pseudovariable.

6. Marital status. In a number of cases, wife's attitude has been cited as the reason for withdrawal from training by candidates wishing to leave the program by means of self-initiated elimination. It seems logical, therefore, that marital status could be a predictor of this type of attrition from the program.

7. Educational level. Kaplan (5) found low correlations between educational level and various criteria within the training program. In general, the correlations were positive with academic performance and negative with flight and leadership performance.

8. Months of prior service. This variable will be highly correlated with the rank variable in the case of both officers and WOCs. While it is unlikely that both rank and prior service will be useful, the question of which is more useful must be empirically resolved.

9. Number of dependents. This variable also can be expected to correlate highly with age, rank and marital status, but the initial problem is to distinguish which one or combination of these will contribute most to prediction of performance.

C. Actions.

1. Progress categories. This is a statement of management actions taken on students as they progress through the program. Perhaps the most important of these is the setback for training deficiency, which may be either flight or academic. Other reasons for setbacks are medical holds, administrative holds, emergency leaves, lack of motivation, disciplinary problems, and unsatisfactory military progress.

2. Location of advanced flight training. This variable reflects the location of advanced rotary wing training. World War II research in pilot training showed clearly that standards among flight school locations can vary enough so that equations which are valid for one location will be useless for another (7).

D. Pretraining information.

1. FAST composite score. In order to qualify for flight training, an applicant must score a minimum of 250 points on the warrant officer rotary wing FAST battery or 155 points on the officer rotary wing FAST battery. A previous study of the ability of the FAST to further discriminate among men who qualify for training has shown that it is a strong predictor of flight deficiency elimination among the students selected (8).

2. AFQT score. While this is not a variable directly applicable to selection for the aviation program, a minimum score of 31 on this test is necessary for entrance into the Regular Army as an enlisted man. It is a basic cognitive aptitude test of a type which has been shown to be valid in the Navy's aviation training program and the World War II Army Air Corps program. Cognitive tests have been strong predictors of academic performance in WORWAC (5).

3. GT score. In the FAST validation study (5), this cognitive score, derived from the arithmetic reasoning and verbal scores of the Army Classification Battery, had the highest single correlation with academic performance of all measures investigated. It is a measure of general cognitive ability of the sort that has been shown to be valid for predicting performance in almost any situation in which academic scores are a component.

E. Primary academic variables.

The Navy program academic grades which have been shown to be related to probability of completion of the Navy flight training course are: mathematics, physics, navigation, engineering, aerodynamics, and physiology (9). The Army aviation examination program is not divided in terms of classic technical or academic subject matter areas, but similar subject matter is identifiable at various points in the Airmanship Examination series. PREDICT will statistically evaluate the relations of all Army academic examinations to training success. The Warrant Officer and Officer Development Examinations (which test development of military knowledge) are obtained from the same data sources as the Airmanship Examinations. Thus there is little additional cost in including these examinations in the initial matrices. Examples of Navy-Army academic program similarities follow, along with statements of the relationships between performance of Navy student pilots in the various content areas and criteria of success in the Navy program:

Army Examinations	Navy Content Area	Navy Point-biserial Correlations with Complete/Attrite	
AME-1	Aerodynamics	Non-officers	.144
		Officers	.151
AME 2 and 3	Engineering	Non-officers	.124
		Officers	.168
AME 4, 5, 6, 7, 12, and 15, 16, 17	Physics	Non-officers	.105
		Officers	---
	Math	Non-officers	.150
		Officers	.122
AME 11, 13 and 14; WDE 7 and 8; RWC-1, RWC-2	Navigation	Non-officers	.162
		Officers	.147

F. Fort Wolters flight grades.

The major source of attrition in the aviation program is failure to learn to fly the aircraft properly. Obviously, then, flight grades are job samples for the purpose of this study, and should form strong predictors throughout the program. In the Navy study, once flight grades are available, they become the strongest single predictor of future performance for non-officers and officers through the remainder of the training program. While the average grade for the previous phase of flight is the strongest predictor in each case, for non-officers the flight grades from the presolo period are significant contributors to prediction for every subsequent phase of the program (9).

G. - K.

The rationale for Ft. Wolters' academics and flight grades also applies to variable classes G, Ft. Rucker or Hunter-Stewart flight grades; H and I, Ft. Rucker academic grades; and J and K, Hunter-Stewart academic grades.

Section 3

METHOD OF DATA COLLECTION, CODING AND STORAGE

Variables whose values were determined from sources not conveniently arranged for IBM card punching are entered by the Work Unit staff on a data form designated the PREDICT Individual Data Record (PIDR). A copy of the PIDR and detailed instructions for its completion (which include coding) are attached as Appendix 1. As the data collection system evolved, increasing automation of the collection and storage process was achieved. Originally, for instance, significant portions of the identification, demographic, biographical and pretraining information listed in parts A, B, and D of Section 1 of this document were found to be missing on the USAPHS IDP. In most cases, lack of entry was in turn due to the fact that Form 20 information for WOCs and Form 66 information for officers had not been properly entered. It was found that effective monitoring of proper entry of a variable most often depended on the frequency of its use by agencies handling personnel records subsequent to handling by the agency responsible for entry. For several variables, little or no subsequent use was evident. Accordingly, data were frequently missing. As notice of monitoring and impending use was given to responsible agencies, record keeping quality substantially improved.

Most documents in the system are organized by class rather than individual. Since PREDICT data files must be organized by individual and include variables from a number of documents organized by class, it was more efficient to transcribe the data from these class documents to a PIDR for each student. For FY 70 classes beginning with 70-9, IBM cards used to generate the class documents were obtained and shipped directly to the HumRRO Computer Center (HCC), precluding clerical entry onto PIDRs.

USAPHS flight grades were originally obtained from computer printouts which are a permanent part of a student's training records. These are amenable to card punching without transcription to the PIDR, but they require some clerical modification. Again, beginning with early FY 70 classes, arrangements were made for obtaining the IBM cards from which these printouts were generated, thus eliminating repunching.

At present, all data for original matrices is flowing automatically from USAPHS to HCC. Data of BCT performance are not now being collected but reinstitution will be immediate if these data for USAPHS classes 70-1 through 70-23 show significant potential for predicting the performance of EO personnel.

Monitoring the completeness of automatically transmitted data will be a computer function. For back-up purposes, manual collection of data will continue until computer-generated completeness records are available. As necessary, manually collected data will be transferred to PIDRs to supplement routinely transmitted data. Manual transcription of data will thus occur by exception rather than routinely.

Appendix 2 contains the Master Data Control Form (MDCF) giving current information on sources of PREDICT data, showing responsible agencies, job titles of responsible individuals within agencies, names of incumbents in those jobs, and ETS for the incumbents. Where the ETS is indefinite, the monitoring schedule for maintaining contact with the incumbent is shown. Turnover of responsibility and job incumbents occurs frequently. The MDCF is revised upon every change of agency, job title, or incumbent involved. Copies are maintained at HumRRO Division No. 6, at the Office of the Special Assistant for Information and Data Systems (SAIDS) at USAPHS, and at HCC.

Appendix 3 reflects the current state of data completeness for manually compiled variables for the classes of the original sample. For the purposes of initial analysis, values of missing data for a specific variable will be estimated by the method outlined in Section 4. Continuing efforts will be made to fill empty cells with actual data by various tracing means.

Appendix 4 contains a summary of methods used to trace data not available from primary sources, including lists of alternate sources, addresses of agencies responsible for alternate sources, job titles and incumbents for staff contacts within those agencies where applicable, means of collection used for each alternate source, and specimen copies of data collection forms.

When a determination is made that a datum is irretrievable, HCC is notified that the estimate used will not be replaced at a later date. If data for a class or classes are determined to be unusable because of missing data, the data bank will contain a detailed explanation for the lack of information on those classes. Because of accidental destruction of academic performance data at USAPHS, FY 69 classes 31 through 44 will not be included. However, data are already available for card punching on a sufficient *N* of FY 69 students in all pertinent categories to allow generation and validation of equations.

Section 4

METHOD OF ANALYSIS

The approach to prediction used in PREDICT I will be that of multiple regression equations derived from multiple correlation matrices. The multiple correlation and regression situation is one in which we have a criterion variable, also called the dependent variable, whose value or values for individuals are to be predicted, and two or more predictor variables, also referred to as independent variables. In addition, we have an experimental sample. In the classic psychometric model, this experimental sample is a random sample of a defined population. Often, however, as is the case with the experimental sample for PREDICT, the sample is not a random sample from a population. In our case the population is defined by the sample. The population consists of the set of all individuals "like" those in the sample; i.e., the set of all individuals who might have been selected for this sample by the same selection procedure. Our experimental sample consists of all personnel going through the training system in classes 69-05 through 69-30. When we use these data to predict the performance of individuals in later classes, we will be making the assumption that the variable-to-performance relationships for students in the new classes will be substantially similar to the set of relationships which were obtained among the ones we measured. This, of course, will not be left as an assumption any longer than necessary. The system will continually test the assumption against the performance of new individuals, and change the equations as necessary. Since large numbers of individuals will be involved in the development of the first set of regression equations, it is expected that the prediction formulae will remain relatively stable.

For the members of the experimental sample, the first dependent variable studied will be completion or failure to complete the training program. The predictor or independent variables will be those listed in previous paragraphs. Performance in the gunnery training program will then be studied as a dependent variable with the same set of predictors used in the first study.

Dependent or criterion variables to be studied in later phases of PREDICT will include numerical grades awarded at the end of each phase of training, and final academic flight and overall grades.

For the first analysis, we have the following prediction situation: y_o represents the value of the criterion variable, and $X_1, X_2, \ldots, X_m$ are predictor variables. The purpose of a multiple regression analysis is to formulate an equation relating y_o as precisely as possible to $X_1, X_2, \ldots, X_m$, using the data from the experimental sample. Using this equation, values of y_o for students who were not in the experimental sample, and whose actual y_o scores are unknown, will be predicted. Also, we will assess *errors of prediction,* which are the differences between the predicted y_c scores and the actual y_o scores of the individuals predicted. This will tell us how much confidence can be placed in the prediction. Consider y_c, a score based on the values of $X_1, X_2, \ldots, X_m$, being used to predict an actual criterion score y_o. For individual students, the error of prediction is the difference $y_o - y_c$. In the multiple linear regression equation, which we will use in PREDICT I, we will be making use of the following linear equation:

$$y_c = b_1X_1+b_2X_2+b_mX_m+C \quad (1)$$

This is a raw score regression equation. $b_1, b_2, \ldots, b_m$ are partial regression coefficients, and C is a constant. y_o, then, is predicted from y_c, which is in turn based on $X_1, X_2, \ldots, X_m$. It is a linear estimate, i.e., a weighted sum of the Xs plus the constant, the bs symbolizing the values of the weights. y_c is then a weighted linear composite of the Xs plus the constant. Equation (1) is so valued as to constitute the best possible linear approximation of all the individual equations $y_o = b_1X_1+b_2X_2+\ldots b_mX_m+C$. These equations, one of which exists for each individual in the sample, are usually inconsistent in that no single set of values given $b_1, b_2, \ldots, b_m$ and C will satisfy all of them. The phrase "best possible approximation," is defined in terms of classical least-squares theory: values of the bs and the constant are to be chosen so as to minimize the sum of squares of the differences between the N pairs of values of y_o and y_c. In other words, $\Sigma(y_o - y_c)^2 = min.$ Completing this process also results in the maximization of r_oC, which is the correlation between the weighted composites of the Xs and the actual observed value of y_o. r_oC is called the coefficient of multiple correlation. Its value varies from zero to one, and its relative size is a statement of the closeness of the approximation of the y_c to the y_o. Restated, this value tells us how well the y_o can be predicted from knowledge of the values of the Xs which make up the approximation equation. The minimization values of the bs and the constant are obtained by determining a solution to a set of m normal equations in m unknowns. Once these values have been determined, a value of y_c for each individual is computed from the resulting equation by substitution.

An assumption implicit in the use of this method is that the errors are random. This implies that all subjects making up the distribution are equally predictable, and a deviation from the best fit straight line is due to errors of measurement. Although it can readily be shown that this assumption is often not met *(10, 11)*, it has been the experience of those working with large numbers of subjects and comparatively few variables, that more complex curves are not useful at Ns of less than 10,000 *(7)*.

Differential predictability will be explored in PREDICT by the use of logically derived subgroups. For example, it is quite reasonable to expect that WOC EO personnel who come into the aviation program directly from civilian life could differ in many ways from those personnel coming into the program from an in-service active duty status. Therefore, separate intercorrelation matrices will be computed for these groups and the predictions derived from their regression equations will be compared. If the predictions differ significantly, separate tables for prediction of performance of these groups will be furnished training managers. If, however, no significant increase in predictability is obtained by considering the two groups separately, a single set of tables for the prediction of WOC performance will be used. Because officer students receive slightly different training in terms of academic and military knowledge tests, separate matrices will be computed for them. The significance of differences between predictions will be tested by means of contingency tests of goodness of predictions in categories.

Equations for each possible combination of valid predictor variables will be computed at several points in training. The first matrix for enlistment option candidates will be composed of primary selection, demographic, and biographical variables and will be computable at the beginning of Ft. Wolters' training. The next matrix will consist of these variables plus academic performance during the first two weeks of preflight. This matrix is necessary to attempt to relate early academic performance, demographic-biographic variables, and selection variables to the attrition by resignation which we experience in the last week of preflight. It was established during exploratory research that daily flight grades on the first five graded flights correlate well with later performance, so the next matrix will consist of selection and training variables through the first five graded flights. Moving forward from that point, matrices will be computed for USAPHS training at the end of the presolo period, at the end of the primary period, and at the end of the advanced period. Moving to Ft. Rucker and Hunter-Stewart, matrices will be computed at the end of the basic instrument phase, the advanced instrument phase, the transition phase, and the last phase at Ft. Rucker, which is tactics. Of course, Rucker academic grades, Wolters academic grades, and Hunter-Stewart academic grades will enter into these matrices as they become available.

Since an equation will be constructed for each possible combination of valid predictor variables at each point, the system will allow for immediate substitution of a new equation at any time that modification of the training program renders one or more variables no longer pertinent. The principal modification which would necessitate a change of equations would be the discontinuance of a particular measure.

There are a number of cautions to be considered in the use of the multiple correlation technique and multiple regression equations, but the majority of these are matters of interpreting results, rather than of the practicality of using weighted scores for predicting performance. Continued monitoring of the predictive utility of this system and empirical comparison of its precision with those of alternative decision methods will be the proper tests of its usefulness. Its proper maintenance, of course, will require prompt communication of changes in the content or sequencing of the program of instruction to those responsible for providing the equations to their users.

The initial analysis of data will be accomplished by use of the HumRRO generalized computer program REGRS I. This is a step-wise multiple linear regression program described in detail in the User's Manual for the HumRRO statistical analysis system. Since REGRS I does not account for missing data, the following preliminary steps will be taken:

1. No variable will be used in analysis unless its value is known for at least 90 per cent of the sample.

2. Regression equations will be computed from the data of all those students whose data are complete for all predictor variables, with each predictor variable successively in the dependent variable position.

3. Scores derived from these equations will be inserted in missing data cells for that variable.

Section 5

GENERATION AND IMPLEMENTATION OF INITIAL PREDICTION EQUATIONS

When all cells have been completed for all variables, REGRS I will be applied with the dichotomy complete/attrite as the dependent variable. The regression equations generated will be applied to each individual in the sample and the resulting predictor scores used to generate the graphs and tables illustrated in Appendix 5. The materials illustrated will be compiled in a notebook for distribution to the agencies designated by the Commandant of USAPHS and USAAVNS to be responsible for computing predictor scores and thus serving as Student Prediction Centers (SPC).

It will be necessary that the schools involved program their data management systems so that the SPCs have immediate access to the selection and training records of all initial entry students in residence. It will be especially important that all agencies involved ensure that the selection and training data are complete for all students, as required by the pertinent ARs.

Upon authorized request, an SPC will compute and furnish predictor scores of students in difficulty.

Once the regression equations are established, they will be updated at quarterly intervals by recomputing from the data base generated by: (1) adding those classes graduated since the last computations, and (2) dropping the data from those classes which graduated in the oldest quarter of the previous computation. The equations will be revised if significant differences arise. If the first quarterly updating procedure shows the equations to be unstable, updating will be performed at shorter intervals until an optimal interval is found. If, on the other hand, the equations are found to be extremely stable on quarterly updating, the updating interval may be appropriately lengthened.

It should be noted that it is highly unlikely that all the variables tested will enter the regression equations used to generate predictor scores. Typically, it is found that the proper combination of a few variables from the original set tested will predict, for practical purposes, as well as a more cumbersome equation using all variables correlated with the criterion. For example, in the original Navy system for non-officers, the regression equations used three variables from eight examined for the first two weeks of training, and seven variables from 18 examined for the last stage of training.

Section 6

ADDITION OF VARIABLES TO THE SYSTEM

A. Basic combat training performance of EO trainees.

Beginning with class 70-1, scores on the following measures were collected for flight training EO trainees at Ft. Polk, Louisiana.

1. Physical Combat Proficiency Test
2. Basic Combat Training Tests
3. Commander's Evaluation
4. Weapons Qualification
5. ACB Sub-tests
6. Officer Candidate Test
7. Driver Aptitude Battery
8. Army Language Aptitude Test
9. Officer Qualification Inventory

For USAPHS classes 70-1 through 70-23, the multiple correlation between predictor variables and the completion/attrition dichotomy will be computed excluding these additional data and then including them. If a significant improvement in the size of the multiple *R* is obtained by including these new variables, the prediction equations then in use will be modified to include scores on those variables.

These data will also be utilized in an attempt to predict "Snobird" attrition. Snobirds are those WOCs who have reported to USAPHS for flight training but who have not yet begun preflight. At present, the number of Snobirds awaiting assignment to training exceeds 400. Attrition by resignation has been high in this group.

B. Addition of scores from the Background Activities Inventory, Situational Confidence Measures, the Officer Student Biographical Data Form, and Contemporary Evaluation Ratings.

The preceding sections have dealt with data generated by the Army aviator selection and training system. In addition to these data, PREDICT I will deal with experimental measures designed to provide types of predictor information not presently generated by the system.

The Background Activities Inventory and Situational Confidence Measures were originally derived from research done by HumRRO Division No. 3 under Work Unit FIGHTER. They were originally described in HumRRO Technical Report 66-12. Descriptions of their modification for use in the aviation training system can be found in several recent HumRRO Professional Papers *(8, 13, 14)*. These instruments are now being subjected to item analysis, and the refined versions will be cross-validated against FY 69 classes of officers and WOCs. Indications from preliminary research *(8, 13)* are that these indices will add to predictive validity.

The Officer Student Biographical Data Form was used by both USAAVNS and USAPHS for collection of data on aviator trainees during recent years. At the recommendation of the PREDICT staff, the Form is now undergoing item analysis. A revised form will be validated, also against FY 69 classes, and if it is found to contribute to prediction, a recommendation for its reinstitution will be made to USAPHS and USAAVNS.

Contemporary Evaluation Ratings, a form of peer rating, have been systematically collected on WOCs by the Troop Brigade at USAPHS beginning with FY 70 class 70-5. Because the current ratings contain only rankings with no scaling against absolute standards, the PREDICT staff has conducted experimental administrations of alternative forms providing for absolute scaling (and also testing for the effects of assurance of anonymity) with WOC classes at USAPHS, beginning with class 70-23, and at USAAVNS, with class 70-5.

Peer ratings have been shown to add predictive validity to the Navy system for both training *(9)* and operational *(15)* performance. They have also proved valid in Army performance prediction *(16)*. It is expected that FY classes 70-5 through 70-13 will furnish sufficient data for experimental determination of the potential contribution of current peer rating forms to the PREDICT matrices and classes 70-23 through 70-31 will furnish data for evaluation of the experimental forms.

C. Addition of summary flight evaluations.

The initial matrices will use means of accumulated daily flight grades as predictors.

Checkride grades at Hunter-Stewart and Ft. Rucker are also being added to the data bank for eventual evaluation but will not be included in the initial matrices. USAPHS checkride grades have been shown in exploratory analyses to be significantly inferior to daily grades as predictors of the complete/attrite dichotomy.

Section 7

SELECTION OF STUDENTS FOR HELICOPTER GUNNERY TRAINING

Two indices of quality of performance in helicopter gunnery training are currently available in quantitative form. These are the Weapons Qualification average grade and the Attack Helicopter Tactical Employment grade which respectively reflect performance in actual firing of weapon systems and in proper tactical employment of the aircraft. These can be used to select students to maximize *training* performance. In addition, a third index of quality can easily be quantified. This is the training data profile of those returned aviators who have completed a combat tour as armed helicopter pilots. This measure may be further refined by use of a peer rating system which would select from these returned aviators those who are considered most successful by their contemporaries. Another refinement now in progress involves study of the performance in initial training of those aviators rated poorest by their peers on the Combat Rating Scale described in HumRRO Professional Paper 34-69 *(17)*. Aviators from USAPHS class 69-5 will begin returning from Vietnam assignments in appreciable numbers during the fourth quarter of FY 70. At that time, ratings of combat performance for subjects for whom full-scale PREDICT data are available will be possible.

In February 1970, the PREDICT staff began conferences with personnel of the Aviation Armaments Division, Department of Tactics, aimed at selecting criteria for definition of the successful armed helicopter pilot. Regression equations against all available criteria will be computed with HumRRO furnishing information on their relative soundness. Decisions regarding the criterion (or composite) to be used for selection must be left to the Army.

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Appendix 1

Codes for PREDICT Individual Data Record for WORWAC/ORWAC Classes

1. Card 1: Identification card.

cc 1 - 4: Ft. Wolters or setback flight classes. Fiscal year (cc 1 & 2) and class number (cc 3 & 4). Odd class numbers designate warrant officer trainees; even numbered classes designate in-service warrants and commissioned officers. For an explanation of "setback class," see description of cc 25 - 28 for Card 6.

cc 5 - 7: Ft. Wolters or setback class roster number. The number assigned to a man within a flight class. This number changes from Ft. Wolters to Ft. Rucker (or Hunter-Stewart) and with Ft. Wolters, Rucker or Hunter-Stewart when a person is set back to another class. Ft. Wolters roster number codes are as follows:

1. 1 - 299: Warrant officer candidate rotary wing initial entry (WORWAC)

2. 401 - 499: Warrant Officer candidate rotary wing setback

3. 601 - 799: U.S. Officer initial entry

4. 901 - 999: U.S. Officer setback

cc 8 - 13: The date the Ft. Wolters flight class started.

cc 14 - 22: Social Security number.

cc 23 - 24: Rank. For WORWACs, rank is coded by the letter "E" (cc 23) followed by the appropriate numeral. Rank designated would be rank of the student prior to his enrollment in the flight training program. For ORWACs, rank is coded as follows:

01: 2LT
02: 1LT
03: CPT
04: MAJ
05: LTC
06: COL

For WORWACs, the codes are:

W1=WO-1
W2=CWO-2
W3=CWO-3
W4=CWO-4

cc 25 - 26: Age. The student's age as of his last birthday before entering flight school.

cc 27 - 28: Months prior service. If student has 1 - 99 months prior service, these figures are entered. If student exceeds 99 months prior service, the following code is used:

A1: 100-105 months prior service
A2: 106-110
A3: 111-115
A4: 116-120
A5: 121-125
A6: 126-130
A7: 131-135
A8: 136-140
A9: 141-145

The "A" codes will be stored in the computer as the rounded means of the range of months for each "A" code, e.g., $A1 = 103 = \frac{100+105}{2}$

cc 29 - 30: Educational level. The number of years of civilian schooling successfully completed.

cc 31: Prior flight training (T for training).

0 - No prior flight experience
1 - AROTC flight training - not completed
2 - AROTC flight training - completed
3 - Limited fixed wing, other than "1"
4 - Fixed wing private license
5 - Fixed wing commercial license
6 - Limited rotary wing experience
7 - Rotary wing private license
8 - Rotary wing commercial license

If both "4" and "5" apply, a "5" is entered. If both "7" and "8" apply, an "8" is entered.

cc 32: Enlistment option or in service (omit for ORWAC).

1 - In service
2 - Enlistment option

cc 33 - 35: Flight Aptitude Selection Test (FAST) composite score, i.e., rotary wing score plus fixed wing score. For data management purposes, the limits for FAST composite for WORWACs are 250-519; for officers 155-519.

cc 36 - 38: General Technical score (GT). Range restricted to 110 to 152. For officers, these columns contain the three-digit procurement source code rather than GT score. The source document for cc 1 - 39, card 1, has a column headed "G/T" for both officers and WOCs, but it was learned after data recording had begun that the columns contained different information. The procurement source codes are as follows:

236 - U.S. military academy
237 - OCS
238 - Direct commission
114 - 902 - College or university from which student received ROTC training (there is no overlap with previous three codes)

cc 39: Number of dependents. Example: one wife and two children coded "3."

cc 40: Blank

cc 41 - 43: Armed Forces Qualification Test (AFQT) score. The limits of the AFQT are 0 - 100. ORWACs do not have an AFQT therefore these columns are left blank for them.

cc 44: Marital status.

S - Single
M - Married
D - Divorced

cc 45 - 46: Exposure score from the HumRRO experimental test, the Background Activities Inventory (BAI).

cc 47 - 48: The raw (or unweighted) Confidence score, BAI.

cc 49 - 50: The raw (or unweighted) Despair score, BAI.

cc 51: Residence (r).

"During the first 16 years of your life did you live <u>mostly</u>:

0. on a farm
1. in the country, but not on a farm
2. in a small town (less than 2,500 people)
3. in a town (from 2,500 to 25,000)
4. in a city (more than 25,000)
5. military dependent
6. frequent moves, not a military dependent"

cc 52: Part of country (p).

"In what part of the country did you live <u>most of the time</u> before you were 16:

0. New England--Me., N.H., Mass., R.I., Conn., Vt.
1. Mid-Atlantic--N.Y., N.J., Pa.
2. East North Central--Ohio, Ind., Ill, Mich., Wis.
3. West North Central--Iowa, Mo., N.D., S.D., Nebr., Kan.
4. South Atlantic--Del., Md., Dist. of Col., Va., W. Va., N.C., S.C., Ga., Fla.
5. East South Central--Ken., Tenn., Ala., Miss., Ark., La.
6. West South Central--Tex., Okla.
7. Mountain--Mont., Wyo., Colo., N.M., Ariz., Utah, Nev., Idaho
8. Pacific--Wash., Ore, Calif., Alaska, Hawaii
9. Outside the United States"

cc 53: Component (C): ORWACs only.

1 or A - Regular Army
2 or C - USAR
3 or I - National Guard
4 or J - U.S. Marine

cc 54: Training specialty (S): ORWACs only.

1 - } These notations appear on some FY 69 ORWAC cards.
2 - } Thus far, USAPHS data processing has been unable to
3 - } decode them. Investigation is continuing.

cc 55 - 56: Branch (Brh): ORWACs only.

IN - Infantry	CE - Corps of Engineers
FA - Field Artillery	AI - Army Intelligence Service
AD - Air Defense	OD - Ordnance Corps
AR - Armor	TC - Transportation Corps
SC - Signal Corps	AG - Adjutant General Corps
MS - Medical Service Corps	FI - Finance
	AV - Aviation Warrant Officer

cc 57 - 59: Quota Source (QS): Included for ORWACs only. Quota Source is an alpha-numeric code used to identify the agency providing the quota for a student's attendance at a service school course of instruction. Codes appearing on the PIDR are noted here. For a complete listing, see Appendix 1, AR 350-2.

14B:	U.S. Army Officer	18P:	Allied students
50K:	Marine Corps	36B:	Others
58A:	Enlisted Option WOC	32B:	Flight surgeons

2. Card 2: Ft. Wolters academics.

cc 1 - 4: Ft. Wolters or setback flight class. Repeated from Card 1.

cc 5 - 7: Ft. Wolters or setback class roster number. Repeated from Card 1.

cc 8 - 9: Maximum number of points (items) for each academic exam. On all exams to date this figure is "20."

cc 10 - 43: Airmanship Examinations (AME). Each AME entry is the number of points (i.e., number of items answered correctly) obtained by the student for that exam. These points are not to be confused with "grade" which is the number of points obtained divided by the maximum number of points and expressed as a percentage.

cc 44 - 63: Officer Development Examinations (ODE). ORWAC PIDR only.

cc 44 - 71: Warrant Officer Development Examinations (WDE). As with AME, WDEs and ODEs are expressed as points, not grade. WORWAC PIDR only.

3. Card 3: Ft. Rucker Academics.

cc 1 - 4: Ft. Wolters or setback flight class.

cc 5 - 7: Ft. Wolters or setback class roster number.

cc 8: R (Rucker). Card 3 is only completed when the student receives his advanced training at Ft. Rucker rather than Ft. Stewart and Hunter Army Air Field, Ga.

cc 9 - 12: Ft. Rucker flight class. In all cases the flight class designation in these card columns will be the same as cc 1 - 4.

cc 13 - 15: Ft. Rucker roster number. Will only be identical to Ft. Wolters roster number by coincidence. Student is given a new roster number upon his registration at Ft. Rucker.

cc 16 - 36: Ft. Rucker academics, WORWAC Phase III, ORWAC Phase II. This phase includes Basic and Advanced Instruments training. The entries in these columns are "grades" (i.e., the per cent of total points received) and thus require three card columns since the maximum grade is 100%.

cc 37: Blank

cc 38 - 58: Ft. Rucker academics, WORWAC Phase IV, ORWAC Phase III. This phase includes transition to the UH-1 ("Huey") helicopter and tactics. Entries here are "grades" as was the case for previous phases.

4. Card 4: Hunter-Stewart academics.

cc 1 - 4: Ft. Wolters or setback flight class.

cc 5 - 7: Ft. Wolters or setback class roster number.

cc 8: H (Hunter-Stewart). Card 4 is only completed when the student takes his advanced flight training at Hunter-Stewart. Approximately one-third of the graduates from Ft. Wolters take their advanced training at Hunter-Stewart.

cc 9 - 12: Hunter-Stewart flight class number.

cc 13 - 15: Hunter-Stewart roster number. This number will be identical to the student's Ft. Wolters roster number only by coincidence.

cc 16 - 39: Hunter-Stewart, WORWAC Phase III, ORWAC Phase II. Like Ft. Rucker, the phase at Hunter-Stewart consists of Basic and Advanced Instruments training. Entries here are "grades," i.e., percentage of maximum points received.

cc 40: Blank.

cc 41 - 61: Hunter-Stewart, WORWAC Phase IV, ORWAC Phase III. Like Ft. Rucker, this phase at Hunter-Stewart consists of transition to the UH-1 ("Huey") helicopter and tactics. Entries here are in terms of "grades."

5. Card 5: Rucker or Hunter-Stewart daily flight grades.

cc 1 - 4: Ft. Wolters or setback flight class.

cc 5 - 7: Ft. Wolters or setback class roster number.

cc 8: R (Rucker) H (Hunter-Stewart).

An "R" or "H" is entered depending on where the student took his advanced training.

cc 9 - 12: Rucker or Hunter-Stewart flight class.

cc 13 - 15: Rucker or Hunter-Stewart roster number.

cc 16 - 30: The first 15 graded flights during the four weeks of Basic Instrument training. A solo flight, an ungraded flight, or an incomplete flight are not included. A description of the contents of each graded flight is not possible since each instructor pilot (IP) may cover different content areas during a given flight. The content areas covered by each IP and his student are noted on the student's flight insert, but vary too widely to be categorized. The entries for graded flights are as follows:

A = Above average
B = Average
C = Below average
U = Unsatisfactory

cc 31: The column labeled "16" on the PREDICT Individual Data Record indicates whether the student was given additional training (1) after receiving a failing stage grade for Basic Instruments or (2) because he was an exceptionally proficient student who was put up for his Basic Instrument checkride some time before the required 25 hours in Basic Instruments. The codes for this entry are:

Y: Yes, he received additional training
N: No, he did not receive additional training

cc 32: "F" stands for the number of Basic Instrument checkrides the student has failed.

cc 33 - 34: Basic Instruments (BI) checkride grade. Usually this is a two-digit numerical grade, but it may also be a letter grade, "A," "B," "C," or "U." A man will get a letter grade only if he has failed at least one previous checkride (a single digit will appear in card column 32, card 5, to indicate how many checkrides the student failed). In computing the student's stage grade (arithmetic average of instructor grade and checkride grade), the latter grade, because it is a retake, is given a weight of 70. This happens no matter whether the letter grade is: A, B, or C. Thus when a letter grade appears for BI, AI, or A, it is stored in the computer as "70."

cc 35 - 49: The first 15 graded flights during the four weeks of Advanced Instrument training. Same code as for BI applies here:

A = Above average
B = Average
C = Below average
U = Unsatisfactory

cc 50: "16": Did the student receive additional training while in Advanced Instruments? Code "Y" for yes, and "N" for no.

cc 51: "F" stands for the number of Advanced Instrument progress checkrides the student has failed.

cc 52 - 53: The Advanced Instruments (AI) checkride grade. This is usually a two-digit grade, but may in some cases be a letter grade (A, B, C, U). See explanation for letter grades in cc 33 - 34 above.

cc 54 - 68: The first 15 graded flights during the four weeks of transition training to the UH-1 ("Huey"). Same codes as for BI and AI apply here:

A = Above average
B = Average
C = Below average
U = Unsatisfactory

cc 69: "16" is used to record whether the student did ("Y" for yes) or did not ("N" for no) receive additional training in transition.

cc 70: "F" stands for the number of transition progress checkrides the student has failed.

cc 71 - 72: The transition checkride grade, "A," is usually a two-digit number, but like BI, and AI, may be in some cases a letter grade (A, B, C, U). See explanation for letter grades in cc 33 - 34 above.

6. Card 6: Criterion card.

cc 1 - 4: Ft. Wolters or setback flight class.

cc 5 - 7: Ft. Wolters or setback class roster number.

cc 8: "W" (Wolters) "R" (Rucker) "H" (Hunter-Stewart)

This column is completed either when a man has been set back or eliminated from the program or when he completes advanced training at Ft. Rucker or Hunter-Stewart. The "W" indicates a Ft. Wolters setback. "R" or "H" may indicate respectively Rucker or Hunter-Stewart setbacks (see cc 25 - 28) or serve as indicators of graduation if ccs 25 - 28, card 6, are blank.

cc 9 - 12: The flight class from which the setback, elimination, or graduation took place. The preceding column indicates whether this was at Wolters, Rucker, or Hunter-Stewart.

cc 13 - 15: The student's roster number in the class from which he was set back, eliminated, or graduated.

cc 16: C (Criterion)

1 = Eliminated
2 = Setback

3 = Graduated
4 = Administrative hold
5 = Eliminated but reinstated in later class
6 = Accelerated; set up to an earlier class

cc 17 - 18: Reason (Rsn) for the setback, elimination, or administrative hold: (Note: Graduation does not get a "reason code.")

10 - flight deficiency
20 - medical, sometimes used generally, sometimes specified as:
  21 - medical, psychological
  22 - medical, fear of flying
30 - resignation
40 - academics
50s - "attitudinal variables," specified as:
  51 - lack of motivation
  52 - discipline
  53 - unsatisfactory military progress (or lack of military development)
60 - accident
70 - unknown
80s - miscellaneous actions, specified as:
  81 - administrative
  82 - emergency leave
  83 - deceased
90 - administrative hold

cc 19 - 24: The date that the setback or elimination took place. Note: Date of graduation is not indicated.

cc 25 - 28: Setback class. For those persons set back to a later Ft. Wolters class, the new class is indicated in these card columns and also in cc 1 - 4 on a second PIDR. This second PIDR contains all the academics and flight grades the person generated as a member of the new class. For those persons set back at Ft. Rucker or at Hunter-Stewart, the procedure is essentially the same: A second PIDR is added containing the academic and flight data for the new class. However, cc 1 - 7 of the second PIDR are left blank; i.e., the man's new Rucker or Hunter class is not indicated here. This procedure insures that the first seven card columns on all cards refer only to the man's identification number at Ft. Wolters.

cc 29 - 31: The roster number the student received in his setback class.

Appendix 2

Master Data Control Form

PREDICT Data Sources

Section I: Fort Wolters, Texas, Data from the U. S. Army Primary Helicopter School (USAPHS)

A. Data mailed to PREDICT staff by USAPHS Student Records Control Branch (SRCB).

1. Initial Data Printout
2. Initial Flight Roster
3. Corrected Initial Flight Roster
4. Monthly setback and elimination report
5. Snobird roster
6. Snobird DF
7. Weekly setback and elimination roster by Flight Division
8. Preflight to finish recap
9. Daily Disposition of students roster
10. Training Analysis Digest (TAD)

a. Agency: USAPHS SRCB.

b. Responsible individual, title, and ETS: Mrs. Shirley Vaul, Statistical Clerk; indefinite ETS.

c. Contact schedule and method: Mrs. Vaul is contacted via AUTOVON (483-3413/3555/3597) on those occasions when expected data do not arrive on time, when necesary for clarification of the data, or when supplementary data are sought.

d. Additional information: Packets of data are mailed by Mrs. Vaul at weekly intervals. Data which accrue during the week are mailed each Friday, and received by PREDICT staff on Monday. In addition, PREDICT staff visit SRCB once a month on the regular monthly Ft. Wolters visit. Other contacts in this office are: CPT Brian Bagnall, Assistant Division Chief, indefinite ETS, and 1LT Jim Houston, Chief of the Statistical Branch, indefinite ETS.

B. Data: Fort Wolters attritee information.

1. Agency: SRCB.

2. Responsible individuals, title, and ETS: Mrs. Shirley Vaul and/or 1LT Jim Houston.

3. Method of data collection: Attritee data are xeroxed by PREDICT staff personnel during monthly visits to Fort Wolters.

4. Additional information: Individual attritees' data are stored in folders sent to SRCB by Mrs. Shirley Avdeef, secretary of the Student Evaluation Review Board (SERB). Mrs. Avdeef is responsible for completeness of PREDICT data for each attritee. Her AUTOVON number is 483-2679.

C. Data: Snobird information (from Form 20)

Snobirds are those WOCs who have reported to Fort Wolters for flight training but who have not yet been placed on the roster of a training class. These data include name of Snobird eliminee, effective date of elimination, age, marital status, AFQT score, GT score, educational level, FAST composite and FAST R/W scores.

1. Agency: Student Personnel Office.

2. Responsible individual, title, and ETS: Mrs. Susie Leatherwood, clerk, indefinite ETS.

3. Contact schedule and method: Monthly visits or AUTOVON calls (483-3347/3193).

4. Additional information: Snobird data collected during monthly visits or via mail upon AUTOVON request to Mrs. Leatherwood.

D. Data: Personnel, academic, and flight information.

1. Agency: Data Processing Division.

2. Responsible individual, title, and ETS: LTC John Mendenhall, Chief of Office of the Special Assistant for Information and Data Systems (SAIDS), indefinite ETS. The Data Processing Division is responsible to him.

3. Contact schedule and method: Contact by monthly visit or AUTOVON (483-2739). LTC Mendenhall effects changes in the operations of Data Processing Division by DF (Form 335).

4. Additional information: When data clarification is needed, contact Mr. Gene Pugh, Data Processing Division (AUTOVON 483-2635/2494), who is familiar with the details of Division operation. In Mr. Pugh's absence, coordinate with Mr. Stanley Aldrich, Division Chief (AUTOVON 483-2635/2494).

Approximately 50,000 IBM data cards are mailed from Ft. Wolters to HCC every two weeks by 1LT Rodney Rawlings, LTC Mendenhall's assistant.

Section II: Fort Polk, Louisiana, Data

A. Data: Training cards 1 and 2 (control cards).

1. Agency: Trainee Administration, Coding Section.

2. Responsible individual, title, and ETS: Mrs. Samudio, clerk, indefinite ETS.

3. Contact schedule and method: Once a month via AUTOVON (733-1325, X-2621), for data collection maintenance.

4. Additional information: Mrs. Samudio mails the control cards every two weeks to PREDICT staff.

Section III: Hunter Army Airfield, Georgia, Data

A. Data:

1. WORWAC and ORWAC Examination Grade Reports.

2. Attritee Data.

a. Agency: Office of the Registrar.

b. Responsible individual, title, and ETS: Mrs. Maggie Hartnett, Civilian Supervisor, indefinite ETS.

c. Contact schedule and method: Monthly, via AUTOVON (434-1520, X-5771/5512), for data collection maintenance.

d. Additional information: SFC Sewell, NCOIC, indefinite ETS, assembles attritee data for mailing.

B. Data:

1. IBM academic and flight cards on WORWAC and ORWAC classes.

2. IBM cards on Cobra classes when they are requested by us.

a. Agency: Automatic Data Processing Division.

b. Responsible individual, title, and ETS: Miss Lucy Waters, Computer Operator, indefinite ETS.

c. Contact schedule and method: Monthly, via AUTOVON (434-1520, X-5027/5230), for data collection maintenance.

d. Additional information: Cards mailed to us upon graduation of the initial entry classes.

Changes in arrangements to be made through Mr. James Morrison, Chief of ADPS, AUTOVON 434-1520, X-5027/5230.

C. Data: Cobra School examination grade reports.

1. Agency: Armed Helicopter Training School (Cobra).

2. Responsible individual, title, and ETS: Mrs. Hopkins, Administrative Secretary, indefinite ETS.

3. Contact schedule and method: Contact via AUTOVON 434-1520, X-5321, as needed (no regular schedule).

4. Additional information: Mrs. Hopkins sends copies of Examination grade reports on the Cobra students upon request via AUTOVON.

Section IV: Fort Rucker, Alabama, Data

A. Data:

1. Letter orders (LOs) (Roster changes)

2. Corrected Initial Phases II and III (ORWAC) and Phases III and IV (WORWAC) Rosters.

a. Agency: Office of the Registrar.

b. Responsible indivduals, titles and ETSs: Mrs. Nell Motley, X-2596, Statistical Clerk, indefinite ETS; Mrs. Gail Turner, X-2596, Chief of the Academic Records Branch, indefinite ETS.

c. Contact schedule and method:

(1) PREDICT staff visits Mrs. Motley every two weeks for data collection maintenance. Mrs. Motley sends the LOs through post distribution.

(2) Every two weeks, PREDICT staff pick up, from Mrs. Turner, originals of class rosters, xerox them, and return the originals to her.

B. Data:

1. IBM academic and flight grade cards for WORWAC and ORWAC classes.

2. Examination grade reports (printouts).

a. Agency: Automatic Data Processing Division.

b. Responsible individuals, titles, and ETSs: (Cards) Mr. Jimmy Walker, X-5293, Computer Operator, indefinite ETS; (Grade reports) Mrs. Sarah Sullivan, X-5293, Clerk, indefinite ETS.

c. Contact schedule and method: IBM cards and printouts are delivered every two weeks by ADPS personnel to PREDICT staff.

C. Data: Flight grade inserts (record sheets) from flight folders (includes Wolters and Rucker flight grades).

1. Agency: Department of Tactics, Supply.

2. Responsible individual, title, and ETS: SP5 Pfau, Supply SGT, indefinite ETS.

3. Contact schedule and method: SP5 Pfau phones PREDICT staff every two weeks when the flight folders of a graduated class are ready to be picked up. Arrangements for changes should be made with SGT Butler, NCOIC, X-3810/2782.

D. Data:

1. Form 20s

2. Form 66s.

a. Agency: Student Personnel Office.

b. Responsible individual, title, and ETS: SGT Eley, X-6114, NCOIC, indefinite ETS.

c. Contact schedule and method: PREDICT staff pick up students' Form 20s and 66s every two weeks, xerox them, and return the originals to Student Personnel Office.

E. Data: Student folders.

1. Agencies: The four WOC companies at Ft. Rucker, Alabama.

2. Responsible individuals, titles, and ETSs:

a. 1st WOC, SGT W.A. Cobb, 1st SGT, X-4987, indefinite ETS.

b. 2nd WOC, SGT F.M. Fairchild, 1st SGT, X-4411, indefinite ETS.

c. 3rd WOC, SGT F. Belcher, 1st SGT, X-6197, indefinite ETS.

d. 4th WOC, SGT H.H. Spradlin, 1st SGT, X-2885, indefinite ETS.

3. Contact schedule and method: Every two weeks on the class input schedule, PREDICT staff collect the folders of the graduated classes from the companies in which the classes were billeted.

Section V: Fort Stewart, Georgia, Data

A. Data: Flight grade inserts (record sheets) from flight folders (includes Wolters and Hunter-Stewart flight grades).

1. Agency: Department of Tactics.

2. Responsible individual, title, and ETS: SGT Fields, NCOIC, indefinite ETS.

3. Contact schedule and method: Once a month, data collection is maintained by AUTOVON 434-3600, X-2966/3770.

4. Additional information: For changes in arrangements, contact MAJ Sam Varney, DOT, AUTOVON 434-3600, X-2966/3770.

Appendix 3

Per Cent Completeness of Manually Compiled Variables for Classes 69-05 Through 69-30

	Variable	WORWAC 69-05 thru 69-29 Enl Op (N=2182)	In Service (N=765)	Total (N=2947)	ORWAC 69-06 thru 69-30 Total (N=1396)
1.	Army Svc. No.	85	85	85	95
2.	Rank	100	100	100	100
3.	Age	100	100	100	100
4.	Mo. Act. Fed. Svc.	100	100	100	99
5.	Education	100	100	100	100
6.	Previous Flt. Trng.	100	100	100	94
7.	Procurement Source	100	100	100	---
8.	FAST Composite Score	98	93	97	29
9.	GT Score	99	98	99	---
10.	Commission Code	---	---	---	99
11.	No. Dependents	100	100	100	99
12.	AFQT Score	81	71	79	---
13.	Marital Status	95	93	95	100
14.	Component	---	---	---	100
15.	Branch	---	---	---	96
16.	Quota Source	---	---	---	100

Appendix 4

Methods of Acquiring Data Not Available From Primary Sources

The Military Personnel Records Jacket (201 File) is a secondary source of demographic, biographic, and primary selection variables selected for inclusion in PREDICT I matrices.

This appendix lists the pertinent documents normally found in students' 201 Files. Their titles are followed by "WOC" (Warrant Officer Candidate) and/or "OS" (Officer Student) to indicate which documents are pertinent to each. The document list is followed by a list of variables selected for inclusion in the initial matrices. After each variable is shown its location on the USAPHS Block Form (BF), the current method of BF data entry, and a series of numbers, keyed to the document list, indicating which of the documents contain an entry for that variable.

Key to 201 File Documents

The following list is comprised of the secondary source documents which may provide demographic, biographic, and primary selection data missing from primary sources. Individuals' 201 Files do not all contain the same documents. Therefore, it will be necessary to scan a given file for all documents listed in order to effect a complete search.

1.	DD Form 4 - Enlistment Record/Enlistment Contract	WOC/OS (If OS enlisted as EM)
2.	DD Form 20 - Enlisted Qualification Record	WOC
3.	DD Form 41 - Record of Emergency Data	WOC/OS
4.	DD Form 47 - Record of Induction	WOC
5.	DA Form 61 - Application for Appointment	WOC/OS
6.	DA Form 66 - Officer Qualification Record	OS
7.	DA Form 160 - Application for Active Duty	WOC
8.	DD Form 398 - Statement of Personal History	WOC/OS
9.	DD Form 507 - Enlisted Personnel Data	WOC
10.	DA Form 873 - Certificate of Clearance and/or Security Determination under EO 10450	WOC/OS
11.	DA Form 1315 - Reenlis	WOC

12.	FAST Scoring Worksheets	WOC/OS
13.	Active Duty Orders	WOC/OS
14.	Application for Flight Training	WOC/OS
15.	Flight Training Orders	WOC/OS
16.	Promotion Orders	WOC/OS
17.	Individual Training Progress Form	WOC

List of PREDICT I Variables and
Secondary Source Documents

When demographic, biographic, or primary selection variables listed below are missing from primary sources, they usually may be found in the individuals' 201 Files on one or more of the DA or DD documents shown above whose marginal numbers follow each variable listed below. The document numbers appear in order of probability that the documents will contain the data sought.

If 201 Files are unavailable for use as secondary sources, their duplicates, the "TAG" Files, are stored for (1) WOCs, at U.S. Army Personnel Services Support Center, Ft. Benjamin Harrison, Indiana; (2) OSs, at Officer Personnel Records, TAGO, Falls Church, Virginia. These records storage centers fill requests for TAG File data.

During the students' training tours at Ft. Wolters, Ft. Rucker, and Ft. Stewart-Hunter AAF, their 201 Files are stored in each post's Student Personnel Office. At Ft. Wolters, the Chief of the Student Personnel Office is CW3 S.A. Porter, indefinite ETS, AUTOVON 483-3346/3347. At Ft. Rucker, it is 2LT John W. Haldeman, indefinite ETS, AUTOVON 899-1450 X-6114. At Hunter AAF, it is MSG R.H. Jones, Personnel SGT, indefinite ETS, AUTOVON 434-1520/5804.

1. Procurement Source. #33 on WOC BF, #62-64 on OS BF. Entered on BF by student at Ft. Wolters during the first week of student company activities. In 201 File: 1, 12, or on phonecon memo from The Aviation Warrant Officer Branch which clears the WOC for WOFT. "Quota Source" on BF (#65-67) also identified EO personnel. For OSs: 6 (item 18), 12, 5 (item 10), or 13.

2. Rank. #28-29 on WOC BF, #28-29 on OS BF. Entered on BF by student. For WOCs: 2, 15, 14, or 16. For OSs: 6, 3, or 16.

3. Age. #30-31 on WOC BF, #30-31 on OS BF. Entered on BF by student. For WOCs: 2, 3, 8, 14, 10, or 1. For OSs: 6, 3, 8, 10, or 5.

4. Branch. (applicable to OSs only) #32 - 33 on OS BF. Entered on BF by student. For OSs: 6, 3, and on all orders.

5. Amount of Prior Flight Training. #46 on WOC BF, #46 on OS BF. Entered on BF by student. For WOCs: 14 or 8. For OSs: 6 (item 16), and in Flight Records Jacket of student.

6 Marital Status. #48 on WOC BF, #47 on OS BF. Entered on BF by student. For WOCs: 2 or 3. For OSs: 6 or 3.

7. Educational level #53 - 54 on WOC BF, #53 - 54 on OS BF. Entered on BF by student. For WOCs: 2, 14, 8, or 4. For OSs: 6 (item 16), 5, or 8.

8 Months Prior Service. #55 - 57 on WOC BF, #55 - 57 on OS BF. Entered on BF by student. For WOCs: 2 or 1. (1 shows enlistment date and date discharged from enlisted active duty to attend WOFT, if man was IS when he applied, and it also shows total AFMS.) For OSs: 6 or 5.

9. Number of Dependents. #58 on WOC BF, #58 on OS BF. Entered on BF by student. For WOCs: 2 or 3. For OSs: 6 or 3.

10. FAST Scores. #70 - 75 on WOC BF, #70 - 75 on OS BF. Entered on BF by Student Personnel Office from any of the following: For WOCs: 2, 12, or 14. For OSs: 6, 12, 14. If FAST scores are not found in the student's 201 File, they may be obtained from the office of Dr. Harry Kaplan, U S. Army Behavioral Science Research Laboratory, The Commonwealth Building, 1320 Wilson Boulevard, Arlington, Virginia, 22209, AUTOVON 224-3705.

11 AFQT Scores (applicable to WOCs only) #59 - 61 on WOC BF. Entered on BF by Student Personnel Office from any of the following: 2, 1, or 4.

12. GT Scores (applicable to WOCs only) #62 - 64 on WOC BF. Entered by Student Personnel Office from any of the following: 2, 1, 4, 17, 14, 9, 11, or 5.

If a GT score is not found in the student's 201 File, he may be scheduled to retake the ACB (under the auspices of AG Testing) for derivation of GT score. It is derived from the verbal and arithmetic subtests of the AFQT or ACB.

13. Ft. Wolters Academics. If the primary source, IBM Academic Cards, normally mailed from Ft Wolters ADPS to HumRRO HCC, should fail, the academic printouts produced by ADPS specifically for PREDICT use serve as back-up for individual examination grades. If PREDICT academic printouts should fail, the academic printouts used and stored by SRCB at Ft. Wolters may be used.

14. Ft. Wolters Flight Grades. If the primary source, the IBM Flight Cards, normally mailed from Ft. Wolters ADPS to HumRRO HCC, should fail, the flight record printouts produced by ADPS for PREDICT use may be used as back-up. If both should fail, the (1) flight record printouts, or (2) daily flight grade slips inserted in the students' Flight Records Jacket may be used. Finally, flight records of Ft. Wolters students are microfilmed and stored by SRCB, providing another source of flight grade data.

15. Ft. Rucker Flight Grades. Currently, the primary source of Ft. Rucker flight grades is the "flight record insert" which is a part of the students' Flight Records Jacket. If that should fail, the grades can be reproduced from the daily flight grade slips also kept in the Flight Records Jacket. There is no other source for Ft. Rucker flight grades.

16. Ft. Rucker WORWAC Phase III.- ORWAC Phase II Academics. If the primary source, duplicate IBM Academic Cards, normally mailed to HCC, should fail, the Examination Grade Report printouts produced by ADPS for PREDICT use may be used as back-up. Originals of the Academic Cards are retained by ADPS for two years. Additional duplicates are made upon request to Mr. J.L. Weeks, AUTOVON 899-1450, X-5293. The Registrar, Rotary Wing Quality Control, DOI, and Student Records also receive copies of the academic printouts. The Registrar's office keeps its copies for one year, then they are stored at Ft. Rucker's Records Holding Department for two years, then stored at National Personnel Records Division, St. Louis, Missouri, for the remainder of 40 years from time of graduation.

17. Hunter-Stewart WORWAC Phase III - ORWAC Phase II Academics. If the primary source, duplicate IBM Academic Cards, normally mailed to HCC fails, the Examination Grade Report printouts mailed to PREDICT staff from the Hunter Registrar's office may be used as back-up. Also, originals of the Academic Cards are retained by ADPS for two years. Duplicates are made upon request.

18. Attritees Data. Attritee files are stored at SRCB at Ft. Wolters and the Registrars' offices at both Ft. Rucker and Hunter AAF. The pertinent data from these files are reproduced for PREDICT use. They include the flight records. For those attritees on whom personnel data are still missing, inquiry is made of the U.S. Army Personnel Services Support Center, Ft. Benjamin Harrison, for the individuals' current military addresses. A letter of inquiry (see appended example) is sent to the CO of the unit to which each individual is attached, requesting specified 201 File data.

Data are considered missing when the sources listed in this appendix fail to provide the information sought.

Appendix 5

Probability Graphs and Tables

FROM:

TO: Distribution List

SUBJECT: Prediction of student success in the initial entry rotary wing aviator training program

1. Purpose. To provide procedures for the prediction of success or failure for students in O/WORWAC ______________.
(Enter Course Number)

2. Discussion. Training managers and student evaluation review boards often must decide whether individuals should be dropped from training, recycled to a later class for remedial training, or retained in training on schedule. An efficient training program demands that these decisions be as accurate and prompt as possible. Using aircraft and instructors for the further training of men who are almost certain to fail to complete the program is a waste of time and money. However, dropping partially trained students who, with a little extra training, could become satisfactory pilots, is also wasteful.

In the primary selection process, extensive quantitative information about student background and capability is compiled. During training, quantitative information on performance accumulates rapidly. Training managers who have to decide about marginal students are faced by more performance data than they can absorb and integrate into a decision in the time available. This sometimes results in failure to consider potentially valuable information. Accordingly, the best predictors have been integrated by computer techniques and transformed into prediction tables and graphs to aid in ensuring the accuracy of managerial decisions concerning the retention or attrition of students. Properly employed in conjunction with other criteria, these materials can help training managers and boards judge each case on its own merits and make recommendations to commanders concerning the disposition of the student.

3. Implementation. Procedures for obtaining the predictor score for individual students and interpreting that score in conjunction with the prediction tables and graphs are included as enclosure 1.

Graph-Tables of Predictor Scores

The following graph-tables provide a method for determining the probability that a student who is having difficulties will or will not complete the program. The procedures conform with the POI as of ____________________. The probabilities given in the tables are actually the success/failure records of classes ____________________ through ________________ for WORWACs and ____________________ through ________________ for ORWACs. To compare a current student with these records, take the following steps:

1. Find the appropriate table. There are separate tables for officers, in-service WOCs, and enlistment option WOCs. There are also separate tables for various stages of training. For example, if you were considering the case of an in-service WOC student who is in difficulty after he has completed five graded flights but who has not yet soloed, you would turn to the table entitled IN-SERVICE WOCS--AFTER 5 GRADED FLIGHTS.

2. Look up the information required in the instructions at the top of the graph table. This will differ from table to table.

3. Call the Student Prediction Center, Extension ________. Give them the student's name, his class and roster number, his point in training, the information specified in the table, and your phone number. (In the case of the student above, you will give his score on AME ____, WDE ____, and his last three flight grades.)

4. Within about fifteen minutes, the Prediction Center will telephone you and give you the prediction score for that student.

5. Compare this score with the data entered in the graph-table. Suppose, for instance, that his predictor score is 36. In the summary table you can see that this score falls into the 35-38 bracket, and that scores made by three per cent of the students fell below this bracket. Since this student's score is near the lower limit of this bracket, you can safely say that he compares to the bottom 10 per cent of students from classes ____________ through ____________ who reached this point in training. The summary table shows that for the 35-38 group as a whole, 45 per cent graduated. Of course, the 35-38 group is a below average one, for on an overall basis, 61 per cent of students who reached this point in training graduated. Looking at the point on the graph which corresponds to a score of 36, you can see that about 40 per cent of men with this score graduated, or that the odds are about 3 to 2 against the man. Said another way, of every five men who had such scores in the past, three did not complete training.

Inclosure 1