DOCUMENT RESUME

ED 110 605 CE 004 372

AUTHOR LeMaster, W. Dean; Gray, Thomas H.
TITLE Ground Training Devices in Job Sample Approach to UPT [Undergraduate Pilot Training] Selection and Screening. Final Report, September 1972-August 1974.
INSTITUTION Air Force Human Resources Lab., Williams AFB, Ariz. Flying Training Div.
REPORT NO AFHRL-TR-74-86
PUB DATE Dec 74
NOTE 59p.

EDRS PRICE MF-$0.76 HC-$3.32 Plus Postage
DESCRIPTORS *Flight Training; Personnel Selection; *Predictive Ability (Testing); *Predictive Measurement; Predictive Validity; *Predictor Variables; Screening Tests; Simulators; Student Testing; *Task Performance

ABSTRACT

The purpose of this study was to develop a screening procedure for undergraduate pilot training (UPT). This procedure was based upon the use of ground-based instrument trainers in which UPT candidates, naive to flying, were evaluated in their performance of job sample tasks; i.e., basic instrument flying. Training and testing sessions were conducted in a highly standardized and tightly controlled environment. Student performance was scored using only objective measures of aircraft control and systems management. The job sample approach proved highly successful in predicting student performance in the T-37 phase of UPT. Attrition, due to causes other than a lack of flying skill, was not satisfactorily predicted by this approach. Two-thirds of the document consists of eight appendixes: T-40 program guide excerpts, T-40 instrument procedures excerpts, test forms and scoring excerpts, T-37 phase summary data, forward selection prediction equations for T-37 phase, pass-fail summary data, forward selection prediction equations for pass-fail, and proposed T-40 screening program guide. (Author/BP)

AFHRL-TR-74-86

c E

AIR FORCE

HUMAN RESOURCES

ED 110605

GROUND TRAINING DEVICES IN JOB SAMPLE APPROACH TO UPT SELECTION AND SCREENING

By

W. Dean LeMaster
Thomas H. Gray

FLYING TRAINING DIVISION
Williams Air Force Base, Arizona 85224

December 1974
Final Report for Period September 1972 – August 1974

Approved for public release; distribution unlimited.

LABORATORY

AIR FORCE SYSTEMS COMMAND
BROOKS AIR FORCE BASE, TEXAS 78235

NOTICE

When US Government drawings, specifications, or other data are used for any purpose other than a definitely related Government procurement operation, the Government thereby incurs no responsibility nor any obligation whatsoever, and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data is not to be regarded by implication or otherwise, as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use, or sell any patented invention that may in any way be related thereto.

This final report was submitted by Flying Training Division, Air Force Human Resources Laboratory, Williams Air Force Base, Arizona 85224, under project 1123, with Hq Air Force Human Resources Laboratory (AFSC), Brooks Air Force Base, Texas 78235.

This report has been reviewed and cleared for open publication and/or public release by the appropriate Office of Information (OI) in accordance with AFR 190-17 and DoDD 5230.9. There is no objection to unlimited distribution of this report to the public at large, or by DDC to the National Technical Information Service (NTIS).

This technical report has been reviewed and is approved.

WILLIAM V. HAGIN, Technical Director
Flying Training Division

Approved for publication.

HAROLD E. FISCHER, Colonel, USAF
Commander

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: AFHRL-TR-74-86	2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle): GROUND TRAINING DEVICES IN JOB SAMPLE APPROACH TO UPT SELECTION AND SCREENING	5. TYPE OF REPORT & PERIOD COVERED: Final, September 1972 – August 1974
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): W. Dean LeMaster, Thomas H. Gray	8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Flying Training Division, Air Force Human Resources Laboratory, Williams Air Force Base, Arizona 85224	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: 62703F, 11230313
11. CONTROLLING OFFICE NAME AND ADDRESS: Hq Air Force Human Resources Laboratory (AFSC), Brooks Air Force Base, Texas 78235	12. REPORT DATE: December 1974
	13. NUMBER OF PAGES: 58
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)	15. SECURITY CLASS. (of this report): Unclassified
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

Complete copies of Appendixes A, B, and C are on file at Air Force Human Resources Laboratory, Flying Training Division, Williams AFB, AZ 85224.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

screening
job sample tasks
student performance prediction
undergraduate
ground based trainer
flight training
attrition

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The purpose of this study was to develop a screening procedure for undergraduate pilot training (UPT). This procedure was based upon the use of ground-based instrument trainers in which UPT candidates, naive to flying, were evaluated in their performance of job sample tasks; i.e., basic instrument flying. Training and testing sessions were conducted in a highly standardized and tightly controlled environment. Student performance was scored using only objective measures of aircraft control and systems management. The job sample approach proved highly successful in predicting student performance in the T-37 phase of UPT. Attrition, due to causes other than a lack of flying skill, was not satisfactorily predicted by this approach.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

PREFACE

This research was completed under Project 1123, United States Air Force Flying Training Development; Task 112303, The Exploitation of Simulation in Flying Training; and Work Unit 11230313, T-40 Screening Study. Mr. James F. Smith was the project scientist and Mr. W. Dean LeMaster was the task scientist. The report covers research performed between September 1972 and August 1974. Complete copies of Appendixes A, B, and C are on file at Air Force Human Resources Laboratory, Flying Training Division, Williams AFB, AZ 85224.

The authors wish to express appreciation to the 82d Flying Training Wing, Williams AFB, Arizona for their cooperation in the conduct of the study; to Lt Col R.W. Newcomer for his management of ATC support, and to Captains J.H. Fuller, Jr. and R.W. McFadden for significant contributions to study training and testing content. Special recognition is given to 1Lt D.K. Bustell for developing the unique schedules required in the study.

TABLE OF CONTENTS

	Page
I. Introduction	5
Statement of the Problem	5
Objectives	5
Background	5
Psychological Factors Considered in the Study Design	6
Approach	6
II. Methods and Procedures	7
Subjects	7
Description of Apparatus	7
Instructor and Operator Personnel	8
Syllabus Development	9
Study Design	11
Preliminary Scoring Procedures	12
Automatic Data Processing	14
Criteria	14
Performance Grades	14
Data Analysis	15
III. Results	16
Data Description and Abandoned Procedures	16
Continuous Dependent Variable Reliability	17
Correlations with T-37 Phase Criteria	18
Correlations with the Pass-Fail Criterion	20
IV. Discussion	23
Training Accomplished	23
Data Collection and Scoring	24
Predictors	24
Proposed Application of Research	24
Prediction of UPT Attrition	25
V. Conclusions and Recommendations	25
References	25
Appendix A: T-40 Program Guide Excerpts	27
Appendix B: T-40 Instrument Procedures Excerpts	30
Appendix C: Test Forms and Scoring Excerpts	32
Appendix D: T-37 Phase Summary Data	36
Appendix E: Forward Selection Prediction Equations for T-37 Phase	40
Appendix F: Pass-Fail Summary Data	46

Appendix G: Forward Selection Prediction Equations for Pass-Fail 50

Appendix H: Proposed T-40 Screening Program Guide 52

LIST OF TABLES

Table		Page
1	T-40 Training Tasks	10
2	Test Form Illustration	13
3	Maneuvers	15
4	Activities	15
5	Procedures	16
6	Maneuvers	17
7	Activities	18
8	Correlations with T-37 Phase Criteria	19
9	AFOQT and T-37 Phase Criteria Correlations	20
10	Summary of Forward Selection Results	21
11	Correlations with Pass-Fail Criterion	22
12	Summary of Forward Selection Results	23

GROUND TRAINING DEVICES IN JOB SAMPLE APPROACH TO UPT SELECTION AND SCREENING

I. INTRODUCTION

Statement of the Problem

The purpose of the study was to investigate the use of the A/F 37A-T40 Instrument Trainer as an effective selection device for early identification of critical flying abilities possessed by undergraduate pilot training (UPT) candidates.

Objectives

The study had two objectives:

1. The primary objective of this study was to provide a means whereby a UPT candidate's ability to learn to perform piloting tasks could be quantified with a high degree of validity.

2. The secondary objective was to provide the participating students with basic instrument flying skills, techniques, and elements of information which would prove beneficial during the T-37 phase of instruction.

Background

As a result of increasing pilot training costs and reduced military budgets, the United States Air Force (the largest source of jet pilots in existence) is vitally interested in pursuing all avenues for reducing trainee losses without reducing the quality of output. Of particular concern, is the continuing average of some 25 percent of all UPT entrants who pass all existing pre-pilot training screening procedures, but who are eliminated for one reason or another after beginning flight training. While it appears improbable that techniques will ever be devised which will permit reducing this percentage to zero, there is some evidence available that indicates the figure could be reduced significantly. In fact, in a recent study of UPT for the 1975 to 1990 time frame, it was indicated that an attrition rate of 10 percent would be a realistic goal.

To address the selection problem, it is necessary to remember that the existing UPT program is composed of a multiple step selection process. First, the requirement for most pilot trainees to obtain a college degree insures a high level of mental ability. Second, the use of the Air Force Officer Qualifying Test (AFOQT) is designed to provide additional assurance that trainees have definite aptitudes for learning to pilot an airplane. Finally, the existing physical examination helps to insure that UPT candidates are physically fit for flight. The use of light aircraft in the pilot indoctrination program/flight instruction program (PIP/FIP) and T-41 program furnishes primary instruction which may reduce the odds of an entrant being lost from later program phases. However, despite all these existing selection and screening procedures, student attrition remains a problem.

The final component of the UPT candidate screening program is a course of instruction in the T-41 aircraft consisting of approximately 16 hours of flight. In conjunction with this program, research is presently being conducted to determine the predictive value of psychomotor assessment of UPT candidates. This research is based on a learning approach and consists of two coordination tests. One is a gross measure of eye-hand coordination and the other a more complex eye-hand-foot coordination measurement. Both tests incorporate psychomotor skills similar to those necessary to flying. Positive results from this research may result in expanding the current UPT selection battery to include this assessment.

While the generally accepted role of ground-based flight simulators has been to enhance training or reduce required aircraft hours in pilot training, research evidence indicates that such equipment could be used to effectively screen out those candidates who have minimum aptitude in the areas of perceptual-motor skills. During World War II such devices were used to predict successful completion of UPT. Two of the more successful were the SAM Two-Hand Coordination Test and the Mashburn Two-Hand Complex Coordinator device. These devices were demonstrated to correlate reasonably well with training performance; however, they were difficult to maintain and were eventually dropped from the UPT selection program.

The use of ground-based flight simulators in a screening role has been recently implemented. The Dutch Training Center, a firm which selects and trains pilots for commercial airlines in the Netherlands, has evolved an extremely effective selection program for pilot trainees (J.F. Smith, personal communication, 18 July 1970). The elimination rate has been reduced to about 6 percent by screening based on measuring candidates' learning rates on a series of progressively more complex basic instrument flying tasks in the Link C-8 instrument trainer. Followup studies have shown student performance in subsequent flight training phases to remain distributed in essentially the same order as that recorded during the screening program.

Research using the Link B-Model GAT-1 trainer (Goebel, Baum & Hagin, 1971) established positive correlations between the instructor's evaluations of student performance as measured in these trainers and student performance in the T-37 aircraft. The study used a job sampling approach that simulated T-41 contact flying.

Another study (Hinrichs, 1970) demonstrated that the job sampling approach to screening was an accurate predictor of performance on tasks requiring psychomotor skills. Prediction accuracy increased in proportion to the extent to which the actual task was sampled.

Psychological Factors Considered in the Study Design

There have been numerous efforts to identify the psychological factors that determine the acquisition of flying ability. Although such investigations have typically produced study-unique taxonomies, the ability to learn flying skills is generally believed to be primarily composed (as are nearly all skilled performances) of cognitive, perceptual-motor, and motivational elements. Accordingly, in this study, the tasks on which student performance was measured were designed to incorporate cognitive and perceptual-motor components to the greatest extent possible. No attempt was made to test for motivation because no satisfactory objective measures of this factor exist in the UPT program.

The cognitive portion of the job-sample tasks consisted of three types of activities: (1) short-term memory, (2) verbal information processing in noise, and (3) rote learning of procedures and nomenclature. The student's response to verbal directions and a light box operation are examples of a test of short-term memory. The communications and directions to the student required the ability to process verbal information over an inserted radio chatter background. Rote learning ability was tested by requiring tasks to be performed in certain sequences and by using appropriate nomenclature.

The perceptual-motor aspects of the behavior tested were tracking, manual dexterity, visual perception, and reaction time. For instance: the maintenance of heading exemplified, *par excellence*, a tracking task, manual dexterity was tested by the many maneuvers requiring stick control; the very nature of instrument flight tasked the student's ability to interpret what he saw displayed before him and finally, the operation of the light box was specifically designed to assess the student's reaction time under task-loading conditions.

Approach

The approach selected for this study was composed of three major elements: job sample testing; training program adaptability; and, objective performance measures.

Job Sample Testing. Selection of the material presented to the subjects of this study required a survey of the UPT flying syllabus tasks to determine those compatible with T-40 capabilities. It was determined that all instrument maneuvers and navigation procedures prescribed in ATC Syllabus P-4A-A could be demonstrated, practiced, and tested in the trainer. Although time constraints on student availability necessitated the elimination of training in instrument penetrations, approaches, and some voice procedures, the maneuvers used in this study constituted an extensive job sample of the instrument training portion of the UPT program. In addition, the light box tasks provided an assessment of the ability of each student to perform problem-solving tasks under the stress situations typical of those encountered during instrument flight.

Training Program Adaptability. This study was designed to be conducted within the time span devoted to T-41 screening for previous classes. This was done to reduce interference with the participating students' ongoing training. For the classes involved, T-40 training was in lieu of T-41 training. The program developed was sufficiently flexible to accommodate delays due to trainer maintenance, instructor availability, or other unforeseen problems.

Student Performance Measures. In order to accomplish the purposes of the study, it was necessary that the measures of student performance obtained from the T-40 trainer be representative of the behavioral domain of UPT flying skills. In addition, it was desired that these measures be free from observer bias or inexperience, and be highly practical to collect. These criteria were met by carefully objectifying each performance measure.

Each student's "flying" ability was measured, using performance indices that could be observed in an objective fashion, simply recorded, and scored with little or no interpretation. Three types of measures were used:

1. *Aircraft Control Measures.* The degree of student control over the aircraft was determined by how closely airspeed, altitude, heading, power setting, etc., matched the flight parameters specified for a given maneuver.

2. *Systems Management Measures.* The tasks required of an Air Force pilot extend beyond merely flying an aircraft. For example, navigation and weapons systems must be managed efficiently. System management tasks were simulated by using the light box to present analogous problems, and the student's response time and errors were observed.

3. *Flying Procedures Measures.* Following procedures constitutes an important part of the pilot's job. In the T-40 study, execution of tasks of this nature was represented by communications, VOR procedures, etc., and scored as either correct or incorrect.

AFOQT Scores. The AFOQT was included in this study because its use entailed practically no additional effort and seemed to complete the set of predictor variables. The five sub-tests of this battery that were used consisted of: AFOQT 1 – pilot percentile; AFOQT 2 – navigator percentile; AFOQT 3 – quantitative percentile; AFOQT 4 – qualitative percentile; AFOQT 5 – officer quality percentile. No further description of this instrument is contained in this report since it has been completely described in many other sources.

II. METHODS AND PROCEDURES

Subjects

Undergraduate pilot training classes 74-05, 74-06 and 74-07, assigned to Williams AFB, were screened for eligible subjects. The planned restriction to use subjects completely naive to flying proved impractical because of the incidence of flight experience among the class members. However, Air Force Academy graduates and students who had completed the ROTC Flight Indoctrination Program were not considered eligible. Additional restrictions to eligibility were:

1. Civilian flying experience not to exceed 150 hours.
2. USAF navigator experience restricted to non-fighter type aircraft (e.g., B-52 Navigator).
3. Other military flying not accomplished during past three years (e.g., Army helicopter pilot).

The number of students completing the study program was: class 74-05, 54; class 74-06, 38; and class 74-07, 36, for a total of 128.

Description of Apparatus

The A/F37A-T-40 Instrument Trainer contains side-by-side pilot's and copilot's stations closely resembling a T-39 cockpit. At the aft end of the cockpit section is an entrance stairway and platform. The motion system hydraulic power supply is located under the platform. The computer modules and electrical power equipment are located in the nose of the cockpit section.

The motion system has two degrees of freedom (pitch and roll) with a cue "wash-out" system. The operator console duplicates most of the cockpit instrumentation, and contains "problem freeze," "altitude freeze," and "position freeze" features. Instrumentation on the pilot's panel is somewhat similar to a T-38; the copilot's panel closely resembles the T-37 panel.

Modifications. For the purposes of the study, certain modifications to the basic T-40 Trainer were required.

Audio Communications. Electrical wiring was modified to permit a cassette tape to be played simultaneously into all three trainers through the UHF radios, to the three operator consoles, and to an adjustable volume speaker in the console area. Cockpit/console wiring was modified to permit the console operator to monitor and interrupt "hot-mike" signals from both cockpit stations. In addition, to make the T-40 microphone system compatible with the Helmet Gu22P/Mask BU5P worn by the subjects, an impedence-matching power supply-amplifier was added to each trainer.

Operator Station. Features of the T-40 instrument console used in this experiment were displays of altitude, airspeed, heading, rate-of-climb, and UHF frequency. These features, of course, are standard, but mounted on each console table was a light control box. Each control box contained three sets of toggle switches; one set of nine and two sets of three switches. On the face of the box were also mounted START, ERROR, COMPLETE, and POWER ON lights, START and STOP buttons, and a POWER ON/OFF switch. Each control box contained its own event timer. This timer was started by the operator the same instant light problems were presented. The timer was stopped either by problem solution in the cockpit or manually by the operator when the allotted time had expired.

Timing. Console operators used an elapsed-time clock located above Console #1 and clearly visible to the other operators. This timer was used to allow operators and instructors to keep track of the timed instruction blocks and to prepare for data recording during test periods.

Instructor and Operator Personnel

The instructor and operator personnel used in the study played a highly important role. The following sections describe their selection, training, and duties.

Instructor Pilots (IPs). Six groups of 12 IPs were utilized in presenting the T-40 course of instruction to the three participating UPT classes. These IPs were selected from the 96th FTS (T-37) and the 97th FTS (T-38) at Williams AFB.

Instructor pilot experience ranged from recent UPT graduates awaiting assignment to the Pilot Instructor Training Course to IPs with several years' experience. IPs assigned to Air Force Human Resources Laboratory, Flying Training Division (AFHRL/FT) served occasionally on a fill-in basis. The average IP used in the study had approximately five and one-quarter months' instructing experience and 600 hours total flying time. These instructor pilots averaged 190 hours experience in active flight instruction time.

Each group of IPs presented eight lessons comprising one half of the course since flight line operational requirements would not permit the retention of a single group of IPs long enough to present the entire program to a class.

IP training was divided into group briefings and individual training sessions. AFHRL/FT pilots conducted the IP training. An outline of the group training session subject matter follows:

1. An introduction including program objectives, related screening programs and research, general methodology, and student/instructor scheduling.

2. T-40 simulator orientation including cockpit layout, control response, and freeze and reset features.

3. Study of the program guide including format and task descriptions, methods for student "hands on" instruction, and reemphasis on standardization.

4. Demonstration of the command tape.

5. Demonstration of test data recording.

6. Demonstration of light box tasks (for second IP group in each class).

After the group briefing, each IP was given a thorough checkout in the T-40 trainer by an AFHRL/FT instructor. The IP practiced flying each maneuver to be presented, resetting the trainer to parameters specified in the program guide, instructing from the guide in coordination with taped time signals, and recording test data while the HRL instructor flew a typical test.

Included in each student training period was a thirty-minute briefing, a forty-five minute trainer flight, and a fifteen-minute debriefing. During the briefing, the IP reviewed and discussed the student's study assignment, used the program guide and an instrument panel training aid in explaining the maneuvers to be covered, and answered questions from the student. The program guide and taped time and test signals controlled the instructor's presentation during the trainer flight. The IP was also required to reset the trainer to specified parameters, repeat taped test commands for the student, and record data during test periods. After the trainer flight, the IP gave the student a critique on his performance in the trainer and answered student questions on the material covered. The student's study assignment for the following lesson was given at this time.

Console Operators. Operators were temporary civil service employees with clerical experience who were hired specifically for this study.

Operators were trained to read and interpret the aircraft instrument displays on the T-40 console, record readings on specified instruments, reset the trainer position and operate the light control box. The chief console operators were further trained to operate the cassette tape player and the master timer.

The primary duty of each console operator was data recording during the training sorties. The course outline and data recording forms kept the operator informed as to the specified data recording requirements. Time signals indicating the instant the required readings were to be taken were received over the operator's headphones from the tape player. The taped commands to the student enabled the operator to keep track of test progress. At the end of each period, the chief operator restarted the tape and synchronized the master timer with the new tape.

During the portion of the program devoted to VOR training, the operators were required to reposition the trainer to predetermined locations on command from the instructor.

The final four training periods were continuous testing sessions and required the operators to initiate a new problem on the light control box at forty-five second intervals, record reaction times, errors, and instrument readings.

When not occupied at the console, operators collected and scored the test forms containing the data collected by both operators and instructors.

Syllabus Development

The syllabus of instruction (Appendix A) for this study was designed to use the job sample approach for screening candidates for UPT. Also, the nature of the study required that identical quantities of training be administered each student in order that the testing provide a valid indication of each student's ability to attain those skills being taught. The predictive criteria were determined to be the candidate's ability to assimilate, retain, and utilize information presented in a flying training situation. Since the devices available for conducting this study were T-40 instrument trainers, the UPT syllabus was examined to determine which of the UPT tasks could be effectively trained in the T-40.

T-40 Capabilities. All instrument flying tasks included in the T-37 phase instrument check were flown by current T-37 instructor pilots in the T-40 trainer. The only maneuver the trainer was incapable of performing properly was the aileron roll (a confidence maneuver) due to the absence of response to backstick pressure when bank exceeded 90 degrees.

Syllabus Design. The syllabus was constructed to accommodate a student with no flight experience and no knowledge of aircraft instruments. A building-block approach was used, starting with straight and level instrument flight and increasing task complexity in logical steps. The scope of the training program was limited by the length of time the students were available. Each student was instructed in basic instrument maneuvers, progressed to steep turns, confidence maneuvers, and unusual attitudes and concluded with practicing VOR instrument navigation skills which included course interception and holding patterns.

Academics. Academic instruction during the screening phase of UPT has not, in the past, contained any instrument flight lectures. This training normally is first encountered during the T-37 phase. Rather than move a block of instrument flight lectures into the screening phase, then repeat the lectures during the T-37 phase, an alternative was exercised. The T-37 academic section of the 82d Student Squadron prepared a special T-40 Instrument Procedures work book (Appendix B). The contents of the work book were limited to instrument tasks and procedures covered in the T-40 study. These work books were issued to each student for independent study. Students received additional daily reading assignments in AFM 51-37, Instrument Flying, and ATC Manual 51-4, Primary Flying, Jet. Access to these manuals was strictly controlled to provide equal study time to each student.

Tasks. Table 1 gives the list of the training tasks selected and the sortie number in which the task was first introduced.

Table 1. **T-40 Training Tasks**

Sortie No.	Task
1	T-40 Trainer Familiarization
2	Straight and Level
3	Attitude Climbs and Descents Constant Airspeed Climbs and Descents Level Off
4	Change of Airspeed Normal Turns (30° Bank) Normal Turns to Headings
5	Change of Airspeed in a Turn Climbing and Descending Turns Steep Turns (60° Bank)
6	Rate Climbs and Descents
7	Simultaneous Changes of Heading, Airspeed and Altitude Vertical "S" – Delta
8 and 8A	Unusual Attitudes Wingover
9	Instrument Takeoff Tech Order Climb VOR Homing
10	RMI and CDI Intercepts VOR Holding
11	Standard Instrument Departure
12-16	Composed of a series of light box stress tasks superimposed on the performance of the simpler basic instrument flight maneuvers introduced in the first six sorties.

Instructional Techniques. In order to present a highly standardized course of instruction with maximum "hands on" student training, the number of situations requiring individual instructor technique or a judgment by the student were minimized. Actions required to perform a task were proceduralized to the maximum extent possible. For example:

1. Turns to headings – the recommended rollout lead point of one third the angle of bank was changed to procedural lead points of 10° for a 30° bank and 20° for a 60° bank.

2. Level off – the recommended lead point of approximately 10 percent of the vertical velocity was made a firm procedural lead point.

Standardization. A major problem in presenting highly standardized training to each student was to overcome variations in instructor quality. IP experience ranged from zero instructor time to over four years. To minimize this effect, a detailed course outline was prepared which covered point-by-point, the items to be discussed in each mission briefing, trainer flight, and debriefing. All instructors were directed to adhere strictly to the course outline and to refrain from using individual techniques in presenting the training.

The taped time signals, received over the instructor's headphones, regulated the length of training time to be devoted to each task.

All instruction in the trainer was presented verbally. No IP demonstrations were utilized With the exception of the unusual attitude setup, the student had the trainer controls throughout the program.

Study Design

The study design was modeled along the classical predictive paradigm common in applied psychological research. Of necessity, such an approach is longitudinal and uses actual job performance as criteria. Based as it is upon empirically established validity, the model is robust. Results obtained from this approach are truly representative of the predictive power of the test instrument since the study conditions actually duplicate the selection situation. The test instrument, of course, was a job sample and this added relevance to the study because the more closely the selection instrument reproduces the behavioral tasks of the actual job, the greater the content validity of the selection procedure. The job sample test was directly related to the activity to be predicted, gave the UPT candidate a taste of piloting, and was minimally (if at all) culturally biased. Individual differences in ability were manifested in differential performance on simulated piloting tasks.

Controls. One of the major difficulties in an approach of this type is maintaining control over the experimental environment. In the present study three dimensions of control were used. First, students in each of the three classes were randomly assigned to one of two sections (A or B). During the course of training the period of instruction was counterbalanced between a.m or p.m for two sections. Second, a tightly controlled plan was developed to alleviate potential instructor/trainer/period of instruction interactions. Through careful scheduling, it was possible to insure that each student had approximately the same number of training flights in each of the three trainers, at different periods of the day, and with the same number of different instructor pilots. As a result, IP-student interaction effects were minimized, trainer device idiosyncrasies were negated, and consequences of circadian functions within students were greatly reduced. Third, by making the training period a minature replica of the flying task, events were highly structured. The student's sequence of activities always followed a rigid pattern: sortie preparation (45 minutes of individual study on printed materials germane to the sortie); pre-sortie briefing (30 minutes in which this material and the sortie were reviewed by the student with his IP); training period (45 minutes of T-40 instrument training); and sortie debriefing (15 minutes of performance critique by the IP for the student).

Testing Procedures. The test of the student's performance adhered to a completely structured protocol. Each test occurred at a predetermined time during the 45 minute period. In all, 25 tests were administered to each student. The first test occupied 10 continuous minutes in the second training period; the 20 subsequent tests were contained in two five-minute intervals occurring during each of the next 10 training periods. In the latter case, each five-minute test was separated by approximately 20 minutes of training. In the remaining four periods (i.e., those incorporating light box problems during the performance of flying tasks), response time/accuracy measures and instrument flying task proficiency measures were observed continuously throughout the training period.

Testing instructions were relayed to IPs and operators via headphones. These instructions dictated the initial setup conditions of the simulator (e.g., altitude 16M, heading 360; airspeed 250 kts, etc.), and the particular test to be given. A one-minute preparatory interval followed in which the simulator was set up; the IPs and operators prepared to collect data; and, the student was alerted that a test would occur.

At the beginning of a test, a taped signal (i.e., beep) was given to IPs and operators. The IP then told the student what maneuversto nerform. As the student attempted this task, "beeps" were sounded at 10-second intervals over the headphones of the IPs and operators. Cued by these stimuli, IPs and operators recorded designated instrument readings from their panels. This process continued until the test was completed.

Dependent Variables. As described in the Introduction, three classes of objective measures of piloting performance — aircraft control, systems management, and flying procedures — were developed in order to assess student achievement. By using the job sample approach, tested student behaviors were directly referenced to specified task performance requirements. Thus all recorded observations of the student's performance were scored upon absolute standards as defined by the maneuver descriptions utilized in UPT. No judgments were made as to the quality of the performance, only the student's measured deviations from established criteria were used in the evaluation process.

The dependent variables corresponding to the three classes of objective measures of piloting performance were as follows:

1. *Measures of aircraft flight parameters* (the analog of aircraft control). Variables used were; airspeed (in knots), altitude (in feet), heading (in degrees), pitch (in barwidths or degrees), bank (in degrees), pitch/bank coordination (displayed wing tip position on the artificial horizon), vertical velocity (in feet per minute), and roll rate (correct rate used — incorrect rate used). The following example is given to clarify the use of these maneuvers: directed to maintain 250 knots IAS, a student was observed at 25<u>2</u>, 25<u>6</u>, 25<u>1</u>, 24<u>8</u>, 25<u>0</u>, and 25<u>0</u> knots IAS during a 60-second test interval. Scores recorded for this performance were the underlined digits; i.e., 2, 6, 1, 2, 0, and 0.

2. *Measures of systems management ability.* Using the light box, problems of various degrees of complexity were presented to the student while he "flew" the trainer. The amount of time (in seconds) the student required to solve these problems and the accuracy (i.e., correct or incorrect) of his solution were recorded.

3. *Measures of flying procedures compliance.* This set of variables consisted of power setting, VOR course intercept, VOR holding, take-off procedures, turns to assigned headings, recovery from unusual attitudes, and simple radio communications. The student's performance was recorded as either correct or incorrect.

The result of this effort was to produce 25 tests in which the total number of items was 342. Since the testing time was fixed, the actual number of items in each test varied, but the total was approximately the same for all tests. Of the 342 items, 208 were composed of "continuous" dependent variable observations (e.g., airspeed) and 134 were composed of "discrete" dependent variable observations (e.g., power setting as correct or incorrect). Examples of the special test forms prepared to record these data are presented in Appendix C. Acting on the taped cues, data recording was accomplished by the instructor pilots and the console operators using these test forms.

Preliminary Scoring Procedures

Before the data could be scored, it was necessary to correct certain data points to account for transitions during a maneuver, instructor errors, or minor trainer malfunctions. Specific examples of these situations are:

1. *Transitions.* During airspeed or altitude changes, a short time interval was allowed for the IP to repeat the command and the maneuver transition to be completed. Only data points occurring after a transition was complete were scored. As an extreme case, six data points were recorded for a transition from 250 KIAS to 230 KIAS. It takes 30 seconds for an IP to repeat the command and for a properly executed airspeed decrease to occur. To allow for this 30 second interval, the first four airspeed data points were deleted and only the last two were scored.

Bank data were scored during the time the aircraft should have been established in a turn. Data points at which the aircraft should have been rolling in or rolling out were not scored.

During the Vertical S maneuvers, only data points at which the aircraft should have been in a steady climb or descent were scored. These points occurred at :20, :30, :50, 1:20, 1:30, 1:40, and 1:50 minutes after the original command. All other points were omitted from the analyses because they occurred during transitions.

The instrument take off could not be scored based solely upon the time elapsed from the original command. IPs did not always get the trainer set up in time for the student to begin the task on command. Therefore, the task was not considered started until brake release, at which point airspeed showed an increase. The maneuver "ITO to 5,000 ft" is a task that illustrates this point (Test 9-1, 10-1). Table 2, which is a partial copy of a test form, is given below to illustrate the discussion of these points.

Table 2. **Test Form Illustration**

	Airspeed	Heading	Altitude	Pitch
Brake Release	X	X	X	X
(first airspeed	X	360	X	X
increase)	X	360	X	X
	X	360	X	10
	X	360	X	10
	X	360	X	10
	X	360	X	10
	220	360	X	X
	220	360	X	X
	220	360	X	X
	X	360	X	X
	X	360	X	X
	250	360	5000	X
	250	360	5000	X

X = Non-relevant Data: Transitional State, etc.
All readings taken at 10 second intervals.

The test form example in Table 2 indicates edited data with an X in the appropriate data space. The desired value for each data point was placed in all other data spaces. Tests were scored by computing the absolute deviations from the desired value. Numbers in the data space on the discrete items, such as communications, indicated the value assigned to that particular response. The examples of test forms presented in Appendix C include this information.

2. *Instructor/Trainer Malfunctions:* In a very few instances, the instructor pilot recorded the wrong data on the test sheet, failed to record the data, did not set up the trainer in the proper configuration, or gave erroneous instructions to the student. Also, trainer malfunctions occasionally invalidated some data. Such situations were rare and accounted for less than 2.5 percent of the total amount of information collected in the study. To fill in the missing data cells, a simplified version of the estimation method described by Bennett and Franklin was used (Winer, 1971, pp. 487-490).

Final Scoring Procedures. When the data matrices were complete, the final scoring steps were performed. Since three classes of objective measures of piloting performance were used as dependent variables, a procedure was required for scoring each type of measure:

1. *Measures of Aircraft Flight Parameters.* For these measures, the absolute deviations from zero (i.e., perfection) for each separate parameter for each maneuver item were converted to Z scores. Large deviations, therefore, were represented by large, positive Z scores. Small deviations (or zero deviations in the case of outstanding performance) became large, negative Z scores. This procedure should be remembered in subsequent discussions of the study results because it explains why *negative* correlations exist between the predictor and criterion variables for this class of measures.

2. *Measures of Systems Management Ability.* These measures consisted of response time and accuracy. The procedures for scoring response times were identical with those described above and similar results were obtained. Inspection of the data revealed that there was too little variation in accuracy scores for these measures to be useful predictors so they were excluded from further processing and analysis.

3. *Measures of Flying Procedures Compliance:* These discrete measures were scored by simply calculating the percent of correct responses out of the total opportunities presented. These percentages were then Z scored.

Automatic Data Processing

The data entered on the test forms was scored and then keypunched on IBM cards. After verification, these cards were read onto magnetic tape and all further data processing and statistical analyses were performed on AFHRL/FT's SEL 86 computer.

Criteria

The selection of criteria measures for quantifying achievement in UPT is not a simple, straightforward process. As with most human undertakings, "success" is a relative matter, and may be viewed from either an individual or institutional standpoint. There is also a temporal aspect to this problem and the determination of when criteria have ripened sufficiently is a subjective judgment. But there do exist practical considerations in UPT which, to some extent, force an operational definition of "success." At the most primitive measurement level passing or failing students may be identified; this crude dichotomy can be refined by using the grades assigned to students based on the performance they exhibit during training. An additional consideration is that the vast bulk of student attrition occurs early (i.e., first eight weeks) in the T-37 phase of UPT.

Conclusions that may be drawn from the preceding paragraph are:

1. The T-37 phase of UPT is an appropriate time to develop criteria.

2. A choice must be made to use pass-fail and/or performance grades as criteria. Consequently, this point will be discussed in some detail.

Pass-fail is an uncomplicated criterion measure, but it may, in some cases, be inappropriate. There are six Air Force categories for attrition, or failure, in UPT: flying deficiency, self-initiated elimination, manifestation of anxiety, academic, medical, and administrative. Although it has been argued that the first four categories reflect a lack of flying ability, experienced investigators know this is often not the case. Student motivation, managerial attitudes, administrative convenience, and a plethora of less easily labeled circumstances invalidate such an assumption. However, the pass-fail criterion is extremely easy to use and, since it did not complicate the analysis, it was included.

Performance Grades

T-37 phase performance grades offer criteria that more closely sample the domain of flying ability. These grades are generated under nearly equivalent test conditions, assigned by highly experienced check pilots and trained IPs, and can be combined to produce a more accurate (and probably stable) picture of the student's capability. Admittedly, most of these grades are based on ratings, but these ratings are judiciously allocated. In fact, these grades represent the best measures of flying ability available in the T-37 phase of UPT.

Four T-37 phase performance grades were obtained for each non-attriting student. These grades and their composition were as follows:

1. *T-37 instrument check-ride grade.* Composed of the summed ratings on maneuvers given on the T-37 instrument flight check.

2. *Combined T-37 check-ride grades.* The arithmetic mean of the rating scores obtained on the two T-37 phase contact check rides and the T-37 instrument check.

3. *T-37 flying score.* A composite of (1) and (2), above, combined with ratings on maneuvers which were assigned daily by the student's IP.

4. *Overall T-37 phase grade.* The final grade assigned at the completion of the T-37 phase; composed of (1), (2) and (3), above, and the student's academic grade.

After careful consideration, the T-37 instrument check, the T-37 check rides, and the overall T-37 phase grade were selected as criteria to be used in this study.

Data Analysis

The data analysis was based on three sequential steps: combining individual test items into larger units of analysis; determining the reliability of these units; and, developing the equation to express the relationship between predictor variables and criteria.

Item Combination. The 25 tests were composed of 342 items of which 208 were defined as continuous measurements and 134 were defined as discrete measurements. Since the total number of UPT students participating in the study was only 128, it was necessary to combine these items in a logical manner to avoid over-determination of prediction. This problem had been foreseen at the outset of the study and its solution was easily obtained. The test items were merely the observed parameters of certain selected piloting and psychomotor tasks; e.g., straight and level instrument flight and response time, which had been converted into Z scores. Thus, the various items could be readily combined into perfectly homogeneous groups of tasks. The proper nomenclature for these item groupings is a *maneuver*, an *activity*, or a *procedure*, depending upon the nature of the task involved. Tables 3, 4, and 5 identify these task groupings and list the number of items so combined.

Table 3. Maneuvers

Name	Number of Items
Straight and Level Flight	26
Pitch Control Maneuvers	4
Change Airspeed	12
Climbs and Descents	18
Turns	22
Rate Climb or Descent	6
Complex Turn	22
ITO	12
Vertical "S" Alpha	8
Vertical "S" Delta	4
Steep Turns	19
Stressed – Straight and Level Flight	6
Stressed – Altitude and/or Airspeed Change	5
Stressed – Complex Turn	8
Stressed – Rate Climb or Descent (VS-A; VS-D)	7

Table 4. Activities

Name	Number of Items
Frequency Response Time – Practice	2
Single Light Position Response Time – Practice	2
Double Light Position Response Time – Practice	1
Frequency Response Time	11
Single Light Position Response Time	11
Double Light Position Response Time	2

Table 5. **Procedures**

Name	Number of Items
Communications	38
Power Setting	12
Turn Direction	8
Roll-Out Accuracy – 30° Bank Turn	21
Roll-Out – 30° Bank Turn	12
Wingover Roll Rate	6
Roll-Out Accuracy – 60° Bank Turn	6
Wingover	18
Advanced Instrument Procedures	13

Reliability. The reliability of each homogenous group of tasks was estimated using the Kuder-Richardson formula 20 to determine its internal consistency (Cronbach, 1970, pp. 158-161).

Prediction Equation. Two contradictory principles are involved in the development of the linear regression equation used to predict the selected criterion. The first principle attempts to include as many predictor scores as possible (in order to obtain the best least squares fit) while the second principle seeks parsimony for purposes of future data collection and interpretation. The compromise between these two principles is a matter of experimenter judgment as to what method will produce the "best" regression equation. The method used in the T-40 study is classified as a forward selection procedure by Draper and Smith (1966, pp. 163-171). The resulting prediction equation reconciled these opposing principles in an optimum manner and was applied to the pass-fail criterion, the T-37 instrument check, the T-37 check rides, and the overall T-37 phase grade criteria.

III. RESULTS

The study results, in general, are a satisfactory confirmation of the job sample approach for UPT selection and screening. This is particularly true when the technique is compared with AFOQT paper and pencil testing and used to predict T-37 phase flying performance scores. The succeeding paragraphs will report the study results in detail, beginning with descriptive aspects of the data and concluding with the inferences that may be drawn from it.

Data Description and Abandoned Procedures

Inspection of the raw data revealed its characteristics and the analysis proceeded through certain "trial and error" steps that were determined to be unfruitful and were discontinued.

Data Description. The absolute scores for the continuous dependent variables observed in the study had an excellent range. The minimum variability shown was approximately a factor of two for response time scores; the maximum variability shown was approximately three orders of magnitude for maintenance of altitude during certain maneuvers. The range of scores observed for the discrete dependent variables was not as great, but here also, good variability was present. For these measures the range of scores ran from nearly a factor of two to slightly over a factor of four.

An analysis of the shape of the distribution was performed on the raw scores for one of the continuous dependent variables. It was found to be Gaussian (in fact, a nearly "perfect" bell-shaped curve) and inspection of the other continuous variables showed they exhibited the same characteristic. The assumption of underlying normality of distribution appeared justified for this class of data. The distribution of discrete dependent variables was slightly negatively skewed (as would be predicted) but this was to such a modest degree that a normalizing transformation was not deemed necessary.

Abandoned Procedures. Two procedures used in the early stages of the analysis were discontinued when they were found to be unnecessary and redundant. This activity is reported only as a guide for other researchers in the area since these procedures have been frequently employed in the past. First, the use of root mean square (RMS) error terms for the continuous dependent variables contributed nothing beyond the use of simple absolute scores. This is not a criticism of RMS measures, but unless automatic recording and transformation of data is available, such a step may introduce additional and unrequired effort. Second, creating tolerance bands .676 and 1.000 Z units from the mean (50 and 68.4 percent of the distribution, respectively) and tabulating the excursions into these bands, did not make a significant improvement in prediction. The lowest correlation observed between counts of these excursions and absolute scores was .88 with the median value being approximately .94. Ergo, this procedure was deemed superfluous and dropped from the analysis.

Continuous Dependent Variable Reliability

The job sample approach used in the study enabled the test instrument to be designed as a power test. Also, since each of the 15 maneuvers and six activities were composed of identical task elements and measured by the same dependent variables, it may be safely assumed that the underlying test structure is unifactor. Based on these considerations, the reliability of these one-factor, power tests was computed using routine statistical methods. Table 6 presents the reliabilities (rounded to two decimal places) for the 15 maneuvers.

Table 6. Maneuvers

Name	Reliability
Straight and Level Flight	.63
Pitch Control Maneuvers	.66
Change Airspeed	.54
Climbs and Descents	.70
Turns	.77
Rate Climb or Descent	.63
Complex Turn	.69
ITO	.60
Vertical "S" Alpha	.64
Vertical "S" Delta	.52
Steep Turns	.59
Stressed – Straight and Level Flight	.54
Stressed – Altitude and/or Airspeed Change	.50
Stressed – Complex Turn	.63
Stressed – Rate Climb or Descent (VS-A; VS-D)	.67

The reliabilities for the six activities (again rounded to two decimals) are given in Table 7.

Table 7. **Activities**

Name	Reliability
Frequency Response Time – Practice	.64
Single Light Position Response Time – Practice	.63
Double Light Position Response Time – Practice One Item	Indeterminate
Frequency Response Time	.88
Single Light Position Response Time	.92
Double Light Position Response Time	.77

As may be seen in Table 6, the maneuver reliabilities range from .50 to .77 with a median value of .63. Although these values are not high enough for the tests to be used as established psychometric instruments, they are quite encouraging and warrant further development of the job sample approach.

The response times (which were the dependent variables measured in the activity tasks) were found to be highly reliable after practice. The observed values are in excellent agreement with those reported in the literature; a most satisfying result.

Correlations with T-37 Phase Criteria

Of the 128 students who completed the study program 71 completed the T-37 phase of instruction in UPT. Thus, the total degrees of freedom between the predictor variables and the criterion variables (i.e., T-37 instrument check, T-37 check rides; and, overall T-37 phase grade) was 69, but since tabled significance level values exist for 70 degrees of freedom, the latter was used for convenience. Table D-1 in Appendix D gives the means and standard deviations for all predictor and T-37 phase criteria variables used in the study, and Table D-2 gives the complete correlation matrix. All correlations are Pearson Product Moment r's uncorrected for curtailment.

Table 8 presents the correlations between the predictor variables and the T-37 phase criteria. As regards the 15 maneuvers, 13 are significant at the .05 level and 11 at the .01 level when used to predict T-37 check ride performance. These 15 maneuvers do not predict scores on the T-37 instrument check as well; only nine are significant at the .05 level and 7 at the .01 level. Finally, and best, these maneuvers do show substantial correlation with the overall T-37 phase grade: 14 out of 15 are significant at the .01 level of confidence. Corresponding statistics for the 6 activity variables are: 3 and 1; 0; and, 4 and 2. The 9 procedure variables were disappointing as predictors with their order in this respect being 3 and 2; 1 and 0; and, 4 and 2.

Table 8. Correlations with T-37 Phase Criteria

Predictor Variable	Variable Name	Criterion Variable: T-37 Check Rides	T-37 Instrument Check	Overall T-37 Phase Grade
Maneuver				
1	M1	−.35**	−.28**	−.52**
2	M2	−.37**	−.30**	−.41**
3	M3	−.33**	−.43**	−.43**
4	M4	−.44**	−.34**	−.52**
5	M5	−.03	−.02	−.07
6	M6	−.37**	−.17	−.47**
7	M7	−.53**	−.49**	−.61**
8	M8	−.23*	−.20	−.34**
9	M9	−.35**	−.14	−.46**
10	M10	−.27*	−.20	−.38**
11	M11	−.35**	−.25*	−.43**
12	M12	−.30**	−.30**	−.41**
13	M13	−.32**	−.28*	−.36**
14	M14	−.21	−.21	−.35**
15	M15	−.36**	−.35**	−.37**
Activity				
1	M16	−.20	−.17	−.25*
2	M17	−.28*	−.11	−.35**
3	M18	−.11	−.09	−.13
4	M19	−.17	.00	−.17
5	M20	−.23*	+.01	−.25*
6	M21	−.34**	−.12	−.32**
Procedure				
1	M22	+.17	+.03	+.24*
2	M23	−.03	+.01	+.05
3	M24	−.10	−.07	−.01
4	M25	+.34**	+.25*	+.41**
5	M26	+.26*	+.12	+.29*
6	M27	+.10	+.13	+.08
7	M28	+.08	+.16	+.06
8	M29	+.30**	+.19	+.31**
9	M30	+.09	+.11	+.19

* Significant at .05 level of confidence.

** Significant at .01 level of confidence.

Table 9 is abstracted from Table D-2 in Appendix D. It shows the correlations obtained between the AFOQT Battery and the T-37 criteria as well as the intercorrelations of the criteria. The findings of major interest revealed in Table 9 may be briefly summarized. There are *no* correlations significant at even the .05 level between any of the AFOQT subtests and the T-37 phase criteria. In fact, the highest correlations observed account for only 2.25 percent of the variance and the "direction" of one-half of these is reversed (i.e., negative). As would be expected (considering their composition), T-37 phase criteria are strongly intercorrelated with in-common variances ranging from 50 to 80 percent.

Table 9. **AFOQT and T-37 Phase Criteria Correlations**

	AFOQT-1	AFOQT-2	AFOQT-3	AFOQT-4	AFOQT-5	Ck Rides	Instr Ck	Overall
AFOQT-1	1.00							
AFOQT-2	+.62**	1.00						
AFOQT-3	+.34**	+.67**	1.00					
AFOQT-4	+.31**	+.19	+.17	1.00.				
AFOQT-5	+.42**	+.35**	+.39**	+.60++	1.00			
Ck Rides	+.14	+.08	+.08	+.02	−.02	1.00		
Instr Ck	−.06	−.07	.00	−.15	−.15	+.71**	1.00	
Overall	+.15	+.10	+.15	+.05	-.01	+.89**	+.70**	1.00

** Significant at 01 level of confidence.

Two prediction equations were developed for each of the three T-37 phase criteria. The first prediction equation in each set was unrestricted; i.e., predictor variables were chosen without restaint so that their designation was determined solely by the mathematics of the forward selection process. The second prediction equation forced in the five subtests of the AFOQT and then permitted the forward selection process to operate freely. The complete set of six equations is reproduced in Tables E-1 through E-6 in Appendix E.

Table 10 contains summary information derived from the forward selection procedure. For each selection condition, the multiple correlation produced and variance accounted for by the selected predictor variables is listed.

The results shown in Table 10 speak for themselves and little need be added. Obviously, the job sample testing approach proved successful in predicting a large portion of the student's measured performance in the T-37 phase of UPT.

Correlations with the Pass-Fail Criterion

As discussed in Section II, Methods and Procedures, from the viewpoint of the training manager UPT students fall into two categorically distinct classes: those who pass and those who fail. To determine the relationships between predictor variables and this criterion, the point biserial correlation coefficient was computed. Although the total degrees of freedom for these correlations is 126, tables exist for 125 degrees of freedom and these were used. The means and standard deviations for all predictor variables are given in Table F-1 in Appendix F. The percentage of successful students was 55 percent; thus the pq ratio is very near 11/9, which is comfortably close to a 50-50 split. Table F-2 presents the complete correlation matrix obtained between the predictor variables and the criterion.

Table 11 is a partial summary of this matrix and gives the correlations between the job sample predictor tests and the pass-fail criterion. Compared to the correlations shown in Table 8, these findings are disappointing. Only nine of the maneuvers were significant at the .05 level of which two were significant at the .01 level. None of the activities correlations were significant at the .05 level. Three procedures had significant correlations at the .05 level. One subtest of the AFOQT was significant at the .05 level, but, unfortunately, with a reversed sign from that designed for UPT selection.

As was done for the T-37 phase criteria, two prediction equations were developed for the pass-fail criterion. Once again the first equation was unrestricted and the second equation forced in the five subtests of the AFOQT. These two equations are given in their entirety in Tables G-1 and G-2, Appendix G.

Table 12 summarizes the results of the forward selection procedure when applied to the pass-fail criterion. While it is true that the multiple correlations are significant at the .05 level for the five subtests of the AFOQT and at the .01 level when job sample instruments are included, these predictors account for only 9 and 20 percent of the pass-fail variance, respectively. Even the latter value would be of marginal utility when applied to UPT selection.

Table 10. Summary of Forward Selection Results

Selection Condition	T-37 Phase Criteria T-37 Check Ride	 T-37 Instrument Check	 Overall T-37 Phase Grade
Unrestricted Forward Selection	Multiple R+.67** Variance = 45 percent Maneuvers: 2, 6, 7 Activity: 6 Procedures: 5, 8	Multiple R = .64** Variance = 41 percent Maneuvers: 2, 3, 7 Activities: 1, 4 Procedure: 7 AFOQT subtests: 2, 4, 5	Multiple R = .76** Variance = 57 percent Maneuvers: 1, 2, 6, 7 Activity: 6 Procedure: 5 AFOQT subtest: 5
Forced Forward Selection – AFOQT Only	Multiple R = .18 Variance = 3 percent AFOQT subtests: 1, 2, 3, 4, 5	Multiple R = .19 Variance = 4 percent AFOQT subtests: 1, 2, 3, 4, 5	Multiple R = .24 Variance = 6 percent AFOQT subtests: 1, 2, 3, 4, 5
Forced Forward Selection – AFOQT and Job Sample Approach Combined	Multiple R = .69** Variance 47 percent Maneuvers: 2, 6, 7 Procedures: 5, 8 AFOQT subtests: 1, 2, 3, 4, 5	Multiple R = .64** Variance = 41 percent Maneuvers: 2, 3, 7 Procedure: 7 AFOQT subtests: 1, 2, 3, 4, 5	Multiple R = .77** Variance = 60 percent Maneuvers: 1, 2, 6, 7 Procedures: 5, 8 AFOQT subtests: 1, 2, 3, 4, 5

** Significant at .01 level of confidence.

Table 11. **Correlations with Pass-Fail Criterion**

Predictor Variable	Correlation with Pass-Fail
Maneuver	
1	–.16
2	–.19*
3	–.20*
4	–.21*
5	–.14
6	–.11
7	–.24**
8	–.21*
9	–.20*
10	–.16
11	–.23**
12	–.20*
13	–.06
14	–.17*
15	–.07
Activity	
1	–.02
2	–.06
3	–.03
4	–.04
5	–.08
6	–.13
Procedure	
1	.11
2	.18*
3	.19*
4	.17*
5	.04
6	.02
7	.08
8	.15
9	.15
AFOQT Subtest	
1	.16
2	.10
3	–.07
4	–.19*
5	–.09

* Significant at the .05 level of confidence.

** Significant at the .01 level of confidence.

Table 12. Summary of Forward Selection Results

Selection Condition	Pass-Fail Criterion
Unrestricted Forward Selection	Multiple R = .45** Variance = 20 percent Maneuvers: 7, 11 Activity: 6 Procedures: 2, 3 AFOQT Subtests: 1, 3, 4
Forced Forward Selection - AFOQT	Multiple R = .30* Variance = 9 percent AFOQT Subtests: 1, 2, 3, 4, 5
Forced Forward Selection — AFOQT	Multiple R = .45** Variance = 20 percent Maneuver: 11 Activity: 6 Procedures: 2, 3, 9 AFOQT Subtests: 1, 2, 3, 4, 5

*Significant at .05 level of confidence.
** Significant at .01 level of confidence.

IV. DISCUSSION

The discussion of the T-40 screening study will be centered about five major topics that warrant further elaboration and clarification. These topics are: (1) the training by-product of the study, (2) data collection and scoring, (3) the valid predictive tasks, (4) a proposed operational program for UPT screening, and (5) the problem of predicting UPT attrition not attributable to flying deficiency.

Training Accomplished

The secondary objective of this study was to provide each student with a general knowledge of basic instrument flying skills. Although the evidence that this was accomplished is subjective and anecdotal, it is believed that this objective was achieved. The average student participating in this study gained an understanding of the basic principles of flight, acquired proficiency in the manipulation of a jet aircraft flight control system, learned how to read and interpret aircraft instrumentation, and became familiar with the cockpit environment.

This was the student's first exposure to the military flight training system and the methods used in this system. To lend realism to the training situation, the student was required to strap in the trainer cockpit using a parachute harness, shoulder straps and lap belt. The student also wore his flight helmet and oxygen mask during the sortie. All trainer instructions were received by the student over the headphones.

Through the use of these procedures, the program was, to a large extent, successful in accomplishing the desired training. In comparing the training received in the T-40 screening program with that received in the T-41 program, the most noticeable advantages of the light aircraft program can be attributed to actual flight. The flight environment provides training in the use of external visual references essential to contact flying. Some indications of the candidate's ability to handle apprehension and become accustomed to flight motion may also be observed in the T-41 program.

The light aircraft program provides valuable training in the use of checklists, aircraft systems knowledge, taxiing, take-off and landing, and contact pilotage. Both programs provide a basic understanding of the principles of flight. The T-40 program furnishes the student proficiency in basic instrument flying skills, familiarity with the jet trainer cockpit environment, and a feel for the control and power response of a jet aircraft.

Data Collection and Scoring

There are three aspects to this topic that are worthy of comment. These are: manual data collection, test composition, and dependent variable weights.

Manual Data Collection. Apart from human frailty in recording and transcribing data (a process which produced very little error in this study), the problem encountered was one of determining that the student was properly initialized at the onset of testing. As previously explained, a logical method of reducing the magnitude of this problem was used by which the early portions (usually 20 seconds) of the student's performance were not scored. This had the effect of not penalizing good students and not rewarding poor ones for conditions beyond their control. In a manual system this procedure is acceptable since no practical alternatives exist. It is, however, a "make-do" approach easily surmounted with computerized control over the trainer and automatic data recording and processing equipment. Such equipment should be used in future studies of this type.

Test Composition. The instrument maneuver was chosen as the unit upon which the analysis of student performance was based. The student was required to execute an individual maneuver (e.g., straight and level flight) at various times throughout the training sorties. His performance on each attempt was scored, and the sum of these scores was used to determine the student's proficiency on that particular maneuver. This proficiency measure was then correlated with certain measures of success in the T-37 phase of UPT. An alternate approach could have used the individual tests as the analytical unit. Whether the observed validities would have increased is unknown, but such an approach is a viable option for future research.

Dependent Variable Weights. Airspeed, altitude and heading are dependent variables expressed in knots, feet and degrees. In addition, the magnitude of their possible variations ranges from tens to hundreds and back to tens. The present study combined these "different-sized apples, oranges and pears" by using the Z-score as a homogenizing function. It would have been preferable to have had a transformation equation to accomplish this, but none exists. Appropriate weighting factors for these three objective performance measures may need to be developed for use in UPT proficiency assessment.

Predictors

The nature of the forward selection procedure was such that it selected the most economical method of combining predictors to get a least squares fit. In effect, the procedure "looked at" the entire correlation matrix and picked out those variables that accounted for a significant portion of the criteria with the least amount of overlap between predictors. The result of this process was to select the following maneuvers to be the most valid combination of tasks in predicting T-37 phase performance scores and T-37 phase pass/fail. These maneuvers were: (1) straight and level flight, (2) pitch control maneuvers, (3) airspeed changes, (4) rate climbs or descents, and (5) complex turns.

Of the activities, the double light response time task was the most effective predictor. The 30° turn roll-out procedure was often a valuable addition to the prediction equation.

The tasks proven effective are obviously basic instrument tasks, taught and scored early in the program. Good performance on these tasks require the ability to rapidly comprehend and utilize:

1. Instrument display information.
2. The relationship between the instrument display and aircraft control; i.e., "stay ahead of the aircraft."
3. Actions and reactions to control movements; i.e., "feel of the aircraft."

Simply stated, the UPT candidate with the ability to rapidly convert verbal instruction into effective perceptual-motor control over the aircraft is the most likely to succeed.

Proposed Application of Research

The most striking feature of the study was not the validity of the job sample approach in predicting UPT success but the rapidity with which essential abilities can be identified. Such a result is extremely advantageous to an operational application. Examination of the training program shows that the pertinent information is gained in the initial presentations of the tasks. Most of the valid prediction information was obtained by the end of fifth sortie; i.e., during the first four hours of training.

Therefore, it appears feasible to propose an operational screening package based on five 45-minute sessions. The sessions would be similar to the first five sorties in the T-40 Program Guide, but would be altered to include more testing periods of shorter duration. The fifth sortie would also include the light box reaction time task or some modification thereof (Sortie 16, T-40 Program Guide). Practice on this task would be accomplished outside of the trainer. Appendix H is an outline of the Proposed T-40 Screening Program Guide. All pre-flight briefings, student activities, instructor activities, and post-flight briefings are identical to those contained in the original program guide.

Prediction of UPT Attrition

The present study successfully demonstrated the utility of the job sample test as a predictor of student performance in the T-37 phase of UPT. On the other hand, the same variables failed to identify students as "non-attritors" or "attritors." These results seem logically inconsistent and require further explanation.

It is believed that tests of ability, *per se*, will not succeed in predicting student attrition in the present UPT environment. Ability is a *necessary* ingredient in UPT, but alone, it is not *sufficient* to insure graduation from the program. Other factors – personal motivation, the training milieu, the military image, etc. – have heavy, but unknown, weights in the pass-fail equation.

V. CONCLUSIONS AND RECOMMENDATIONS

The conclusions that may be drawn from the T-40 study are as follows:

1. Job sample tests provide a valid approach for UPT screening and selection. Their validity, however, is limited to the prediction of student flying proficiency; such tests do not effectively discriminate between attriting and non-attriting UPT candidates because the bulk of attrition results from factors not related to primary flight abilities.

2. Job sample testing can be economically implemented: assessments of student performance can be accomplished within a brief period (i.e., 3 hours, 45 minutes) for personnel naive to flying.

Two recommendations are made:

1. Further development of the job sample test approach is warranted; this to include both test content and equipment.

2. The existing selection battery is not adequate with respect to reducing UPT student attrition; other dimensions of personality and behavior must be assessed.

REFERENCES

Cronbach, L.J. *Essentials of psychological testing.* (3rd ed.) New York: Harper and Row 1970.

Draper, N.R., & Smith, H. *Applied regression analysis.* New York: John Wiley and Sons, 1966.

Goebel, R.A., Baum, D.R., & Hagin, W.V. *Using a ground trainer in a job sample approach to predicting pilot performance.* AFHRL-TR-71-50, AD-741 747. Williams AFB, Ariz.: Flying Training Division, Air Force Human Resources Laboratory, November 1971.

Hinrichs, J.B. Ability correlates in learning of psychomotor tasks. *Journal of Applied Psychology,* 1970, 54, 56-64.

McGrevy, D.V., & Valentine, L.D., Jr. *Validation of two aircrew psychomotor tests.* AFHRL-TR-74-4, AD-777 830. Lackland AFB, Tex.: Personnel Research Division, Air Force Human Resources Laboratory, January 1974.

Melton, A.W. *Apparatus tests.* Report No. 4, Army Air Forces Aviation Psychology Program, Research Reports. Washington, D.C.: United States Government Printing Office, 1947.

Miller, R.E. *Development of officer selection and classification tests – 1968.* AFHRL-TR-68-104, AD-679 989. Lackland AFB, Tex.: Air Force Human Resources Laboratory, July 1968.

Mission Analysis Study Group. *Mission analysis on future undergraduate pilot training: 1975 through 1990, Volume 2.* AFSC-TR-72-001. Test and Evaluation, USAF Mission Analysis Study Group, January 1972.

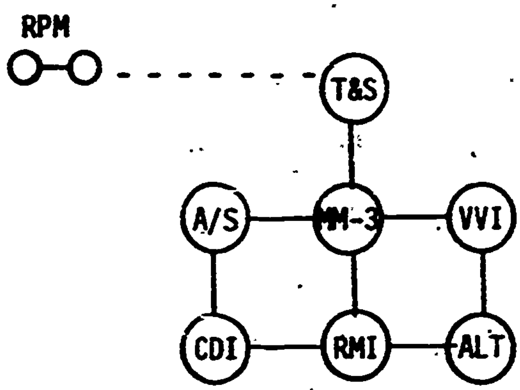
Winer, B.J. *Statistical principles in experimental design.* (2nd ed.) New York: McGraw Hill, 1971.

SORTIE #4 - PREFLIGHT BRIEFING

Objectives: The student will practice previously introduced maneuvers. He will do climbing and descending turns, steep turns, and changes of airspeed in normal turns.

Questions:

1. Have the students label, from memory, the flight instruments on a simple drawing. Draw the diagram and have him fill in the circles.



2. What instrument is the center of the crosscheck? Attitude indicator.

3. What instruments will you use in your crosscheck for a change of airspeed in a turn to a heading? MM-3, RMI, VVI, A/S, Altimeter.

4. Can you verbalize the crosscheck for a climbing turn to a heading?

5. How do you know when you have 60° of bank in a steep turn? By observing the bank pointer at the 60° index the second heavy mark at about 2 o'clock in the case.

New Material:

1. Change of airspeed in a turn to a heading

In this maneuver we are combining two things you have already practiced, turns to headings and change of airspeed. The crosscheck will be about twice as busy.

Let's look at a sample crosscheck in this problem. You are in a left turn from 270° (west) to 125° (southeast). You plan to decrease your airspeed from 270K to 230K. (Use model aircraft and instrument mock-up as necessary.) Smoothly roll into the turn using the MM-3, keep the fuselage dot on the horizon and establish 30° of bank. Reduce the power. Crosscheck RPM, MM-3, VVI, MM-3, Altimeter, MM-3. Initial crosscheck of the RMI and airspeed will be light. As you get closer to 230K and 125°, frequency for airspeed and RMI will increase. Figure lead point for rollout, start power in 2-4K above 230K. Crosscheck: MM-3, RMI, MM-3, Airspeed, MM-3, VVI, Alt, MM-3, etc.

2. Climb and Descending Turns to a Heading.

Again you will be combining two maneuvers you have previously practiced separately.

Remember that you will have two lead points to figure, level off and rollout. Initially you will not crosscheck the RMI and altitude very frequently. Here is a sample crosscheck: MM-3, Airspeed, MM-3, Airspeed, MM-3, Altimeter, RMI, MM-3, Airspeed, MM-3, Alt, VVI, MM-3, RMI, MM-3, Airspeed, etc. Notice that you use the VVI only to compute the level off leadpoint.

3. Steep Turns 60° of Bank

This maneuver is not normally done in actual instrument conditions. It is practiced to improve the crosscheck. In a steep turn the rate of change in airspeed and altitude is faster. In order to keep deviations small, they must be quickly recognized and quickly and accurately corrected.

In a steep turn, lift decreases because the wings are not parallel to the horizon. To maintain level flight a slight pitch increase is necessary. The steep turn also increases the drag. Therefore, a slight power increase (3-5% RPM) is required to maintain airspeed.

Roll smoothly into 60° of bank. Keep the fuselage dot exactly on the horizon until you see a need for a change on the VVI. As you pass 45° of bank increase back pressure. Add power as required. The crosscheck for a steep turn is the same as a normal turn.

Change A/S Turn	05:00		16M		250K		

SA:

1. Practice increasing and decreasing A/S while performing 30° bank turns.

IA:

1. Have the student turn to a heading 90° - 120° away while he changes his A/S.

2. Have student complete on 360° and 250K.

WUP	- - -	19:00
PREP FOR TEST - RESET TRAINER	- -	19:30
REFER TO TEST 4-1 DATA SHEET		

Test 4-1	05:00	CHD	16M	360	250K		20:00

60 Seconds remaining in Test 4-1	- - -	24:00
PREP	- -	24:30
START	-	25:00

APPENDIX B: T-40 INSTRUMENT PROCEDURES EXCERPTS

ATTITUDE INDICATOR

The attitude indicator provides the pilot with a substitute for the earth's horizon and a reference for maintaining desired aircraft attitude during all weather conditions. The attitude indicator provides an immediate, direct, and corresponding indication of any change in aircraft pitch or bank attitude.

MM-3 Attitude Indicator

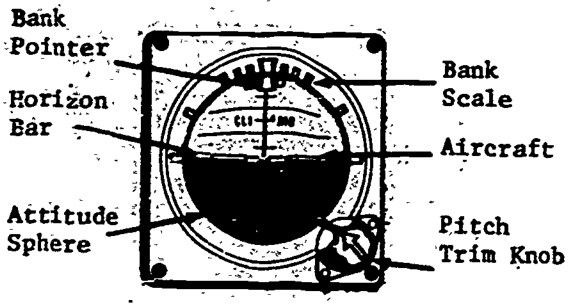
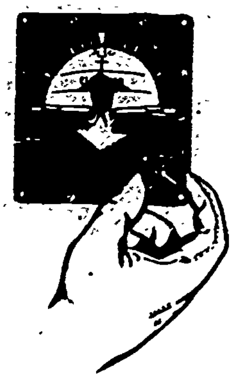


Figure B-2

Figure B-3



Adjusting the
Attitude Indicator
Figure B-4

The T-40 simulator uses the MM-3 attitude indicator. The attitude sphere on the MM-3 is divided by a white horizon line. The top or "sky" half is colored a light gray; the lower or "ground" half is black. A pitch reference scale indicates pitch angle through 90° climb or dive. These pitch lines are graduated in 5° intervals with numerical indications at 30° and 60° of pitch. The words CLIMB and DIVE are depicted on the sphere at 15° and 45° of pitch. Bank attitude is indicated by the position of the bank pointer relative to the bank scale which is marked with 0°, 10°, 20°, 30°, 60°, and 90° bank indices. The bank pointer, or "sky pointer" as it is sometimes called, always points towards the sky. It therefore points opposite to the direction of turn. A right turn of 25° of bank, as shown in figure 3, will put the bank pointer between the second and third indices to the left.

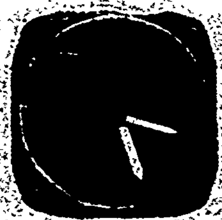
The pitch the aircraft requires to maintain level flight largely depends on airspeed. You must be aware that everytime you change airspeed in level flight, you can also expect to have to readjust the attitude indicator in order to superimpose the minature aircraft on the horizon bar.

An attitude warning flag will appear on this indicator whenever electrical power to the system has failed or is interrupted. The instrument is unreliable whenever this "off flag" is visible.

33

EXERCISES

1. The airspeed indicated below is:



a. 350 knots

b. 230 knots

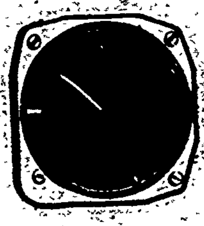
c. 250 mph

d. 330 knots

////////////////////////////////////

b.

2. What is the indication on the VVI below?



a. 5000 fpm climb

b. 500 fps descent

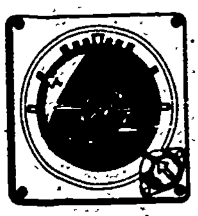
c. 500 fps climb

d. 500 fpm climb

////////////////////////////////////

d.

3. What is the indication on the MM-3 below?



a. 20 degree climb, 30 degree right bank

b. 10 degree dive, 60 degree left bank

c. 20 degree dive, 30 degree left bank

d. 20 degree dive, 60 degree right bank

////////////////////////////////////

d.

APPENDIX C: TEST FORMS AND SCORING EXCERPTS

TEST 3-1

INSTRUCTOR/SSAN__________ STUDENT/SSAN__________

DATE__________ TRAINER__________ PERIOD__________

Task 1: Reduce airspeed to 230 Kt;
Comm 4 - "Echo 03: Say indicated airspeed."

Score: Heading

~~360~~
360
360
360
360

Score: Comm 4

Correct 0
Incorrect 1
No Response 2

Task 2: Descend at 230K to 15,000

Score: Heading

~~360~~
~~360~~
360
360
360
360
360
360

Score: Power Setting

Correct 0
Incorrect 1

Task 3: Increase airspeed to 270 kt;
Comm 5 - "Echo 03: Traffic; 2 o'clock, 4 miles."

Score: Heading

~~360~~
360
360
360
360

Score: Comm 5

Correct 0
Incorrect 1
No Response 2

Task 4: Climb at 270 Kt to 16,000

Score: Heading

~~360~~
~~360~~
360
360
360
360
360
360
360

Score: Power Setting

Correct 0
Incorrect 1

35

TEST 3-1

OPERATOR/SSAN________________ STUDENT/SSAN ________________

DATE________________ TRAINER__________ PERIOD__________

Task 1: Reduce airspeed to 230 kt; Comm 4

Score: Airspeed	Score: Altitude
XXX	1600
XXX	1600
XXX	1600
XXXX	1600
230	1600
230	1600

Task 2: Descend at 230 Kts to 15,000

Score: Airspeed	Score: Altitude
230	XXXX
230	XXXX
230	XXXX
230	XXXX
230	XXXX
230	XXXX
230	1500
230	1500

Task 3: Increase airspeed to 270 kt; Comm 5

Score: Airspeed	Score: Altitude
XXX	1500
XXX	1500
XXX	1500
XXX	1500
270	1500
270	1500

Task 4: Climb at 270 kt to 16,000

Score: Airspeed	Score: Altitude
270	XXXX
270	XXXX
270	XXXX
270	XXXX
270	XXXX
270	1600
270	1600
270	1600
270	1600
270	1600

Go to instruction sheet.

TEST 15

INSTRUCTOR/SSAN______________ STUDENT/SSAN______________

DATE______________ TRAINER__________ PERIOD__________

Check trainer frozen at 16M, 360; 250K
Check UHF radio manual; relay taped commands.

4:45 Fly straight and level

5:00 Unfreeze trainer

7:45 Vertical S Alpha

Heading	Climb Rate
(313,731)	
360	1000
360	1000
360	1000
(3689, 2457, 522)	
360	1000
360	1000
360	1000
(212, 3469, 522, 212, 3479)	
360	1000
360	1000
360	1000
360	1000
360	1000
360	1000
(2347,421,2349,3458,832)	
360	1000
360	1000
360	1000

(212,2368,2679,731)

Heading	Climb Rate
360	1000
360	1000
360	1000
360	1000
360	1000
360	1000
360	1000

24:55 PROBLEM FREEZE

25:45 Fly straight and level

25:55 Unfreeze trainer

27:45 Vertical S Delta

Bank	Climb Rate
(111, 212, 421)	
30	1000
30	1000
30	1000
(2489, 2579, 3467)	
30	1000
30	1000
30	1000

TEST 15

OPERATOR/SSAN__________ STUDENT/SSAN__________

DATE__________ TRAINER__________ PERIOD__________

11:40 Check code box switch ON, press SET button.

Task

1. Switches (313)

   Errors______ Time______

2. Switches (731)

   Errors______ Time______

   INSTRUMENTS

   Airspeed

   250

   250

   250

3. Frequency (3689)

   Time______

4. Frequency (2457)

   Time______

5. Switches (522)

   Errors______ Time______

   Airspeed

   250

   250

   250

6. Switches (212)

   Errors______ Time______

7. Frequency (3469)

   Time______

8. Switches (522)

   Errors______ Time______

9. Switches (212)

   Errors______ Time______

10. Frequency (3479)

    Time______

    Airspeed

    250

    250

    250

    250

    250

    250

11. Frequency (2347)

    Time______

12. Switches (421)

    Errors______ Time______

13. Frequency (2349)

    Time______

APPENDIX D: T-37 PHASE SUMMARY DATA

TABLE D-1

VARIABLE NAME	INDEX	SAMPLE SIZE	MEAN	VARIANCE	STANDARD DEVIATION
M1	1	71	- 1.23	53.28	7.30
M2	2	71	- 0.47	4.90	2.21
M3	3	71	- 0.88	20.01	4.47
M4	4	71	- 1.37	45.56	6.75
M5	5	71	3.83	8.56	2.93
M6	6	71	- 0.34	8.29	2.88
M7	7	71	- 1.73	40.81	6.39
M8	8	71	1.74	1.69	1.30
M9	9	71	- 0.78	14.60	3.82
M10	10	71	- 0.37	4.93	2.22
M11	11	71	- 1.37	38.40	6.20
M12	12	71	- 0.58	8.40	2.90
M13	13	71	0.90	0.30	0.55
M14	14	71	- 0.63	9.95	3.15
M15	15	71	- 0.24	12.33	3.51
M16	16	71	- 0.02	3.08	1.76
M17	17	71	0.39	0.15	0.39
M18	18	71	0.20	0.04	0.20
M19	19	71	- 0.26	62.75	7.92
M20	20	71	- 0.56	63.08	7.94
M21	21	71	0.39	0.13	0.36
M22	22	71	0.12	0.69	0.83
M23	23	71	0.18	0.80	0.89
M24	24	71	0.18	0.84	0.92
M25	25	71	0.19	0.75	0.87
M26	26	71	0.03	0.95	0.97
M27	27	71	0.04	0.90	0.95
M28	28	71	0.07	0.94	0.97
M29	29	71	0.14	0.87	0.93
M30	30	71	0.15	0.85	0.92
AFOQT-1	31	71	70.07	436.97	20.90
AFOQT-2	32	71	56.97	703.86	26.53
AFOQT-3	33	71	43.25	495.34	22.26
AFOQT-4	34	71	44.15	421.12	20.52
AFOQT-5	35	71	59.79	622.84	24.96
FLS-1	36	71	83.34	11.24	3.35
FLS-2	37	71	87.77	26.58	5.16
FLS-3	38	71	36.61	2.06	1.44

TABLE D-2

	1	2	3	4	5	6	7	8
1	1.0000(71)							
2	0.3290(71)	1.0000(71)						
3	0.4406(71)	0.1124(71)	1.0000(71)					
4	0.5238(71)	0.2714(71)	0.6109(71)	1.0000(71)				
5	0.3214(71)	0.1998(71)	0.3509(71)	0.3202(71)	1.0000(71)			
6	0.3436(71)	0.2415(71)	0.3611(71)	0.4147(71)	0.3071(71)	1.0000(71)		
7	0.4833(71)	0.2563(71)	0.6187(71)	0.6035(71)	0.1203(71)	0.4072(71)	1.0000(71)	
8	0.4644(71)	0.1988(71)	0.1817(71)	0.3881(71)	0.1257(71)	0.1630(71)	0.3985(71)	1.0000(71)
9	0.5302(71)	0.3597(71)	0.4560(71)	0.4305(71)	0.3070(71)	0.4414(71)	0.4770(71)	0.3960(71)
10	0.4597(71)	0.2573(71)	0.2121(71)	0.3139(71)	0.1537(71)	0.3210(71)	0.4603(71)	0.4698(71)
11	0.4829(71)	0.3093(71)	0.4907(71)	0.3911(71)	0.2977(71)	0.4588(71)	0.4985(71)	0.2342(71)
12	0.4446(71)	0.3218(71)	0.3337(71)	0.3077(71)	0.3136(71)	0.3301(71)	0.3649(71)	0.3052(71)
13	0.3379(71)	0.2690(71)	0.4247(71)	0.2875(71)	0.1407(71)	0.3521(71)	0.3045(71)	0.0198(71)
14	0.4433(71)	0.4205(71)	0.3036(71)	0.2447(71)	0.0965(71)	0.3068(71)	0.3672(71)	0.2560(71)
15	0.3637(71)	0.1978(71)	0.4813(71)	0.4050(71)	0.1964(71)	0.2513(71)	0.4626(71)	0.1936(71)
16	0.1701(71)	0.2646(71)	0.1896(71)	0.3021(71)	0.1365(71)	0.1211(71)	0.1833(71)	0.1321(71)
17	0.2480(71)	0.2718(71)	0.2545(71)	0.4218(71)	0.1728(71)	0.2735(71)	0.3367(71)	0.2363(71)
18	0.0623(71)	0.1107(71)	0.1839(71)	0.3370(71)	0.1885(71)	0.1008(71)	0.1878(71)	0.1002(71)
19	-0.0195(71)	0.0751(71)	0.0907(71)	0.0716(71)	-0.0619(71)	-0.0236(71)	0.0927(71)	-0.0431(71)
20	0.0444(71)	0.1077(71)	0.1690(71)	0.2396(71)	0.1284(71)	0.2217(71)	0.0777(71)	-0.0672(71)
21	0.0846(71)	0.1375(71)	0.0940(71)	0.2839(71)	0.1298(71)	0.0968(71)	0.2250(71)	0.0285(71)
22	-0.2943(71)	-0.2196(71)	-0.1237(71)	-0.2018(71)	-0.0558(71)	-0.0703(71)	-0.0805(71)	-0.1421(71)
23	-0.1421(71)	-0.0913(71)	0.0014(71)	-0.0058(71)	0.0027(71)	-0.0401(71)	0.0563(71)	-0.0471(71)
24	-0.0570(71)	-0.0717(71)	0.1738(71)	-0.0820(71)	-0.1187(71)	0.0159(71)	0.1125(71)	-0.2751(71)
25	-0.3079(71)	-0.2615(71)	-0.3354(71)	-0.4605(71)	-0.3312(71)	-0.4051(71)	-0.4766(71)	-0.2694(71)
26	-0.2099(71)	-0.0241(71)	-0.1505(71)	-0.1871(71)	-0.1832(71)	-0.1310(71)	-0.1934(71)	-0.0636(71)
27	-0.0593(71)	-0.0336(71)	-0.0932(71)	-0.1582(71)	0.0650(71)	0.1276(71)	-0.2269(71)	-0.1291(71)
28	-0.0578(71)	0.0355(71)	-0.0580(71)	-0.2270(71)	-0.0839(71)	0.0614(71)	-0.1123(71)	-0.1031(71)
29	-0.2790(71)	-0.1019(71)	-0.1224(71)	-0.1871(71)	-0.0914(71)	-0.1342(71)	-0.3192(71)	-0.2959(71)
30	-0.3218(71)	-0.1976(71)	-0.0555(71)	-0.0801(71)	-0.1050(71)	-0.0277(71)	-0.1972(71)	-0.2163(71)
31	-0.2739(71)	0.0237(71)	-0.1238(71)	-0.2021(71)	-0.2251(71)	-0.1764(71)	-0.1708(71)	-0.3033(71)
32	-0.2964(71)	0.0017(71)	-0.1567(71)	-0.2728(71)	-0.2153(71)	-0.1076(71)	-0.1591(71)	-0.2513(71)
33	-0.2395(71)	-0.1033(71)	-0.0941(71)	-0.2042(71)	-0.1043(71)	-0.0584(71)	-0.0759(71)	[illegible]
34	-0.0096(71)	0.0374(71)	-0.0317(71)	-0.2176(71)	-0.1131(71)	-0.1233(71)	-0.1448(71)	-0.0910(71)
35	0.0115(71)	0.1582(71)	-0.0720(71)	-0.1248(71)	-0.1088(71)	-0.0365(71)	-0.1444(71)	-0.0474(71)
36	-0.3548(71)	-0.3715(71)	-0.3262(71)	-0.4355(71)	-0.0349(71)	-0.3013(71)	-0.5324(71)	-0.2328(71)
37	-0.2794(71)	-0.2997(71)	-0.4292(71)	-0.3446(71)	-0.0209(71)	-0.1659(71)	-0.4941(71)	-0.1967(71)
38	-0.5170(71)	-0.4139(71)	-0.4271(71)	-0.5194(71)	-0.0691(71)	-0.4731(71)	-0.6099(71)	-0.3436(71)

	9	10	11	12	13	14	15	16
9	1.0000(71)							
10	0.6797(71)	1.0000(71)						
11	0.4224(71)	0.3016(71)	1.0000(71)					
12	0.2823(71)	0.3219(71)	0.5266(71)	1.0000(71)				
13	0.2551(71)	0.2837(71)	0.3667(71)	0.3530(71)	1.0000(71)			
14	0.4625(71)	0.4247(71)	0.4340(71)	0.4368(71)	0.4858(71)	1.0000(71)		
15	0.3749(71)	0.3093(71)	0.4543(71)	0.5211(71)	0.4842(71)	0.4359(71)	1.0000(71)	
16	0.0149(71)	0.0608(71)	0.3178(71)	0.3499(71)	0.3608(71)	0.2327(71)	0.2952(71)	1.0000(71)
17	0.3846(71)	0.2543(71)	0.3684(71)	0.3329(71)	0.3215(71)	0.3172(71)	0.3098(71)	0.5400(71)
18	0.0430(71)	0.0322(71)	0.3356(71)	0.1721(71)	0.1905(71)	0.1908(71)	0.2511(71)	0.4915(71)
19	0.0743(71)	0.0117(71)	0.4095(71)	0.0394(71)	0.2459(71)	0.1366(71)	0.1990(71)	0.3420(71)

20	0.1782(71)	0.0386(71)	0.1839(71)	0.0427(71)	0.2990(71)	0.1803(71)	0.1877(71)	0.5192(71)
21	0.1153(71)	0.0549(71)	0.1760(71)	0.0785(71)	0.2056(71)	0.0315(71)	0.1234(71)	0.4667(71)
22	-0.2756(71)	-0.1225(71)	-0.0133(71)	-0.1113(71)	-0.1101(71)	-0.1023(71)	-0.0135(71)	-0.0987(71)
23	0.0219(71)	0.0299(71)	-0.0462(71)	0.1576(71)	0.0872(71)	-0.0279(71)	0.0947(71)	0.0786(71)
24	-0.0281(71)	-0.1299(71)	-0.0503(71)	-0.2033(71)	0.0948(71)	-0.0702(71)	0.0809(71)	-0.0995(71)
25	-0.3710(71)	-0.2845(71)	-0.4518(71)	-0.3196(71)	-0.2854(71)	-0.1959(71)	-0.3707(71)	-0.2960(71)
26	-0.1492(71)	-0.0956(71)	-0.1434(71)	-0.1754(71)	-0.0484(71)	0.0866(71)	-0.0860(71)	-0.1121(71)
27	-0.0413(71)	-0.1971(71)	0.0024(71)	-0.1640(71)	-0.0468(71)	-0.1370(71)	-0.0635(71)	-0.2183(71)
28	-0.1184(71)	-0.0958(71)	-0.1194(71)	-0.0689(71)	0.1841(71)	0.0185(71)	0.0190(71)	0.0306(71)
29	-0.3816(71)	-0.3736(71)	-0.4117(71)	-0.2437(71)	0.0308(71)	-0.2565(71)	-0.1407(71)	-0.0805(71)
30	-0.0071(71)	-0.1362(71)	-0.1237(71)	-0.2693(71)	-0.0323(71)	-0.0182(71)	-0.0177(71)	-0.2370(71)
31	-0.2048(71)	-0.1824(71)	-0.2279(71)	-0.1860(71)	-0.1058(71)	-0.0952(71)	-0.0644(71)	-0.1052(71)
32	-0.2583(71)	-0.1620(71)	-0.2137(71)	-0.2667(71)	-0.1519(71)	-0.1269(71)	-0.0930(71)	-0.2417(71)
33	-0.1339(71)	-0.1342(71)	-0.1569(71)	-0.3508(71)	-0.2452(71)	-0.0570(71)	-0.0184(71)	-0.2338(71)
34	-0.0982(71)	0.0269(71)	-0.1263(71)	-0.1027(71)	0.0675(71)	0.1100(71)	0.0366(71)	-0.2263(71)
35	0.0131(71)	0.0063(71)	0.0104(71)	-0.0401(71)	-0.0191(71)	0.1855(71)	0.0776(71)	0.0417(71)
36	-0.3462(71)	-0.2002(71)	-0.3481(71)	-0.2989(71)	-0.3244(71)	-0.2075(71)	-0.3635(71)	-0.2049(71)
37	-0.1375(71)	-0.1968(71)	-0.2518(71)	-0.3019(71)	-0.2808(71)	-0.2143(71)	-0.3541(71)	-0.1671(71)
38	-0.4583(71)	-0.3792(71)	-0.4345(71)	-0.4133(71)	-0.3627(71)	-0.3533(71)	-0.3726(71)	-0.2504(71)

	17	18	19	20	21	22	23	24
17	1.0000(71)							
18	0.5419(71)	1.0000(71)						
19	0.3889(71)	0.3620(71)	1.0000(71)					
20	0.6185(71)	0.3433(71)	0.6658(71)	1.0000(71)				
21	0.4992(71)	0.5027(71)	0.5875(71)	0.7058(71)	1.0000(71)			
22	-0.2269(71)	0.0931(71)	-0.1181(71)	-0.1591(71)	-0.0490(71)	1.0000(71)		
23	-0.0826(71)	0.0763(71)	-0.0024(71)	-0.1171(71)	0.0419(71)	0.0257(71)	1.0000(71)	
24	-0.0091(71)	-0.0353(71)	0.0389(71)	0.0278(71)	0.0778(71)	0.0108(71)	0.0976(71)	1.0000(71)
25	-0.2600(71)	-0.1758(71)	-0.1784(71)	-0.1399(71)	-0.1105(71)	0.2230(71)	-0.0782(71)	0.0467(71)
26	-0.0748(71)	0.1163(71)	-0.1329(71)	-0.0996(71)	-0.1055(71)	0.2414(71)	0.0410(71)	0.0937(71)
27	-0.0904(71)	-0.2433(71)	-0.2000(71)	-0.0664(71)	-0.1161(71)	0.0583(71)	-0.1114(71)	-0.0472(71)
28	0.0595(71)	-0.0485(71)	0.0107(71)	0.0398(71)	-0.1113(71)	-0.0896(71)	-0.0505(71)	0.0476(71)
29	0.0202(71)	-0.0880(71)	0.0530(71)	0.1127(71)	0.0200(71)	-0.0101(71)	-0.0886(71)	0.0091(71)
30	-0.1439(71)	-0.0688(71)	-0.0733(71)	-0.0924(71)	-0.1239(71)	0.0161(71)	0.0702(71)	0.2951(71)
31	-0.1990(71)	-0.1002(71)	0.0738(71)	0.0235(71)	-0.1168(71)	0.0497(71)	0.0032(71)	0.1291(71)
32	-0.2639(71)	-0.0630(71)	0.0143(71)	-0.0647(71)	-0.1823(71)	0.1465(71)	-0.0542(71)	0.2342(71)
33	-0.2750(71)	-0.0146(71)	-0.0193(71)	-0.0914(71)	-0.1847(71)	0.1224(71)	-0.0371(71)	0.1302(71)
34	-0.1252(71)	-0.1659(71)	-0.1962(71)	-0.1934(71)	-0.2782(71)	-0.0243(71)	-0.0134(71)	0.1346(71)
35	0.0520(71)	-0.0293(71)	0.0175(71)	0.0090(71)	-0.2118(71)	-0.1784(71)	-0.1130(71)	0.1663(71)
36	-0.2847(71)	-0.1102(71)	-0.1667(71)	-0.2311(71)	-0.3359(71)	0.1714(71)	-0.0303(71)	-0.0955(71)
37	-0.1147(71)	-0.0908(71)	0.0015(71)	0.0118(71)	-0.1161(71)	0.0253(71)	0.0121(71)	-0.0746(71)
38	-0.3461(71)	-0.1276(71)	-0.1736(71)	-0.2529(71)	-0.3187(71)	0.2417(71)	0.0482(71)	-0.0097(71)

	25	26	27	28	29	30	AFOQT-1 31	32
25	1.0000(71)							
26	0.3269(71)	1.0000(71)						
27	0.1430(71)	0.0325(71)	1.0000(71)					
28	0.0649(71)	-0.0051(71)	0.0931(71)	1.0000(71)				
29	0.2020(71)	0.2477(71)	0.3588(71)	0.1151(71)	1.0000(71)			
30	0.2249(71)	0.1820(71)	0.0708(71)	0.0028(71)	-0.0337(71)	1.0000(71)		
31	0.1637(71)	0.0639(71)	0.0339(71)	0.1039(71)	0.1872(71)	0.1675(71)	1.0000(71)	
32	0.0714(71)	0.1795(71)	0.0625(71)	0.1500(71)	0.1304(71)	0.1795(71)	0.6207(71)	1.0000(71)
33	0.1000(71)	0.3294(71)	0.0334(71)	0.0964(71)	0.0175(71)	0.2859(71)	0.3405(71)	0.6691(71)
34	0.2405(71)	0.1045(71)	0.1965(71)	0.1865(71)	0.1400(71)	0.1480(71)	0.3145(71)	0.1406(71)
35	0.1915(71)	0.2121(71)	0.1461(71)	0.0374(71)	0.0353(71)	0.1312(71)	0.4151(71)	0.3452(71)

36	0.3424(71)	0.2584(71)	0.1011(71)	0.0764(71)	0.3048(71)	0.0890(71)	0.1406(71)	0.0801(71)
37	0.2480(71)	0.1201(71)	0.1256(71)	0.1597(71)	0.1856(71)	0.1138(71)	-0.0628(71)	-0.0663(71)
38	0.4110(71)	0.2919(71)	0.0780(71)	0.0584(71)	0.3075(71)	0.1859(71)	0.1452(71)	0.0994(71)

	13	34	35	36	37	38
33	1.0000(71)					
34	0.1692(71)	1.0000(71)				
35	0.3935(71)	0.5999(71)	1.0000(71)			
36	0.0766(71)	0.0165(71)	-0.0168(71)	1.0000(71)		
37	-0.0047(71)	-0.1468(71)	-0.1496(71)	0.7097(71)	1.0000(71)	
38	0.1499(71)	0.0461(71)	-0.0109(71)	0.8870(71)	0.6978(71)	1.0000(71)

APPENDIX E: FORWARD SELECTION PREDICTION EQUATIONS FOR T-37 PHASE

TABLE E-1

NO	VB	MEAN	SIGMA	Z WEIGHT	RAW SCR WT	CRIT R	Z WT*CRIT R	
8	2	- 0.47	2.21	-0.20	-0.30	-0.37	0.07	M2
11	6	- 0.34	2.88	-0.13	-0.16	-0.37	0.05	M6
6	7	- 1.74	6.39	-0.31	-0.16	-0.53	0.17	M7
7	21	0.39	0.36	-0.27	-2.53	-0.34	0.09	M21
9	26	0.03	0.97	0.17	0.59	0.26	0.04	M26
10	29	0.14	0.93	0.14	0.51	0.30	0.04	M29
1	31	70.07	20.90	0.14	0.02	0.14	0.02	AFOQT-1
2	32	56.97	26.53	-0.11	-0.01	0.08	-0.01	AFOQT-2
3	33	43.25	22.26	-0.03	-0.00	0.08	-0.00	AFOQT-3
4	34	44.16	20.52	-0.15	-0.02	0.02	-0.00	AFOQT-4
5	35	59.79	24.96	-0.06	-0.01	-0.02	0.00	AFOQT-5

TABLE E-2

NO	VB	MEAN	SIGMA	Z WEIGHT	RAW SCR WT	CRIT R	Z WT*CRIT R	
9	2	- 0.47	2.21	-0.13	-0.31	-0.30	0.04	M2
7	3	- 0.88	4.47	-0.19	-0.22	-0.43	0.08	M3
6	7	- 1.74	6.39	-0.36	-0.29	-0.50	0.18	M7
10	16	- 0.03	1.76	-0.20	-0.60	-0.17	0.03	M16
11	19	- 0.26	7.92	0.14	0.09	0.00	0.00	M19
8	28	0.07	0.97	0.19	1.00	0.16	0.03	M28
1	31	70.07	20.90	-0.01	-0.00	-0.06	0.00	AFOQT-1
2	32	56.97	26.53	-0.22	-0.04	-0.07	0.01	AFOQT-2
3	33	43.25	22.26	0.05	0.01	-0.00	-0.00	AFOQT-3
4	34	44.16	20.52	-0.22	-0.05	-0.15	0.03	AFOQT-4
5	35	59.79	24.96	-0.00	-0.00	-0.15	0.00	AFOQT-5

TABLE E-3

NO	VB	MEAN	SIGMA	Z WEIGHT	RAW SCR WT	CRIT R	Z WT*.CRIT R	
9	1	-1.23	7.30	-0.17	-0.03	-0.52	0.09	M1
11	2	-0.47	2.21	-0.15	-0.10	-0.41	0.06	M2
7	6	-0.34	2.88	-0.20	-0.10	-0.47	0.10	M6
6	7	-1.74	6.39	-0.33	-0.07	-0.61	0.20	M7
8	21	0.39	0.36	-0.22	-0.89	-0.32	0.07	M21
10	26	0.03	0.97	0.15	0.22	0.29	0.04	M26
12	29	0.14	0.93	0.10	0.15	0.31	0.03	M29
1	31	70.07	20.90	0.10	0.01	0.15	0.01	AFOQT-1
2	32	56.97	26.53	-0.18	-0.01	0.10	-0.02	AFOQT-2
3	33	43.25	22.26	0.09	0.01	0.15	0.01	AFOQT-3
4	34	44.16	20.52	-0.08	-0.01	0.05	-0.00	AFOQT-4
5	35	59.79	24.96	-0.09	-0.00	-0.01	0.00	AFUQT-5

TABLE E-4

NO	VB	MEAN	SIGMA	Z WEIGHT	RAW SCR WT	CRIT R	Z WT*CRIT R	
2	2	-0.47	2.21	-0.19	-0.28	-0.37	0.07	M2
5	6	-0.34	2.88	-0.14	-0.16	-0.37	0.05	M6
1	7	-1.74	6.39	-0.32	-0.17	-0.53	0.17	M7
3	21	0.39	0.36	-0.24	-2.23	-0.34	0.08	M21
6	26	0.03	0.97	0.14	0.48	0.26	0.04	M26
4	29	0.14	0.93	0.14	0.50	-0.30	0.04	M29
7	35	59.79	24.96	-0.12	-0.02	-0.02	0.00	AFOQT-5

TABLE E-5

NO	VB	MEAN	SIGMA	Z WEIGHT	RAW SCR WT	CRIT R	Z WT*CRIT R	
4	2	-0.47	2.21	-0.14	-0.33	-0.30	0.04	M2
3	3	-0.88	4.47	-0.19	-0.22	-0.43	0.08	M3
1	7	-1.74	6.39	-0.35	-0.28	-0.50	0.17	M7
8	16	-0.03	1.76	-0.21	-0.62	-0.17	0.04	M16
9	19	-0.26	7.92	0.14	0.09	0.00	0.00	M19
5	28	0.07	0.97	0.19	1.01	0.16	0.03	M28
7	32	56.97	26.53	-0.20	-0.04	-0.07	0.01	AFOQT-2
6	34	44.16	20.52	-0.23	-0.06	-0.15	0.03	AFOQT-4
2	35	59.79	24.96	0.02	0.00	-0.15	-0.00	AFOQT-5

TABLE E-6

NO	VB	MEAN	SIGMA	Z WEIGHT	RAW SCR WT	CRIT R	Z WT*CRIT R	
6	1	- 1.23	7.30	-0.18	-0.03	-0.52	0.09	M1
2	2	- 0.47	2.21	-0.17	-0.11	-0.41	0.07	M2
3	6	- 0.34	2.8[illegible]	-0.20	-0.10	-0.47	0.09	M6
1	7	- 1.74	[illegible].39	-0.34	-0.08	-0.61	0.21	M7
5	21	0.39	0.36	-0.19	-0.80	-0.32	0.06	M21
4	26	0.03	0.97	0.16	0.24	0.29	0.05	M26
7	35	59.79	24.96	-0.11	-0.01	-0.01	0.00	AFOQT-5

APPENDIX F: PASS-FAIL SUMMARY DATA

TABLE F-1

VARIABLE NAME	INDEX	SAMPLE SIZE	MEAN	VARIANCE	STANDARD DEVIATION
M1	1	128	- 0.00	71.15	8.44
M2	2	128	0.00	7.90	2.81
M3	3	128	- 0.00	23.71	4.87
M4	4	128	0.00	51.93	7.21
M5	5	128	4.18	8.03	2.83
M6	6	128	- 0.00	12.50	3.53
M7	7	128	0.00	62.56	7.91
M8	8	128	2.01	2.07	1.44
M9	9	128	- 0.00	17.94	4.24
M10	10	128	- 0.00	6.51	2.55
M11	11	128	- 0.00	42.81	6.54
M12	12	128	0.00	10.82	3.29
M13	13	128	0.93	0.38	0.61
M14	14	128	- 0.00	17.66	4.20
M15	15	128	0.00	16.22	4.03
M16	16	128	- 0.00	2.90	1.70
M17	17	128	0.41	0.15	0.38
M18	18	128	0.21	0.04	0.21
M19	19	128	0.00	55.71	7.46
M20	20	128	- 0.00	68.09	8.25
M21	21	128	0.43	0.12	0.35
M22	22	128	0.02	0.97	0.99
M23	23	128	0.01	1.00	1.00
M24	24	128	0.01	1.00	1.00
M25	25	128	0.01	1.00	1.00
M26	26	128	- 0.00	1.00	1.00
M27	27	128	- 0.00	1.00	1.00
M28	28	128	0.01	1.00	1.00
M29	29	128	0.01	1.00	1.00
M30	30	128	0.01	1.00	1.00
AFOQT-1	31	128	66.91	473.88	21.77
AFOQT-2	32	128	54.73	673.17	25.95
AFOQT-3	33	128	44.72	537.37	23.18
AFOQT-4	34	128	47.38	374.99	19.36
AFOQT-5	35	128	61.64	550.43	23.46
PASS-FAIL	36	128	0.55	0.25	0.50

TABLE F-2

	1	2	3	4	5	6	7	8
1	1.0000(128)							
2	0.4144(128)	1.0000(128)						
3	0.5559(128)	0.2404(128)	1.0000(128)					
4	0.5939(128)	0.4287(128)	0.6003(128)	1.0000(128)				
5	0.3384(128)	0.2299(128)	0.3826(128)	0.3428(128)	1.0000(128)			
6	0.3448(128)	0.3311(128)	0.3815(128)	0.4239(128)	0.2743(128)	1.0000(128)		
7	0.6043(128)	0.4461(128)	0.6322(128)	0.6199(128)	0.2598(128)	0.5058(128)	1.0000(128)	
8	0.4226(128)	0.2461(128)	0.2184(128)	0.3797(128)	0.1482(128)	0.0512(128)	0.3676(128)	1.0000(128)
9	0.5770(128)	0.3315(128)	0.5762(128)	0.4777(128)	0.3222(128)	0.4438(128)	0.5579(128)	0.2699(128)
10	0.4905(128)	0.3483(128)	0.2778(128)	0.3837(128)	0.1228(128)	0.2969(128)	0.5632(128)	0.4594(128)
11	0.4853(128)	0.3044(128)	0.5334(128)	0.4287(128)	0.2748(128)	0.4046(128)	0.5651(128)	0.3752(128)
12	0.4696(128)	0.4235(128)	0.3949(128)	0.4469(128)	0.2974(128)	0.2795(128)	0.5041(128)	0.3143(128)
13	0.4392(128)	0.3677(128)	0.4450(128)	0.4667(128)	0.1606(128)	0.4303(128)	0.4867(128)	0.1505(128)
14	0.5565(128)	0.4301(128)	0.3811(128)	0.3764(128)	0.1626(128)	0.1676(128)	0.4591(128)	0.3393(128)
15	0.5490(128)	0.3724(128)	0.5098(128)	0.4665(128)	0.2416(128)	0.3099(128)	0.5364(128)	0.2626(128)
16	0.1678(128)	0.2661(128)	0.1406(128)	0.1814(128)	0.1145(128)	0.1070(128)	0.1957(128)	0.0925(128)
17	0.1592(128)	0.2793(128)	0.1489(128)	0.2796(128)	0.0946(128)	0.2225(128)	0.2414(128)	0.1693(128)
18	0.2092(128)	0.1535(128)	0.2293(128)	0.2938(128)	0.1658(128)	0.1301(128)	0.2971(128)	0.1618(128)
19	0.1012(128)	0.1441(128)	0.0869(128)	0.0792(128)	0.0009(128)	-0.0201(128)	0.0964(128)	0.0563(128)
20	0.1765(128)	0.2120(128)	0.1198(128)	0.2229(128)	0.0538(128)	0.1524(128)	0.1130(128)	0.0724(128)
21	0.2104(128)	0.2000(128)	0.1474(128)	0.2769(128)	0.0767(128)	0.0852(128)	0.2292(128)	0.0737(128)
22	-0.4549(128)	-0.2999(128)	-0.3143(128)	-0.2808(128)	-0.2210(128)	-0.1565(128)	-0.2999(128)	-0.2478(128)
23	-0.3263(128)	-0.3013(128)	-0.2420(128)	-0.3315(128)	-0.1337(128)	-0.2281(128)	-0.2756(128)	-0.1833(128)
24	-0.1924(128)	-0.1869(128)	-0.0806(128)	-0.2096(128)	-0.1081(128)	-0.0638(128)	-0.1470(128)	-0.3639(128)
25	-0.3722(128)	-0.3574(128)	-0.3412(128)	-0.4150(128)	-0.2989(128)	-0.2917(128)	-0.4788(128)	-0.3900(128)
26	-0.2455(128)	-0.2036(128)	-0.2064(128)	-0.2311(128)	-0.2661(128)	-0.1820(128)	-0.2309(128)	-0.1432(128)
27	-0.1319(128)	-0.0428(128)	-0.0726(128)	-0.0802(128)	0.0573(128)	-0.0716(128)	-0.1876(128)	-0.1975(128)
28	-0.0582(128)	-0.1199(128)	-0.0687(128)	-0.2206(128)	-0.0697(128)	-0.0621(128)	-0.0965(128)	-0.0351(128)
29	-0.2889(128)	-0.0332(128)	[illegible](128)	-0.1115(128)	-0.1613(128)	-0.1525(128)	-0.2719(128)	-0.3149(128)
30	-0.3255(128)	-0.3101([illegible])	-0.2696(128)	-0.2046(128)	-0.0890(128)	-0.1817(128)	-0.2969(128)	-0.1882(128)
31	-0.3330(128)	-0.1356([illegible])	-0.2181(128)	-0.2369(128)	-0.1620(128)	-0.1321(128)	-0.2128(128)	-0.2842(128)
32	-0.2842(128)	-0.1145(128)	-0.6015(128)	-0.2379(128)	-0.1527(128)	-0.1766(128)	-0.2681(128)	-0.1699(128)
33	-0.1476(128)	-0.1857(128)	-0.1273(128)	-0.095 (128)	-0.1588(128)	-0.1311(128)	-0.1694(128)	-0.0517(128)
34	-0.0830(128)	0.0082(128)	-0.1225(128)	-0.17[illegible](128)	-0.0492(128)	-0.0418(128)	-0.1227(128)	-0.0530(128)
35	-0.0142(128)	0.0866(128)	-0.1363(128)	-0.0457(128)	-0.0695(128)	-0.0185(128)	-0.1299(128)	-0.0637(128)
36	-0.1621(128)	-0.1867(128)	-0.2010(128)	-0.2124(128)	-0.1373(128)	-0.1084(128)	-0.2448(128)	-0.2119(128)

	9	10	11	12	13	14	15	16
9	1.0000(128)							
10	0.5709(128)	1.0000(128)						
11	0.4664(128)	0.4471(128)	1.0000(128)					
12	0.4519(128)	0.4028(128)	0.4845(128)	1.0000(128)				
13	0.4506(128)	0.4221(128)	0.4242(128)	0.4931(128)	1.0000(128)			
14	0.3956(128)	0.4074(128)	0.4423(128)	0.5104(128)	0.4618(128)	1.0000(128)		
15	0.5032(128)	0.4974(128)	0.5061(128)	0.5108(128)	0.5121(128)	0.5994(128)	1.0000(128)	
16	0.1362(128)	0.0886(128)	0.1611(128)	0.2683(128)	0.3304(128)	0.2056(128)	0.2979(128)	1.0000(128)
17	0.3365(128)	0.2110(128)	0.2791(128)	0.3088(128)	0.2673(128)	0.2439(128)	0.3748(128)	0.5068(128)
18	0.2310(128)	0.1846(128)	0.3331(128)	0.2353(128)	0.2411(128)	0.3348(128)	0.3769(128)	0.4071(128)
19	0.1588(128)	0.1505(128)	0.0957(128)	0.0858(128)	0.2453(128)	0.2532(128)	0.2882(128)	0.5687(128)
20	0.2373(128)	0.1595(128)	0.1364(128)	0.1929(128)	0.3027(128)	0.3282(128)	0.2725(128)	0.5014(128)
21	0.2750(128)	0.1934(128)	0.2205(128)	0.2469(128)	0.2508(128)	0.2532(128)	0.3080(128)	0.4341(128)

22	-0.3560(128)	-0.2362(128)	-0.1725(128)	-0.2161(128)	-0.2014(128)	-0.3379(128)	-0.2704(128)	-0.1410(128)
23	-0.2361(128)	-0.1763(128)	-0.1880(128)	-0.1137(128)	-0.1630(128)	-0.2235(128)	-0.2511(128)	-0.0466(128)
24	-0.1488(128)	-0.2399(128)	-0.1978(128)	-0.2391(128)	-0.0954(128)	-0.2650(128)	-0.1581(128)	-0.1734(128)
25	-0.3332(128)	-0.3696(128)	-0.3888(128)	-0.2977(128)	-0.3175(128)	-0.2726(128)	-0.3510(128)	-0.2424(128)
26	-0.2227(128)	-0.2046(128)	-0.1269(128)	-0.2459(128)	-0.1391(128)	-0.0972(128)	-0.2170(128)	-0.1078(128)
27	-0.0822(128)	-0.2696(128)	-0.0490(128)	-0.0114(128)	-0.0483(128)	-0.1713(128)	-0.1137(128)	-0.1581(128)
28	-0.1001(128)	-0.1153(128)	-0.1077(128)	-0.0748(128)	-0.0391(128)	-0.1063(128)	-0.0848(128)	-0.0485(128)
29	-0.3662(128)	-0.3294(128)	-0.3217(128)	-0.1365(128)	-0.1006(128)	-0.2092(128)	-0.1401(128)	-0.0843(128)
30	-0.1797(128)	-0.2167(128)	-0.1754(128)	-0.2831(128)	-0.0974(128)	-0.2028(128)	-0.1803(128)	-0.2259(128)
31	-0.1951(128)	-0.2073(128)	-0.2278(128)	-0.2213(128)	-0.1085(128)	-0.1222(128)	-0.1272(128)	-0.0432(128)
32	-0.2309(128)	-0.2453(128)	-0.1927(128)	-0.2369(128)	-0.1332(128)	-0.1060(128)	-0.1203(128)	-0.1015(128)
33	-0.0863(128)	-0.1723(128)	-0.1620(128)	-0.1922(128)	-0.1416(128)	0.0080(128)	-0.0363(128)	-0.1270(128)
34	-0.0587(128)	-0.0512(128)	-0.1728(128)	-0.0540(128)	0.0061(128)	-0.0578(128)	-0.0879(128)	-0.1306(128)
35	0.0208(128)	-0.0363(128)	-0.0420(128)	-0.0252(128)	0.0683(128)	0.0789(128)	0.0263(128)	0.0525(128)
36	-0.2044(128)	-0.1597(128)	-0.2344(128)	-0.1951(128)	-0.0639(128)	-0.1681(128)	-0.0605(128)	-0.0160(128)

	17	18	19	20	21	22	23	24
17	1.0000(128)							
18	0.5255(128)	1.0000(128)						
19	0.3515(128)	0.3431(128)	1.0000(128)					
20	0.5306(128)	0.3441(128)	0.6798(128)	1.0000(128)				
21	0.5080(128)	0.5097(128)	0.6031(128)	0.7107(128)	1.0000(128)			
22	-0.1974(128)	-0.0930(128)	-0.2540(128)	-0.2908(128)	-0.1780(128)	1.0000(128)		
23	-0.1983(128)	-0.1550(128)	-0.0460(128)	-0.1100(128)	-0.1163(128)	0.1898(128)	1.0000(128)	
24	-0.1393(128)	-0.1676(128)	-0.1442(128)	-0.1460(128)	-0.1527(128)	0.2686(128)	0.1772(128)	1.0000(128)
25	-0.1648(128)	-0.2204(128)	-0.2142(128)	-0.1818(128)	-0.1887(128)	0.3640(128)	0.1788(128)	0.2154(128)
26	-0.1627(128)	-0.0521(128)	-0.1783(128)	-0.1750(128)	-0.1696(128)	0.3556(128)	0.2430(128)	0.2156(128)
27	-0.1091(128)	-0.1006(128)	-0.2139(128)	-0.1687(128)	-0.0745(128)	0.2831(128)	0.0531(128)	0.0828(128)
28	-0.0306(128)	-0.0907(128)	-0.1235(128)	-0.1345(128)	-0.1686(128)	0.0935(128)	0.0526(128)	0.0897(128)
29	-0.0560(128)	-0.0788(128)	-0.0818(128)	-0.0419(128)	-0.0238(128)	0.2228(128)	0.0709(128)	0.1322(128)
30	-0.1437(128)	-0.1349(128)	-0.1142(128)	-0.2180(128)	-0.2322(128)	0.1887(128)	0.2521(128)	0.3451(128)
31	-0.0470(128)	0.0611(128)	0.0894(128)	0.0385(128)	-0.0020(128)	0.1241(128)	0.1495(128)	0.1106(128)
32	-0.0818(128)	-0.0220(128)	0.1087(128)	0.0659(128)	-0.0030(128)	0.0459(128)	0.1193(128)	0.1570(128)
33	-0.0987(128)	-0.0394(128)	0.0667(128)	0.0561(128)	-0.0518(128)	0.0028(128)	0.0368(128)	0.0623(128)
34	-0.0716(128)	-0.1986(128)	-0.1402(128)	-0.1275(128)	-0.1744(128)	0.0031(128)	0.0830(128)	0.0885(128)
35	0.1064(128)	0.0015(128)	0.0399(128)	0.0605(128)	-0.0791(128)	-0.1103(128)	-0.0182(128)	0.0899(128)
36	-0.0638(128)	-0.0302(128)	-0.0385(128)	-0.0752(128)	-0.1323(128)	0.1061(128)	0.1799(128)	0.1886(128)

	25	26	27	28	29	30	31	32
25	1.0000(128)							
26	0.4258(128)	1.0000(128)						
27	0.2303(128)	0.1554(128)	1.0000(128)					
28	0.1388(128)	0.0904(128)	0.2226(128)	1.0000(128)				
29	0.2359(128)	0.2507(128)	0.4022(128)	0.0707(128)	1.0000(128)			
30	0.3045(128)	0.3021(128)	0.1430(128)	0.8415(128)	0.0329(128)	1.0000(128)		
31	0.1759(128)	0.1267(128)	0.0015(128)	-0.0417(128)	0.1446(128)	0.2907(128)	1.0000(128)	
32	0.1732(128)	0.1897(128)	0.0374(128)	0.0067(128)	0.0987(128)	0.3159(128)	0.0331(128)	1.0000(128)
33	0.1636(128)	0.2610(128)	-0.0904(128)	-0.0587(128)	0.0187(128)	0.3419(128)	0.2847(128)	0.0593(128)
34	0.2046(128)	0.1054(128)	0.0573(128)	-0.0044(128)	0.1249(128)	0.1657(128)	0.2116(128)	0.2326(128)
35	0.1637(128)	0.1177(128)	0.0062(128)	-0.1473(128)	0.0499(128)	0.2743(128)	0.3935(128)	0.4236(128)
36	0.1679(128)	0.0364(128)	0.0226(128)	0.0755(128)	0.1461(128)	0.1477(128)	0.1618(128)	0.0966(128)

	33	34	35	36
33	1.0000(128)			
34	0.2318(128)	1.0000(128)		

35	0.5029(128)	0.5868(128)	1.0000(128)	
36	-0.0705(128)	-0.1860(128)	-0.0881(128)	1.0000(128)

APPENDIX G: FORWARD SELECTION PREDICTION EQUATIONS FOR PASS-FAIL

TABLE G-1

NO	VB	MEAN	SIGMA	Z WEIGHT	RAW SCR WT	CRIT R	Z WT*CRIT R	
1	7	0.00	7.91	-0.12	-0.01	-0.24	0.03	M7
5	11	0.00	6.54	-0.13	-0.01	-0.23	0.03	M11
7	21	0.43	0.35	-0.10	-0.14	-0.13	0.01	M21
8	23	0.01	1.00	0.09	0.04	0.18	0.02	M23
3	24	0.01	1.00	0.13	0.06	0.19	0.02	M24
4	31	66.91	21.77	0.17	0.00	0.16	0.03	AFOQT-1
6	33	44.72	23.18	-0.11	-0.00	-0.07	0.01	AFOQT-3
2	34	47.38	19.37	-0.27	-0.01	-0.19	0.05	AFOQT-4

TABLE G-2

NO	VB	MEAN	SIGMA	Z WEIGHT	RAW SCR WT	CRIT R	Z WT*CRIT R	
6	11	0.00	6.54	-0.20	-0.02	-0.23	0.05	M11
8	21	0.43	0.35	-0.10	-0.15	-0.13	0.01	M21
9	23	0.01	1.00	0.10	0.05	0.18	0.02	M23
10	24	0.01	1.00	0.09	0.05	0.19	0.02	M24
7	30	0.01	1.00	0.07	0.03	0.15	0.01	M30
1	31	66.91	21.77	0.08	0.00	0.16	0.01	AFOQT-1
2	32	54.73	25.95	0.15	0.00	0.10	0.01	AFOQT-2
3	33	44.72	23.18	-0.23	0.00	-0.07	0.02	AFOQT-3
4	34	47.38	19.37	-0.31	0.01	-0.19	0.06	AFOQT-4
5	35	61.64	23.46	0.07	0.00	-0.09	-0.01	AFOQT-5

APPENDIX H: PROPOSED T-40 SCREENING PROGRAM GUIDE

Sortie #1

Instructional Task	Task Time	Elapsed Time
1. Strap In	5:00	2:00
2. Yoke	2:00	7:00
3. Attitude Indicator	4:00	11:00
4. Trim	4:00	15:00
5. Straight & Level	10:00	25:00
6. Straight & Level (Test)	2:00	27:00
7. Throttles	5:00	32:00
8. Pitch Bank Power	11:00	43:00
9. Straight & Level (Test)	2:00	45:00

Sortie #2

Instructional Task	Task Time	Elapsed Time
1. Strap-In	2:00	2:00
2. Straight & Level	10:00	12:00
3. Straight & Level (Test)	2:00	14:00
4. Climbs Descents	3:00	17:00
5. CAS Climb Descents	10:00	27:00
6. Pitch Climb Descent (Test)	2:00	29:00
7. Level Off	9:00	38:00
8. Straight & Level (Test)	2:00	40:00
Pitch Climb Descent (Test)	2:00	42:00
9. Straight & Level	1:00	43:00
10. CAS Climb, Level Off (Test)	2:00	45:00

Sortie #3

Instructional Task	Task Time	Elapsed Time
1. Strap In	2:00	2:00
2. Straight & Level	3:00	5:00
3. A/S Changes	5:00	10:00
4. Straight & Level (Test)	2:00	12:00
A/S Increase (Test)	2:00	14:00
5. A/S Changes	5:00	19:00
6. A/S Decrease (Test)	2:00	21:00
7. Normal Turn	5:00	26:00
8. Turn to Heading	10:00	36:00
9. Turn to Heading (Test)	2:00	38:00
Turn to Heading (Test)	2:00	40:00
10. CAS Climb/Descent	2:00	42:00
11. CAS Climb Level Off (Test)	2:00	44:00
CAS Descent Level Off (Test)	1:00	45:00

Sortie #4

Instructional Time	Task Time	Elapsed Time
1. Strap In	2:00	2:00
2. Straight & Level	2:00	4:00
3. Change A/S	3:00	7:00
4. Straight & Level (Test)	2:00	9:00
Airspeed Decrease (Test)	2:00	11:00
5. Turn to Heading	5:00	16:00
6. A/S Change in Turn	5:00	21:00
7. Turn to Heading (Test)	2:00	23:00
8. Climbing/Descending Turns	5:00	28:00
9. CAS Climb Level Off (Test)	2:00	31:00
Complex Turn (Test)	2:00	33:00
10. Rate Climb/Descent	8:00	41:00
11. Rate Climb/Descent (Test)	2:00	43:00
Complex Turn (Test)	2:00	45:00

Sortie #5

Note: Pre-flight briefing should include practice on light task

Instructional Task		Task Time	Elapsed Time
1.	Strap In	2:00	2:00
2.	Straight & Level	2:00	4:00
3.	Airspeed Changes	5:00	9:00
4.	A/S Decrease (Test)	2:00	11:00
5.	Rate Climb, Descent	5:00	16:00
6.	Rate Climb, Descent (Test)	3:00	19:00
7.	Complex Turns	5:00	24:00
8.	Complex Turn (Test)	2:00	28:00
	Complex Turn (Test)	2:00	32:00
9.	Straight & Level	3:00	35:00
10.	Light Tasks: Straight & Level	4:00	39:00
	Turns	3:00	42:00
	Cas Climb	3:00	45:00