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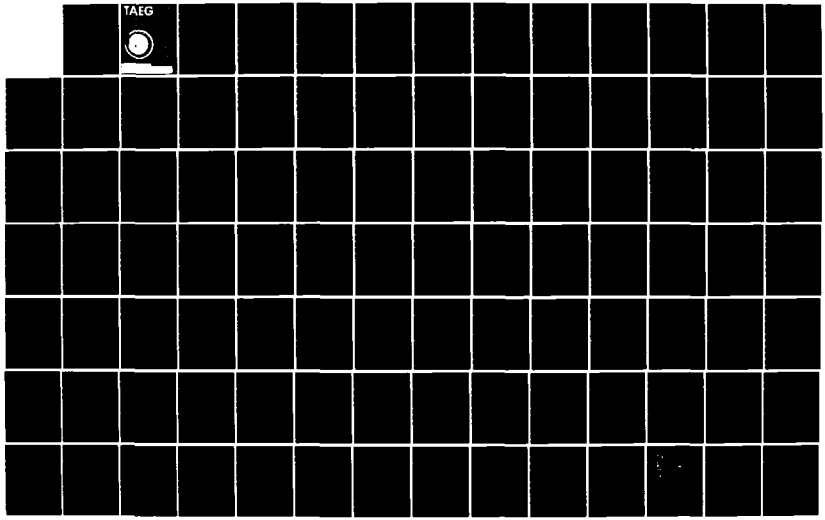

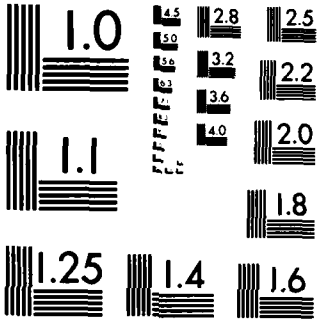

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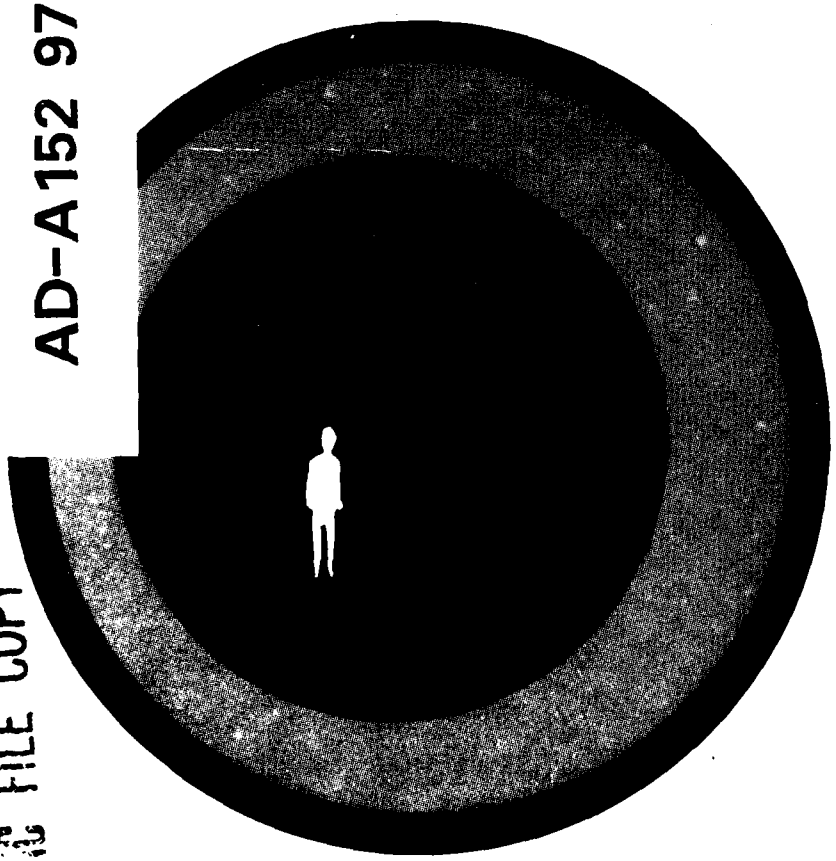

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13. ABSTRACT

The Phase I effort of a two phase study of Navy undergraduate pilot training is presented in this report. It contains:

1) Methodology used to identify pilot training requirements of the post 1975 period.

2) Results of a commonality analysis used to identify general skills required of all pilots and specific skills required by one or more aircraft communities.

3) System designs for a long-term pilot training system and alternative.

4) Economic analysis of long range pilot training system and alternatives.

The first of two long-term training system models presented describes an optimized system design featuring an advanced state-of-the-art pilot selection technique. Synthetic trainers are employed for predicting general flying abilities and predicting future attrites.

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Robert F. Browning
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We are also indebted to a number of our Training Analysis and Evaluation Group (TAEG) co-workers including: Dr. W. M. Swope, who developed the economic model and provided consulting services for the economic analyses; Mr. W. F. Parrish, who wrote the computer programs for the economic and commonality analyses and directed the data processing of the large amount of data; and Mr. J. M. Henry, who assisted in performing the commonality and economic analyses.

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SECTION I

INTRODUCTION

A number of factors have brought about a need for change in the Navy Undergraduate Pilot Training (UPT) Program. Among these are:

- the need to replace obsolete training aircraft,
- the promise of improved training through exploitation of the significant advances in simulation and training technology,
- the demand for more cost-effective training coupled with collateral demands for conserving energy and the environment which has created pressures for seeking alternative solutions to in-flight training, and
- the introduction and planned introduction of new aircraft into the operational inventory with the attendant requirement for an updated UPT program to sustain responsiveness to Fleet needs.

BACKGROUND

The impetus for this study was the recognition by the staffs of the Chief of Naval Education and Training (CNET) and the Chief of Naval Air Training (CNATRA) of a need to develop a cost-effective system for meeting the pilot training requirements of the post-1975 period. The Training Analysis and Evaluation Group (TAEG) was subsequently tasked by CNET to determine future UPT requirements and to develop alternative system designs to meet these requirements. The tasking letter directed that the study be conducted in two phases and that the systems approach to training system design be employed. No constraints were to be imposed by present or planned training support (i.e., aircraft or synthetic trainers).

PURPOSE

The purpose of this study is to identify Navy UPT requirements for the post-1975 period and to seek an optimum design for a training system to meet these requirements. The study is being performed in two phases. This report presents the results of the Phase I effort which was concerned with an analysis of the current system, identification of future training requirements, and the preliminary design of future training system models. The Phase II effort will be concerned with translating the outputs of Phase I into a detailed system design. The scope of the second phase will be determined by the management decisions concerning recommended system designs.

APPROACH

A project team was organized within TAEG to accomplish the study. The permanent and adjunct members of the study team have extensive experience relevant to pilot training and training system design. One is an education specialist, experienced in training system design, a licensed pilot and former Naval Aviator with extensive flight experience, including carrier aviation. A second member, also a licensed pilot with degrees in psychology, management, and engineering, has experience as a human factors engineer in the aircraft industry. The third permanent member has considerable engineering experience in flight simulation, both in industry and government, plus experience in task and training analysis. The adjunct members bring experience in economics, engineering, computer systems, aviation psychology, and education.

In accomplishing the study, maximum use has been made of the findings of the training technology (research) literature and the experiences of other UPT organizations. The data from the various studies and the results of research in training technology have been applied where applicable.

Methodology Used to Identify Pilot Training Requirements. Identification of the UPT requirements for the post-1975 period involved: (1) study of current and projected operational requirements; (2) analysis of the CNATRA UPT Task Inventory;[1] (3) examination of the current undergraduate syllabi, Naval Air Training and Operating Procedures (NATOPS) Manuals, on-site observations (including participation in training flights); and (4) mission and commonality analysis. Operational skill requirements were obtained from the CNATRA UPT Task Inventory and through visits to Navy and Marine Corps replacement training squadrons and to the Coast Guard Aviation Training Facility at Mobile, Alabama.[2] Visits were also made to Headquarters, Marine Corps and appropriate codes in the Bureau of Naval Personnel and Chief of Naval Operations.[3] Data concerning the numbers and types of pilots required and the aircraft expected to be in the operational aircraft inventory for the period under study were furnished to the study team.

The CNATRA Task Inventory task statements were arranged by the pilot role, duty, and task. These had to be rearranged into a systematic and chronological order to facilitate mission and commonality analyses and to

---

[1] The inventory was administered to replacement training squadron instructors and squadrons receiving recent UPT graduates to determine and validate undergraduate training requirements.

[2] The Coast Guard program represents a vigorous application of the "systems approach" to training system design and full acceptance of synthetic training as a viable substitute for in-flight training.

[3] The principal activities visited during the course of this study are listed in appendix A of this report.

cilitate the detailed task analysis to be accomplished in Phase II. 'ter identification of operational skill requirements by community, each ill was examined to determine if it should be included in UPT.

A commonality analysis was performed on all task statements directly ·lated to flight using the classic stimulus-response paradigm. The task ıs analyzed to determine if the cues, mediation processes and responses ·re similar between aircraft communities (jet to helo, helo to multi-ıgine, and jet to multi-engine). The results of this analysis were inputs ı the system design.

/stem Design. System models reflecting the design of a UPT system ·sponsive to long-term needs were developed. These system models or plans ·re developed on the basis of identified training requirements, mission ıalysis, commonality analysis, and economic analyses.

HASE II. The follow-on Phase II effort is envisaged to be concerned with ·velopment of a detailed training system design and expected to include ıe following activities:

- Training requirements will be subjected to a detailed maneuver/task analysis to determine the exact piloting skills required to satisfy the identified and approved training requirements.

- The "optimum" sequencing of instruction for developing the required skills and knowledges will be specified.

- Terminal training objectives required for the development of a program of instruction for the academic, flight support, synthetic, and in-flight phases of UPT, together with specified proficiency levels, can then be completed.

- An analysis will be made to determine the media appropriate for training the required skills and knowledges (the classes of devices, specific characteristics, and the numbers required will be determined).

- System simulation will be used as an analytical tool to enable a detailed examination, evaluation, and manipulation under stated conditions of the specified training system. The model objectives will be to:

  1. simulate the flow of students through the system using various training media,

  2. project system output based on student input characteristics and expected performance, and

SECTION III

TRAINING REQUIREMENTS FOR FUTURE UNDERGRADUATE PILOT TRAINING

A major part of this study effort was concerned with identifying the training requirements for UPT in the post-1975 period. For purposes of this study, a "Training Requirement" is operationally defined as a required pilot skill or knowledge without specifying a performance standard. A training requirement may be a single task such as "retract flaps" or a group of related tasks such as "mission preparation."

The training requirements were derived in the following manner. A working assumption was that future UPT should be maximally responsive to the needs of operational flying. Thus, the roles and missions of the operational units and types of aircraft were examined to determine the skills UPT should train to facilitate transition to operational aircraft. A primary source of data was the CNATRA Task Inventory. This was supplemented by consultations with operational personnel and a review of relevant documents. The operational requirements, thus derived were analyzed and subjected to tradeoff considerations to identify future UPT requirements.

THE ANALYSIS

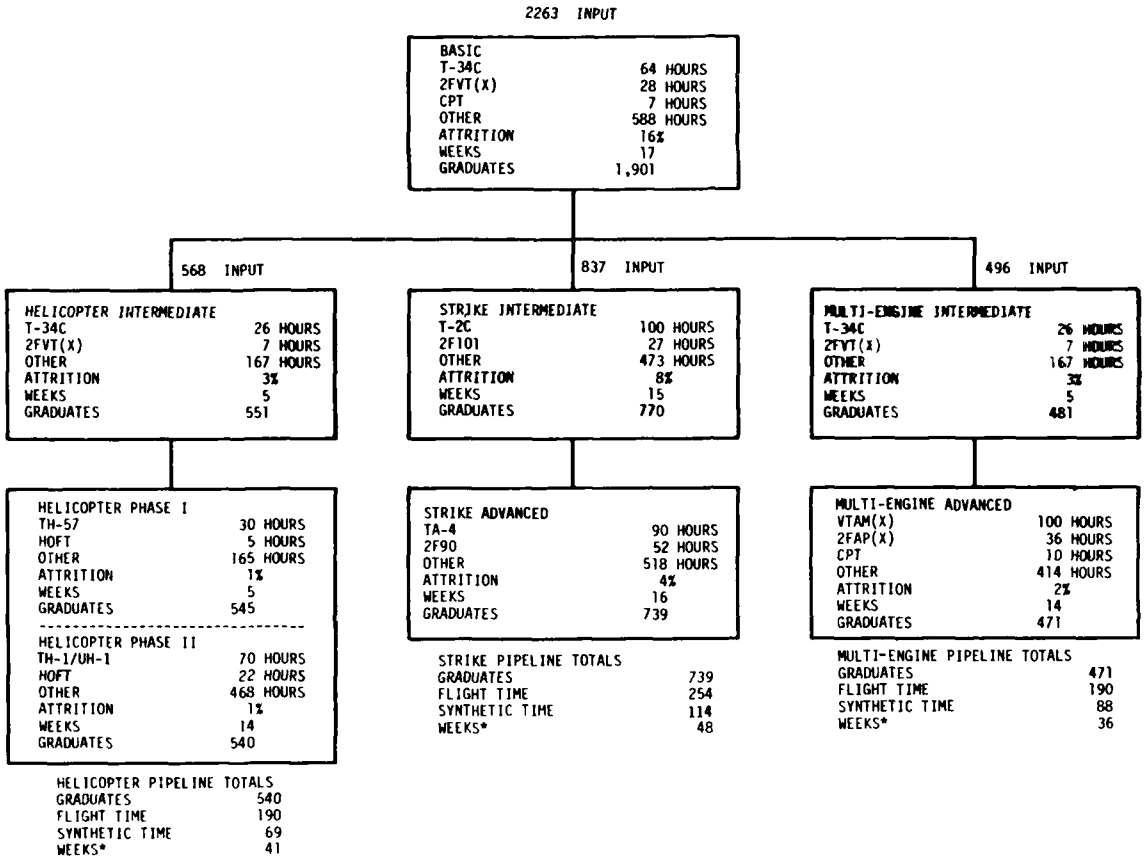
The CNATRA Undergraduate Pilot Training (UPT) Task Inventory and the subsequent CNATRA report of findings were used as the primary input data for development of training requirements. The CNATRA Inventory provided an extensive listing of tasks performed in each operational community. It contained a number of tasks not presently trained in addition to those currently trained. This inventory was developed to verify current training procedures and curricula and/or to identify deficiencies and problem areas requiring curriculum modification (CNATRA, 1974). CNATRA administered questionnaires to instructor pilots at replacement training squadrons and to selected operational squadrons that receive newly designated aviators for further training. Over 700 Navy, Marine, and Coast Guard evaluators responded to the questionnaire. The data and summarized findings are reported in CNATRA "Undergraduate Pilot Training Task Analysis Phase I Report."

The task statements contained in the Inventory are in molar form; e.g., control aircraft during instrument takeoff. To utilize the data contained in the Inventory and in the CNATRA Phase I Report most effectively, it was necessary to "rearrange" the task statements into time-ordered, sequential, and systematic activities. This reordering was necessary to facilitate a commonality analysis, for identification of training requirements, and for the detailed task/training analysis to be accomplished in the subsequent Phase II of this study.

MISSION ANALYSIS. Tasks reported in the CNATRA task inventory document were rearranged into a chronological order by mission phases, or segments

Replacement of the jet trainers to meet the requirements of 1990 and beyond will require extensive study. The use of a single type aircraft may provide a more cost-effective approach. Variable stability has been examined as a concept for expanded utilization of a single type aircraft. To date this concept has not been adequately demonstrated as feasible for a large-scale application.

*LRPTS has been redesignated as NIFTS (Navy Integrated Flight Training System) subsequent to submission of this report but prior to printing.



*DOES NOT INCLUDE AVIATION OFFICER CANDIDATE SCHOOL (11 WEEKS) AND ENVIRONMENTAL INDOCTRINATION (3 WEEKS)

Figure 2. Long Range Pilot Training System (CNATRA)
(Chief of Naval Operations OP-591, December 1974.
Data added for analysis includes inputs, attrition, etc.)

Combat Maneuvering, and Carrier Qualification. Advanced Jet training is in the McDonnell-Douglas TA-4, a tandem seating version of the A-4 attack aircraft.

The TA-4 is a transonic, swept wing, single engine jet aircraft. It has adequate communications and navigation equipment for training and operation in the airways system. The aircraft is equipped for training a wide variety of tactical tasks (except for air to air gunnery). It, too, will require SLEP or replacement in the mid 1980's. Device 2F90, Operational Flight Trainer (OFT) provides synthetic training support for the TA-4.

Synthetic Training Support. Much of the synthetic training equipment used in UPT is obsolete and generally not suitable to provide effective support for the in-flight training program. Except for the jet programs only token substitution of synthetic training for in-flight training is evident. This is in part due to the age and quality of the devices. Device 2F101, the T-2C OFT, which has only recently been delivered, has a design capability for considerable substitution of synthetic flight hours for in-flight training as the instructional strategy is improved.

Device 2F90, the TA-4 OFT, is an older digital device that receives heavy utilization. A modification and improvement program for the device is expected to correct reported deficiencies in control response. One device, located at Naval Air Station (NAS) Kingsville, Texas, has also been used for training transfer experiments and for evaluation of a computer generated visual system. A production model of the visual system is expected to be installed on Device 2F90 located at NAS Chase Field, Texas. Evaluation of a voice generated Ground Controlled Approach (GCA) System on one cockpit of the device is also underway at NAS Chase Field, Texas.

FUTURE UNDERGRADUATE PILOT TRAINING. The Naval Air Training Command, recognizing the need for modernizing the UPT process, developed a Long Range Pilot Training System (LRPTS)* Plan in 1973 (figure 2). The age of various UPT aircraft demanded that cost and training effective replacement aircraft be identified. Since that time, several changes in system design have occurred.

Training Aircraft Replacement. The LRPTS Plan projects replacement of the T-34B, Primary trainer, and the T-28, Basic trainer with the turboprop T-34C. The T-34C, with its improved performance and avionics, will be used in conjunction with an expanded primary syllabus for all pipelines and as an intermediate trainer for the Rotary Wing and Multi-engine pipelines.

The LRPTS also calls for replacement of the TS-2, Advanced Multi-engine training aircraft, with a twin turbine-powered, off-the-shelf aircraft. The replacement aircraft is presently designated VTAM(X). With the introduction of VTAM(X), carrier qualification will be eliminated from the multi-engine pipeline.

digital device presently configured for training one pilot (no copilot position provided).

MULTI-ENGINE PIPELINE. Pilots selected for multi-engine training proceed from the T-34B to Basic Propeller (Multi-Engine Intermediate) training in the T-28. The aircraft and basic syllabus are the same as used for prehelo.

Advanced Multi Engine. The advanced multi-engine syllabus length ranges from 91 to 104 hours dependent on prospective operational assignment. The syllabus provides Familiarization, Basic Instruments, Night Familiarization, Radio Instruments, Airways Navigation, Formation, and Carrier Qualification (prospective carrier pilots only). Synthetic training support for the Grumman TS-2 training includes Cockpit Procedures Trainers (Device 2C5A) and Instrument Flight Trainers (Device 2B13). Dead Reckoning and LORAN navigation training are supported by Device 1A22.

The TS-2, used for advanced training, is an obsolete carrier antisubmarine warfare aircraft that is expensive to operate and maintain. It has two 1525 HP reciprocating engines, folding wings, and a tail hook. It was not designed as a training aircraft and is not well equipped for this task. The aircraft is slow, unpressurized, unairconditioned; its performance, avionics, powerplants, and operating altitudes are considerably different from the aircraft that graduates will probably fly operationally such as the Lockheed P-3.

JET PIPELINE. The basic jet syllabus contains Familiarization, Basic Instruments, Radio Instruments, Formation, Night Familiarization, Gunnery, and Carrier Qualification. Flight training in the basic jet syllabus is conducted in the North American T-2C.

The T-2C is a moderate performance twin turbine powered, straight wing, pure jet aircraft with tandem seating arrangement. It has adequate communication and navigation equipment to operate under instrument conditions in the Federal Airways System. The T-2C which was designed as a training aircraft, is an outgrowth of the earlier T-2A/B. The aircraft will require a Service Life Extension Program (SLEP) or replacement in the 1980's.

Synthetic training support for the Basic Jet Program is provided by a recently delivered flight simulator, Device 2F101. The device, the most modern in the UPT inventory, is used for teaching procedural and instrument training tasks. It is equipped with a six-degree of freedom motion system but has no visual simulation.

Advanced Jet. The Advanced Jet syllabus is more operationally oriented than either the Helo or Multi-Engine pipelines. It includes 115 hours of in-flight training accomplished in 11 stages: Basic Instruments, Radio Instruments, Airways Navigation, Familiarization, Formation, Tactical Formation, Night Familiarization, Operational Navigation, Weapons, Air

multi-engine pipelines. Upon completion of Primary, students proceed to Helicopter (Rotary Wing), Jet, or Multi-engine pipelines.

HELICOPTER PIPELINE. Upon assignment to helicopter training, prospective rotary wing pilots receive (basic) Pre-Helicopter training in the North American T-28 aircraft. The 89-hour syllabus, designed to prepare the student for transition to advanced training, is divided into six stages: Familiarization, Basic Instruments, Radio Instruments, Airways Navigation, Formation, and Night Familiarization. Aerobatics are included in the Familiarization Stage.

The T-28 is a two-place tandem seating aircraft powered by a 1425 HP reciprocating engine. The now obsolete aircraft has been a mainstay in UPT since it was introduced in 1956. The powerplant, performance, navigation and communication equipment are not compatible with the equipment that trainees will use in the operational community. T-28 training is supported by cockpit procedures trainers and instrument trainers.

Primary Helicopter. At the completion of Pre-Helicopter Propeller Training, the prospective rotary wing pilot proceeds to Primary Helicopter Training. The 30-hour syllabus is designed to prepare the student for transition to advanced rotary wing training. In the Primary Helicopter phase of training the emphasis is on the fundamentals of rotary wing flight and contact tasks. The Bell TH-57A, used for introduction to rotary wing flying, is a light turbine powered aircraft with a side-by-side seating arrangement. The aircraft, among the more modern aircraft used in UPT, is not equipped with adequate instruments to train other than contact tasks. However, instrument packages are available for this aircraft. The TH-57, with its unique contractor supported maintenance program, has enjoyed an in-commission rate for a 33-month period of 70+ percent compared to 57+ percent for TH-1/UH-1.

TH-57 training is supported by a classroom systems trainer and a cockpit familiarization trainer. There are no flight simulators used in the existing rotary wing primary training phase.

Advanced Helicopter. Advanced helicopter training is accomplished in the Bell TH-1/UH-1 "Huey." The syllabus provides Basic Instrument, Formation, Radio Instrument, Airways Navigation, Operational, and Tactics phases. Approximately 65 hours of in-flight instruction are given. The training is generalized as operational assignments for graduates are diverse.

The TH-1/UH-1 is a combat-tested aircraft used in significant numbers by the Army and to a lesser degree by the Marine Corps. The models used in undergraduate training are skid-equipped single turbine-powered aircraft with instrument capability. The use of several different models with various avionics suites necessitates variations within the syllabus. The aircraft is reasonably modern and, as yet, a suitable replacement has not been identified. There are sufficient numbers of the aircraft to meet foreseeable requirements. The TH-1/UH-1 is supported by a cockpit familiarization trainer and an instrument simulator, Device 2B18. The 2B18 is an older

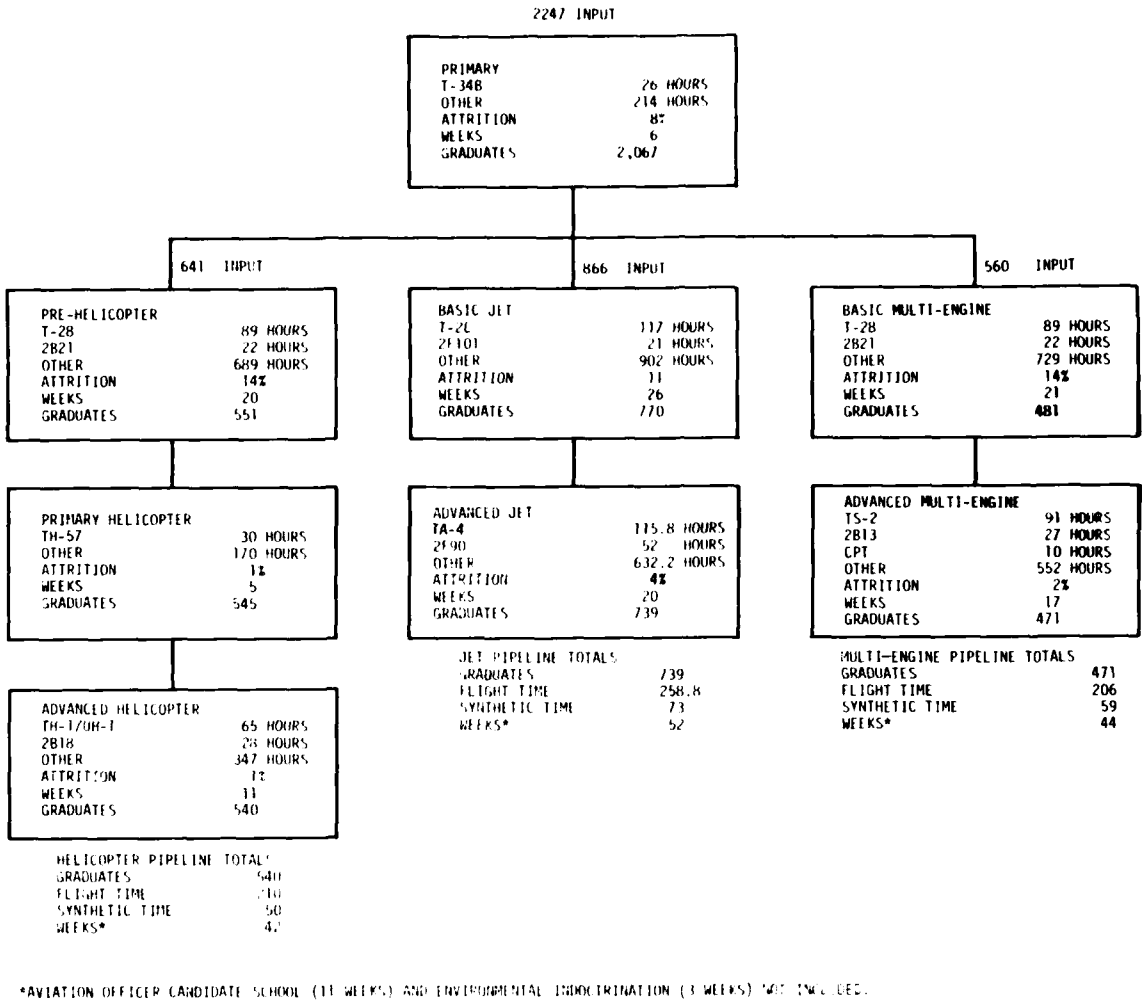


Figure 1. Current Undergraduate Pilot Training System Model (Developed from Chief of Naval Air Training Instructions, 1542 Series. Inputs, attrition, and other data added for analysis purposes.)

NAVY UNDERGRADUATE PILOT TRAINING

Undergraduate pilot training is the responsibility of the Naval Air Training Command headquartered at the Naval Air Station, Corpus Christi, Texas. The United States Navy is responsible for training aviators for the Navy, Marine Corps, and Coast Guard. Unique Navy UPT requirements have been generated by the diverse needs of these three services. Navy UPT must provide general skills in rotary wing, fixed wing and carrier jet aircraft which can be developed into the mission skills required by each service. All undergraduate pilots receive primary flight training at Pensacola, Florida; and basic and advanced training in the Pensacola, Florida; Meridian, Mississippi; or Corpus Christi, Texas areas.

Candidates for Navy Undergraduate Pilot Training. Candidates for the three services are principally obtained from the service academies, reserve officer training programs, and various officer commissioning programs. Each service has its own peculiar selection criteria; e.g., age, education, paper and pencil tests. These will not be addressed in this report since this information is readily available in publications.

CURRENT PROGRAM. Exclusive of the time spent in physical and officer quality training prior to commencing flight training, the duration of the undergraduate pipelines (courses) varies from 45 weeks for rotary wing training to 59 weeks for jet training (DoD, 1974). Figure 1 depicts the current system model with weeks normally expected in each phase of training, aircraft utilized, aircraft training hours, and training paths.

Primary Training. The six-week primary syllabus is conducted in two phases. The first, or Pre-Solo, stage is concerned with teaching fundamentals of airmanship and basic contact tasks. The Precision stage follows and is concerned with teaching spins, stalls, barrel rolls, loops, Immelmans, and other precision maneuvers. In-flight training conducted in the Beech T-34B is supported by cockpit procedures and bailout trainers. Academic instruction provides basic aeronautical knowledge and aircraft specific system knowledge.

The T-34B was introduced into UPT in the late 1950's. It is a low wing monoplane powered with a 225 horsepower (HP) reciprocating engine and has a tandem seating arrangement. The aircraft, which is no longer in production, is not equipped with the communications or navigation equipment to teach other than basic VFR maneuvers. After approximately 17 hours of flight instruction selections are made for the various pipelines; i.e., jet, helicopter, or multi-engine. Selections are based on flight performance, academic grades, and student preference. Navy students are eligible for all pipelines; Marines are assigned to jet or helicopter; and Coast Guard candidates may be assigned to either helicopter or

training consists of 165 hours in the Beech Bonanza, a light single engine aircraft. This is followed by 95 hours of training in the Beech Baron, a light twin engine aircraft. Both aircraft have side-by-side seating; both are relatively inexpensive airframes in comparison with military training aircraft; but both are well equipped with navigation and communication equipment. The avionics capability exceeds that of many military training aircraft.

Significant features of the Lufthansa/PSA program are outlined below.

1. After the rigid selection process the attrition rate over a 16-year period has been only 6 percent for all causes. Attrition attributed to lack of aeronautical ability was 1-1/2 to 2 percent (Reese, 1971).

2. A simple, general aviation trainer is used for ground instrument training, but all instruction is given by a certified instrument instructor qualified to instruct instruments in the air. This is in contrast to the military situation where simulator instruction is often given by a non-pilot.

3. The aircraft availability and utilization reported are far superior to that reported for military UPT programs. The resident manager of the PSA program, reported that availability of aircraft ranged upward form 95 percent with an average of 2000 hours per year utilization.[4] (It must be noted that weather is not a factor in Phoenix.)

4. Of particular interest is the fact, proven through years of experience, that training in light, well-equipped aircraft will transfer well to the large high-performance aircraft used in airline operations.

At the conclusion of PSA training, pilots return to Germany for further training. They receive 30 to 40 hours in a King Air Turbo-prop aircraft for the purpose of familiarization with the routes and airports that they will be operating from and to accustom them to higher operating speeds. This training is followed by instruction in either the 737 or 727 flight simulator before proceeding to the aircraft. Once assigned to either the 737 or 727 they must spend 60 to 80 hours in an observer status before assuming copilot duties.

Flight Safety, Inc. Pilot Training. The second civilian pilot training institution visited was Flight Safety, Inc., Vero Beach, Florida. They are engaged in training zero-time pilots for airline flying for the emerging nations. The philosophy of training pilots in low-cost, but well equipped, aircraft was repeated. Initial training is in single engine Piper aircraft followed by training in a Piper twin.

A side-by-side seating arrangement was standard in the aircraft used for both the PSA and Flight Safety programs.

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[4] Personal Communication, Mr. Will Ennis

in the 2B24 and the 10-week course of 30 hours in the UH-1 replaced the former course of 7-1/2 hours in the 2B24 and 40 hours in the aircraft.

Advanced Phase. The Advanced Phase is designed to qualify candidates in the UH-1 helicopter and to instruct the skills and techniques required to operate Army aircraft under tactical conditions. This 10-week phase provides 65 hours of training in the UH-1 with heavy concentration on operational flying techniques; e.g., Nap of the Earth (NOE), high gross weights, reconnaissance, formation flight, confined area operations, navigation, and night operations. Army UPT concentrates on operational specific training in the advanced phase as many of the graduates proceed directly to operational assignments. Some may proceed directly to fixed wing transition training or transition training to medium or heavy lift helicopters.

FUTURE ARMY UNDERGRADUATE ROTARY WING TRAINING. Extensive research has been conducted in support of Army undergraudate pilot training. This research has addressed instructional strategies, development of synthetic training support, and measurement/validation of training transfer. The result has been a significant reduction of in-flight training time with prospect for further reductions as expertise in utilization of new assets and training system design is realized. The 2B24 flight simulator, a part of the Synthetic Flight Training System (SFTS), is the first of a series of advanced concept helicopter simulators introduced. The device has demonstrated the utility of helicopter simulators as substitutes for in-flight rotary wing training at the undergraduate level (Caro, 1972). The success of the device and the use of a systematic approach in the development of an integrated training system have emphasized the value of identifying realistic training objectives and the development of device characteristics based on these objectives.

Fixed Wing Training As a Prerequisite for Rotary Wing Training. The Army has discontinued undergraduate fixed wing training for rotary wing pilots.

RELEVANT CIVILIAN UNDERGRADUATE PILOT TRAINING

During the study, it came to the attention of the project team that there were at least three UPT programs in the United States that were engaged in training ab initio (zero time) prospective pilots for airline pilot positions. Two training sites were visited during the early study effort.

Pacific Southwest Airlines (PSA) Training. The PSA training facility, located in Phoenix, Arizona, trains pilots for Lufthansa Airlines. Prospective pilots undergo a rigid selection process in Europe. This includes both written and perceptual-motor testing (see section IV and appendix B). The thoroughly screened candidates are then brought to this country for an intensive academic, synthetic and in-flight training course. Initial

> The application of flight simulation in UPT was recognized as the most significant finding of the Mission Analysis. The Steering Committee recommended that ATC take action to state an immediate requirement for the TS-2 flight simulators and that AFSC investigate the feasibility of expediting the availability of TS-3 full-mission simulators.

The Air Force report also provided six feasible UPT system alternatives; three were later eliminated by the Steering Committee. A number of aircraft alternatives were studied as possible replacements for the T-37 and T-38; however, information received indicates that both the T-37 and T-38 will be retained for some time, and sophisticated flight simulators for these aircraft are under procurement. The simulators will have six-degrees of freedom motion systems and visual systems.

U.S. ARMY UNDERGRADUATE PILOT TRAINING

Undergraduate helicopter pilot training for the Army, the Army Reserve, the Army National Guard, foreign commitments, and the Air Force is conducted by the U.S. Army Aviation School, Fort Rucker, Alabama. Two undergraduate rotary wing pilot courses (Officer/Warrant Officer Rotary Wing Aviator Course and Warrant Officer Candidate Rotary Wing Aviator Course) are offered. Fixed Wing UPT was discontinued in 1970.

CANDIDATES FOR ARMY ROTARY WING PILOT TRAINING. Candidates for the Officer/Warrant Officer Course are selected from the U.S. Military Academy, Army ROTC, active duty officers and warrant officers, and Officer Candidate School (OCS). Candidates for the Warrant Officer Candidate Course are recruited from qualified high school graduates who must be between the ages of 18 and 27 at the time of enlistment.

CURRENT ARMY UNDERGRADUATE PILOT TRAINING. Undergraduate rotary wing training requires 36 weeks for officers and warrant officers, and 38 weeks for warrant officer candidates. This 36/38 week course of 180 hours is the shortest aviator training course in both duration and flight hours of the three military services.

Primary Phase. All candidates receive approximately 85 hours of flight training in the Hughes TH-55, a light reciprocating engine helicopter. The syllabus contains various contact tasks such as takeoffs, landings, emergencies, patterns, confined area operations, pinnacle operations, slope operation, navigation and cross country.

Instrument Qualification Phase. From Primary, students proceed to the Instrument Qualification Phase where they receive training in the skills and knowledges necessary for instrument qualification. Training is received in Device 2B24 (a high fidelity flight simulator configured to the UH-1) and in the UH-1 aircraft. In 1974, a 4-week course of 20 hours

Force research concerned with this perceptual motor testing program is contained in appendix B of this report.

CURRENT AIR FORCE PROGRAM. The Air Force fixed wing training program utilizes a single track system in a 48-week, 210 flight-hour curriculum. Candidates without previous flight experience receive 14 hours of training in a light aircraft (Cessna T-41) conducted under commercial contract. Pilots with previous experience proceed directly into the Cessna T-37.

Basic Training. All candidates receive approximately 90 hours of flight training in the T-37, a twin engine, straight-wing jet of moderate performance. The trainer, which has a side-by-side seating arrangement, was introduced in 1957. The syllabus provides training in contact, instrument, navigation, aerobatics, and formation flying.

Advanced Training. All candidates receive approximately 120 flight hours in the Northrop T-38, a high performance aircraft. This aircraft, which has a tandem seating arrangement and two afterburning engines, has been in use since 1961. The syllabus contains contact, instrument, navigation and formation phases; no weapons or tactical training are received. Mission-specific training is given postgraduates at Combat Crew Training Schools (CCTS). As appropriate, Fighter Lead-In is given at the completion of UPT.

Undergraduate Rotary Wing Pilot Training. The Air Force has a limited requirement for rotary wing pilots. The principal assignments are in the Aerospace Rescue and Recovery Service. Unlike the Navy and Marine Corps, candidates for Air Force rotary wing training are recruited directly for that assignment. Air Force rotary wing UPT students are trained by the Army Aviation School, Fort Rucker, Alabama. There they receive approximately 180 hours of rotary wing training. The Army syllabus and aircraft are used. Upon completion of UPT, graduates proceed to CCTS for transition and operational readiness training in Air Force helicopters. At some later point in their career, rotary wing pilots may request transition to fixed wing aircraft.

FUTURE AIR FORCE UNDERGRADUATE PILOT TRAINING. The Air Force, concerned with future UPT, sponsored a major study effort to identify and define a training system for the 1975-1990 time frame. The work was performed under two contracts. One study was by a Lockheed and Singer team (Lockheed, 1971) and the other by a Northrop and Bunker-Ramo team (Northrop, 1971). Subsequently, an Air Force in-house study was accomplished. The Air Force report, "Mission Analysis on Future Undergraduate Pilot Training: 1975-1990," (USAF, 1972) provides an in-depth analysis of pilot training requirements, training equipment requirements, training technology, selection and related areas. One of the findings that was concurred in by the Air Force Mission Analysis Steering Committee (USAF, 1972, p. 117) is quoted below:

SECTION II

MILITARY AND CIVILIAN UNDERGRADUATE PILOT TRAINING SYSTEMS

A number of military and civilian UPT systems were examined during the course of this study. Even though the various services and civilian institutions have different operational requirements, they have in common the same basic goal--initial qualification and certification of pilots. The various systems were examined, both for an understanding of the current operation and for extraction and modification of features that might be usefully applied to Navy training. Brief descriptions of the various UPT systems examined are provided in this section, but no attempt has been made to compare their relative merits. Navy UPT, current and planned, was critically examined to assess strong and weak characteristics and to determine its capacity for change to meet future training requirements. The current and planned Navy UPT systems are described in detail later in this section.

U.S. AIR FORCE UNDERGRADUATE PILOT TRAINING

The U.S. Air Force UPT program is the responsibility of the Air Training Command headquartered at Randolph Air Force Base, San Antonio, Texas. Air Force UPT is designed to meet the requirements of the Air Force, the Air Force Reserve, the Air National Guard, and to satisfy foreign commitments. Air Force UPT emphasis is directed toward training universally assignable pilots. All U.S. Air Force fixed wing pilots are trained in a single track system. Selection of candidates for various operational communities is deferred until completion of UPT. Mission specific skill training is received in postgraduate pilot training programs conducted by the various operational communities.

CANDIDATES FOR AIR FORCE UNDERGRADUATE PILOT TRAINING. Candidates are drawn from the Air Force Academy (AFA), Air Force ROTC, Officer Training School (OTS), and the active duty officer corps. Due to reductions in pilot production requirements since cessation of the Vietnam conflict, the Air Force has been able to meet candidate quotas primarily from non-OTS sources.

Candidates must be between 20-1/2 and 27-1/2 years of age before entering flight training. They must pass the necessary physical examination and achieve a qualifying score on the Air Force Officer Qualification Test (AFOQT). The AFOQT has been the principal aptitude test used by the Air Force since 1953.

Extensive research, concerned with the development of cognitive and psychomotor tests for use in selection and prediction, is underway at Lackland Air Force Base, Texas. One research program, utilizing synthetic ground training devices to predict student performance during flight training, may have direct application to Navy UPT. A discussion of Air

3. produce a time-oriented profile of the training complex output mix.

- A detailed economic analysis of the specified system and alternatives within the system will be made.

ORGANIZATION OF THE REPORT

In addition to this section which briefly describes the study effort, section II provides brief descriptions of the various military and civilian pilot training systems examined. Candidate selection criteria, training equipment utilized, and systems concepts are included.

Section III describes the analytical techniques employed for the mission and commonality analyses and discusses the methodology used for identifying the UPT requirements appropriate to the post-1975 period.

Section IV is concerned with system design. Two long-term system models for UPT are presented. The first model describes an optimized system design featuring an advanced state-of-the-art selection technique. Synthetic ground trainers are employed for predicting general flying abilities and predicting potential attrites. The model is the result of application of the systems approach to training. The essential training requirements are defined and the training to meet these requirements is organized in the most cost- and training-effective manner. A second model employs the same basic system design without the selection feature. Both designs are expected to provide significant reductions in training time, training costs, and required numbers of instructors and training aircraft over the existing system or the CNATRA Long Range Pilot Training System (LRPTS) currently being implemented.

Section V describes the various economic analyses conducted in this phase of study. The costs of three alternative systems are compared in this section. A cost model developed by TAEG in connection with a general media analysis project was used for this phase of study.

Section VI contains conclusions and recommendations resulting from the Phase I study.

of flight. Pilot tasks were organized within 10 principal "phases of flight," typical of most aircraft missions. Additional "phases of flight" were added to accommodate activities concerned with abnormal/special procedures, emergency procedures, carrier, and shipboard operations. Categories were also added to permit classification of training requirements for training skills which must be developed in preparation for learning mission skills. The mission analysis format is defined in appendix D.

COMMONALITY ANALYSIS. The ultimate test of training value is the degree to which the learned skills or knowledges transfer to a new situation. One way of assessing the potential for transfer of training is to analyze the similarity of tasks and task elements in the two situations to determine the extent to which they have common elements. A commonality analysis was performed on each task statement contained in the task inventory. The cues presented, the mediation processes, and the responses required to pilot aircraft in each community were compared. The commonality analysis was accomplished to determine which skills are required of all pilots regardless of operational aircraft assignment and which are unique to a specific aircraft community. This information was used to develop training tracks in system design. A number of techniques are suitable for commonality analysis. However, the classic "stimulus--organism--response" (S--O--R) paradigm was chosen for its simplicity and applicability for further task analysis requirements in Phase II.[5] The technique is comparable and compatible with the Chapanis (1956) "Simplified Model of a Man-Machine System" which was developed for examining the role of man in the man-machine system. The Chapanis model consists of the functions of sensing, processing, and controlling. In the S--O--R model used for the analysis of UPT task statements for the jet, helo and multi-engine communities the functions are described as:

STIMULUS	ORGANISM/OPERATOR	RESPONSE
Cues sensed from inside the cockpit such as a light, position of an instrument needle, from a control feel and from out of cockpit such as other aircraft, velocity, height or altitude cues.	Information processed from cues, interpreted, mental calculation performed, rules or past experiences recalled, and decisions made on handling.	Responds by movement of stick, rudder, power lever; pressing a button; or verbal response.

After all items in the CNATRA Task Inventory were arranged in a sequential and chronological order in the Mission Analysis, each item was then broken down into its three components; i.e., stimulus/sensing,

[5] Commonality Analysis is discussed further in appendix F. Figure 9 illustrates the analysis process and a sample computer printout is attached to appendix F.

cognitive/information processing, and response/controlling. The degree of commonality for the individual subcomponents of each task was determined for the three communities: jet to multi-engine, jet to helo, and helo to multi-engine. Judgments of commonality were made by the study team after consulting subject matter experts, NATOPS, and other references. The degree of intercommunity commonality for each task subcomponent was rated on a five-point scale ranging from 0 (no commonality) to 4 (identical).

The numerical ratings of the subcomponents were then summed to determine the commonality of that task (stimulus, cognitive, response) among all three communities and between each intercommunity comparison (e.g., jet to helo). The sums were converted to percentages and used as a basis for a computer sort by degree of commonality. Printouts were made of comparisons across all aircraft communities and between paired communities. The computer program also arranged the tasks by mission phase and by percent commonality from high to low. A sample is contained in appendix F. The sheer volume of printouts precluded including all combinations and comparisons in this report. The data have been retained in TAEG for use in Phase II, and are available for inspection.

The S--O--R commonality analysis technique used to examine each task is also a valuable tool for examination of individual tasks. It provides information useful for determining skill requirements, training equipment requirements, instructional strategies, and training system design. The results of the Commonality Analysis were used to identify tasks, consistent with the order of training, that should be included in a single track for all pilots, and those operationally specific tasks that should be included in separate tracks. System design is discussed in section IV of this report.

TRANSLATION OF OPERATIONAL SKILL REQUIREMENTS INTO UNDERGRADUATE TRAINING REQUIREMENTS. During the study, new aircraft coming into the operational inventory and those being considered for operational use, were examined to determine their impact on UPT requirements. Aircraft recently introduced into the inventory which were examined for their impact on UPT requirements included the F-14, S-3, and AV-8. Aircraft not yet procured, or aircraft concepts being considered by the Navy and Marine Corps, that were examined include a follow-on to the AV-8 "Harrier"; HSX and/or UTTAS as a follow-on to LAMPS; the SH-3 "PLUS" for rotary wing ASW; the H-53 for Marine lift requirements; and the VFA(X) for the VA/VF community. A replacement for the P-3 as an ASW shore-based aircraft could not be identified.

In considering new aircraft such as the F-14, aspects such as the on-board weapon system and the swing-wing, were examined to determine new skill requirements. Appropriate trade-off analyses were made to address the question, "Should training be provided at the UPT level?" The unique piloting skills associated with the vertical takeoff and landing capability

of the AV-8 "Harrier" were discussed with Marine Corps representatives to determine UPT training requirements for that aircraft.[6]

Undergraduate Pilot Training Requirements. The Phase I study has been confined to requirements directly related or incident to flight since these requirements have the greatest impact on system cost and system design. Training requirements that will be met primarily through academic training will be addressed in detail in Phase II of this study after major system selection decisions have been made. The extensive analytical effort by CNATRA to identify training objectives for academic, synthetic, and in-flight training domains for the current training system is expected to be compatible with TAEG's Phase I and II study outputs.

The principal UPT training requirements identified by this study are arranged by mission phase (or segments) and according to aircraft communities (Rotary-Wing, Multi-Engine, and Jet). Table 1 presents Rotary-Wing, table 2 presents Multi-Engine, and table 3 presents the Jet requirements.

ROTARY WING TRAINING REQUIREMENTS. The methodology used for determining operational requirements and translating them into training requirements has been explained earlier and an example of the rotary wing operational requirements is contained in Appendix E. The philosophy and strategy for training to these requirements is discussed in the following paragraphs.

Introduction of the helicopter into the Fleet required the transition of experienced fixed wing pilots into rotary wing. Thus, the training of novice rotary wing pilots naturally evolved from this approach. However, research of an early study (Johnson and Melton, 1954) revealed a finding that prior fixed wing training did not improve performance of the novice except in the early stages of training. This was in the area of orientation to the air environment. Instrument training was not included in helicopter training at that time.

The commonality analysis which is discussed further in section IV indicates that basic control and integrated instrument/contact skills should be the basis of any common core for a rotary/fixed wing curriculum. However, it has been adequately demonstrated that these skills are trainable in synthetic trainers and at relatively high rates of transfer (Caro, 1972; Woodruff and Smith, 1974).

Dual Qualifications. The requirement for dual fixed and rotary wing qualification has been eliminated as a future training requirement (table 1 and section IV). This study has not found a substantial reason for dual qualification for the future. Many rotary wing Navy and Marine pilots serve only one tour and consequently have no opportunity to

[6] An extensive and informative discussion of new aircraft and utilization concepts is contained in "Naval Aviation in the Next Decade," U.S. Naval Institute Proceedings, Naval Review (1974).

TABLE 1. ROTARY WING UNDERGRADUATE PILOT TRAINING REQUIREMENTS

MISSION SEGMENT

- Mission Preparation
  - Ground Operations
- Pre-Takeoff
  - Systems Checks (NATOPS)
  - Air Taxi, Day/Night
- Takeoff
  - Sliding Takeoff - Day/Night
  - Normal Takeoff to Hover, from Hover - Day/Night VFR/IFR
  - Normal Takeoff from Ground - Day/Night VFR/IFR
  - Max Power Takeoff - Day/Night VFR/IFR
  - Confined Area Takeoff - Day/Night
- Climb/Departure
  - Transition to Forward Flight from Hover - Day/Night
  - Climb
    - VFR/IFR
  - Instrument Departure
    - SID - TACAN/VOR
    - Radar
- Cruise
  - Transition from Climb to Cruise
    - VFR/IFR Navigation
- Tactical Operations
  - Confined Area Operations
    - Obstacle Takeoff
    - High Speed Quick Stop
    - High Speed Approach to Spot
    - #Pinnacle Landings (Marines)
    - Spiral Approaches

TABLE 1. ROTARY WING UNDERGRADUATE PILOT TRAINING REQUIREMENTS (continued)

SAR Operations
- Hoisting Over Land
- #Hoisting Over Water
- Slope Landings

External Load Operations

Heavy Lift

Night Landing Zone Operations

Tactical Navigation and Approaches
- #Nap of the Earth (Marines)
- Low Level Tactical Navigation (contact, 500' AGL)
- #Contour (Marines)

*Formation/Rendezvous

*Tactical Communications

Descent/Approach

Descent - Day/Night
- VFR/IFR

Approach - Day/Night
- VFR/IFR
  - TACAN/VOR
  - ADF
  - RADAR
  - Holding
  - Localizer (VOR equipped aircraft)

Final Approach/Missed Approach/Landing

Final Approach - Day/Night
- VFR/IFR
  - TACAN/VOR
  - ADF
  - RADAR - PAR/ASR

Missed Approach/Waveoff - Day/Night
- VFR/IFR

Landing - Day/Night
- Vertical Landing - to Hover/to Landing
- Sliding/Run on
- Max Gross Weight
- Touch and Go

Post Landing

Air Taxi

TABLE 1. ROTARY WING UNDERGRADUATE PILOT TRAINING REQUIREMENTS (continued)

Post Mission

- Ground Operations

Abnormal & Special Procedures

- Crosswind Takeoffs and Landings
- Unusual Attitude Recovery
- Recognition of Blade Stall
- Boost Off Operations

Emergencies

- Aborted Takeoff
- Engine Fire - Start/In-flight/Post Flight
- Engine Failure - Hover/In-flight
- System Failures
- Autorotation -
  - Forced Landing
  - Power Recovery
  - Flared Landing
  - Run on Landing (sliding)
- Ground Resonance Recognition/Recovery
- Failure/Loss of Tail Rotor - Partial, Complete, Low/High Speed
- Ditching/Crash Landing
- Lost Plane/Emergency Communications

Contact Training Tasks

- Precision Maneuvers/Hover Control
  - Constant-Heading Square
  - Parallel-Heading Square
  - Perpendicular-Heading Square
  - Figure Eight Pattern
  - Turn on the Spot
- Basic Control Tasks
  - Altitude/Attitude Control
  - Turns
  - Formation Flight
- Communications
- Navigation (Pilotage)

TABLE 1. ROTARY WING UNDERGRADUATE PILOT TRAINING REQUIREMENTS (continued)

Basic IFR Tasks

- Communications
- Navigation
- Basic Control
  - Needle Calibration
  - Partial Panel
  - Unusual Attitude Maneuvers
  - Confidence Maneuvers, Patterns
  - Basic Radio Instrument Procedures
    - Orientation
    - Bracketing/Tracking
    - Radial Intercept

Crew Coordination

- Pilot Tasks
- Copilot Tasks
- NATOPS Procedures

Carrier Operations

- FCLP/LSE Signals
- Carrier Landings

#Collision Avoidance/Scan Training

#Decision Making

- Without Positive Control
- With Degraded Systems

* not presently trained or only partially trained in present UPT

\# potential training requirement

TABLE 2. MULTI-ENGINE UNDERGRADUATE PILOT TRAINING REQUIREMENTS

MISSION SEGMENT

- Mission Preparation
  - Ground Operations
- Pre-Takeoff
  - Systems Checks (NATOPS)
  - Taxi - Day/Night
- Takeoff
  - VFR - Day/Night
  - IFR - Day/Night
- Climb/Departure
  - Transition to Climb Configuration
  - VFR - Day/Night
  - IFR - Day/Night
    - SID (TACAN & VOR)
    - RADAR
- Cruise
  - Transition to Cruise Configuration
  - Navigation - VFR/IFR
    - *Overwater
    - *Inertial
- Tactical Operations
  - #Low Level Flight
- Descent/Approach
  - Descent Day/Night
    - Positive Control - VFR/IFR
    - Approach - IFR
    - TACAN
    - ADF
    - Holding
    - VOR
    - RADAR

TABLE 2. MULTI-ENGINE UNDERGRADUATE PILOT TRAINING REQUIREMENTS (continued)

Final Approach/Landing/Missed Approach

- Final Approach - Day/Night
  - VFR
  - IFR
    - TACAN
    - VOR
    - ADF
    - #ILS
    - RADAR - PAR/ASR
- Missed Approach/Waveoff - Day/Night VFR/IFR
- Landing - Day/Night
  - Optical Landing Systems
  - #Reversing
  - #Steering
    - Asymmetrical Thrust
    - Brakes
    - Rudder
    - #Nosewheel Steering

Post Landing

- Taxi

Post Mission

- Ground Operations

Abnormal and Special Procedures

- #SAR Drop
- In-flight Engine Shutdown/Starts
- Stall and Spin Prevention/Recognition/Recovery
- Unusual Attitudes
- Crosswind Takeoffs and Landings
- No Flap Landings

Emergencies

- Aborted Start
- Aborted Takeoff
- *Stalls
- Engine Failures and Fires
- System Failures
- Single Engine Operations and Landings
- Landing Gear Emergencies
- #Propeller Pitchlocked, other propeller malfunctions

TABLE 2. MULTI-ENGINE UNDERGRADUATE PILOT TRAINING REQUIREMENTS (continued)

Brake Fire
#Explosive Decompression/Emergency Descent
Waveoff with inoperative engine
Flat Tire Landing
Ditching
Bailout
#Boost Failures (if included on training aircraft)
Lost Plane/Emergency Communications

Basic Contact Tasks

Communications
Navigation (Pilotage)
Basic Control
- Slow Flight
- Speed Changes
- Turn Patterns
- Altitude Changes
- Touch and Go Landings

Basic IFR Tasks

Communications
Navigation
Basic Control
- Needle Calibration
- Partial Panel
- Unusual Attitude Maneuvers
- Confidence Maneuvers, Patterns
- Basic Radio Instrument Procedures
- #Flight Director System
- Slow Flight
- #RNAV (Area Navigation)

Crew Coordination

Pilot Tasks
Copilot Tasks
NATOPS procedures

#Collision Avoidance

#Decision Making

Without Positive Control
With Degraded Systems

* not presently trained or only partially trained in present UPT

potential training requirement

TABLE 3. JET UNDERGRADUATE PILOT TRAINING REQUIREMENTS

MISSION SEGMENT

- Mission Preparation
  - Ground Operations
- Pre-Takeoff
  - Systems Checks (NATOPS)
  - Taxi - Day/Night
- Takeoff
  - VFR - Day/Night
  - IFR - Day/Night
- Climb/Departure
  - Transition to Climb Configuration
  - VFR - Day/Night
  - IFR - Day/Night
    - SID
    - RADAR
- Cruise
  - Transition to Cruise Configuration
  - Navigation - VFR/IFR
    - Airways
    - Dead Reckoning
    - *Overwater
    - *Inertial
  - Formation Cruise
- Tactical Operations (VA/VF Only)
  - Formation Flight - Day/Night
    - Two and four plane
    - Rendezvous and Break
  - Low-level Flight
    - Operational Navigation (Pilotage)
  - Weapons
    - Gunnery
    - Rockets
    - Bombing
    - Strafing
  - Air Combat Maneuvering (ACM)

TABLE 3. JET UNDERGRADUATE PILOT TRAINING REQUIREMENTS (continued)

Descent/Approach

- Descent - Day/Night
  - Positive Control - VFR/IFR Conditions
  - High Speed Descent
- Approach - IFR
  - TACAN
  - ADF
  - RADAR
  - Penetration
  - Holding
  - Section Formation (Parade)

Final Approach/Missed Approach/Landing

- Final Approach - Day/Night
  - VFR
  - IFR
    - TACAN
    - ADF
    - RADAR - PAR/ASR
    - Section Formation (wingman dropoff)
    - #ILS/ACLS
- Missed Approach/Waveoff - Day/Night
  VFR/IFR
- Landing - Day/Night
  - Touch and Go
  - Optical Landing Systems

Post Landing

- Taxi

Post Mission

- Ground Operations

Abnormal and Special Procedures

- Crosswind takeoffs and landings
- Unusual Attitude Recovery
- Spin and Stall Recognition and Prevention/Recovery

Emergencies

- Recovery from Departed Flight
- Abort Procedures (practice aborts not done in aircraft)
- Systems Failures
- No Flap/No spoiler Landings

TABLE 3. JET UNDERGRADUATE PILOT TRAINING REQUIREMENTS (continued)

Runaway Trim
Lost Plane/Emergency Communications
Emergency Egress Procedures

Basic Contact Tasks

Communications - Visual and Radio
Navigation - Dead Reckoning, Pilotage
Basic Control
- Confidence Maneuvers - patterns - slow flight

Climb Schedules
Stall Series
Aerobatics and High G Maneuvers
Formation Flying
- Non-tactical
- Tactical
- Angle of Attack Flight

Basic IFR Tasks

Communications
Navigation
Basic Control
- Partial Panel
- Unusual Attitude Recovery
- Patterns
- Basic Radio/Instrument Procedures

Carrier Operations

Launch/Recovery Communications
Deck Operations
Catapult Launch
Carrier Rendezvous and Breakups
Mirror Landing Practice (field) - Day
Carrier Landing Practice
- Day
- *Night
- *CCA
- *Marshalling Procedures

#Collision Avoidance

#Decision Making

Without Positive Control
Flight Leadership
With Degraded Systems
During ACM and Tactical Operations

* not presently trained or only partially trained in present UPT
# potential training requirement

exercise the dual qualification. Other than in the Marine Corps, migration between aircraft communities is expected to be extremely limited due to specialized training requirements and limited opportunity for Fleet seats. For the very few pilots who will some day require dual qualification, transition training when required is considered to be the most feasible and cost-effective alternative.

The foregoing represents a significant departure from the traditional approach to training rotary wing pilots and is considered to be a viable long-term goal for a system designed to train pilots to realistic objectives in the most cost/training effective manner.

RAINING ADVANTAGE OF THE SIMULATOR OVER THE AIRCRAFT. Shumway (1974) eports that the number of events that can be accomplished per hour in ie simulator versus the aircraft favor the simulator by a 3:1 ratio. iis, coupled with a flying hours availability ratio of 10:1, provides total effectiveness ratio of 30:1 in favor of the simulator. Thus the umber of events and time required for each must be considered in deter-ining allocation of training tasks to the simulator and to the training ircraft.

The learning that can be accomplished per unit of time that will ffectively transfer from the synthetic situation to the aircraft varies ith a number of factors. The airline experiences in substituting syn-hetic training for in-flight training (Browning, et al., 1972) and studies oncerned with rotary wing training (Caro, 1972) and multi-engine training Browning, Ryan, and Scott, 1973) suggest that for these communities much f the training can be accomplished with modern simulators. The capabili-ies of flight simulators can be further enhanced by the addition of a arrow angle visual system. The Coast Guard Aviation Training Center, obile, Alabama, has demonstrated the effectiveness of high fidelity simu-ators coupled with a systems engineered training program for teaching asks for rotary wing aircraft, even without a visual simulation capability. n fact, all FAA instrument checks are now given in the flight simulator.[10]

IMITATION OF SYNTHETIC TRAINING. Only modest substitution of synthetic raining for in-flight training has been proposed for the jet training rack in this study. Again, the instrument and procedural tasks are the rincipal ones identified for synthetic training. Present state-of-the-rt in flight simulators does not provide adequate capability for realis-ically simulating the proprioceptive and visual cues required to train trike tactics (e.g., onset of G, sustained G, and visual field of view). s yet, a surrogate for in-the-air experience has not been devised that ill adequately prepare the novice jet pilot to assume command of a high erformance aircraft in a situation that requires complex decisions and requent exercise of initiative. The research underway on visual and iotion systems, G-Seats, and combat maneuvering trainers offers some romise for future reductions of in-flight training time. But the search or a visual system that will provide full simulation for all mission egments may be impeding identification of systems that will train for elected segments (e.g., part-task visual systems).

PTIMIZED LONG-TERM UNDERGRADUATE PILOT TRAINING SYSTEM

Figure 3 shows the proposed long-term pilot training system (the hilosophy of the concept has already been discussed). The various train-ng tracks are displayed in the block diagram. The total system, identified s an optimized flight training system that utilizes unique selection tech-iques, will be identified as SPOT for brevity. The acronym "SPOT"

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0 Personal communication received during on-site visit to the Coast Guard facility, May 12, 1974.

hours for a hypothetical new fighter via varied simulator applications. Shumway's estimates of potential flying hour reductions are:

Simulator	Percent Flying Hour Reductions
No visual	6
Narrow Field of View (FOV), night only	14
Narrow FOV, air to air	19
Extended FOV, air to air	25
Full FOV, air to air and air to ground	33

It is interesting to note that Shumway's forecast reductions for simulator substitution for fighter aircraft are considerably less than the reductions that have been achieved in multi-engine and helicopter aircraft.

A comparison of the in-flight training times for both rotary wing and multi-engine tracks in the proposed training system models with those in the present system will reveal significant time reductions. However, this does not signify a reduction in the quality of training received. In fact trainee quality should improve with either of the long-term alternatives as more training events are offered in validated requirements. The reductions of in-flight training times are possible through the applicaton of training technology and improved simulation.

With the exception of pilots retained for instructor duty, no instances were found in the course of the study wherein graduates of either rotary or multi-engine training were assigned to command aircraft upon reporting to an operational assignment. In practice, graduates of UPT must acquire a specified number of flight hours in operational aircraft, pass examinations on NATOPS, pass flight checks, and demonstrate the maturity and judgment requirements before they are allowed to command an aircraft operationally. This suggests that greater emphasis on synthetic training would not only be more cost effective but would not compromise safety. The same standards of performance can be retained and the results of training can and should be demonstrated in the aircraft.

Training. Development of a center for synthetic testing candidates for UPT selection would of course require a substantial investment. However, economic analyses indicate that these costs could be recovered through savings resulting from reduced numbers of training aircraft and reduced flying hours for both students and instructors. Early identification of potential attrites, reduction of in-flight training requirements prior to pipeline selection, and the accomplishment of certain training requirements concurrent with selection testing suggest the cost-effectiveness of a synthetic selection system.

SUBSTITUTION OF SYNTHETIC TRAINING FOR IN-FLIGHT TRAINING

Trade-off analyses were made for the proposed systems to determine which training requirements could best be met using synthetic training equipment and which would require in-flight training. Both proficiency and economic factors were considered.

The in-flight training times estimated in the models are based partly on the premise that modern synthetic trainers will be provided. Thus, more of the training now done in the aircraft could be accomplished in synthetic devices. The actual substitution ratios are dependent upon the specific training requirements, the capabilities of the synthetic trainers, and the training strategy employed. Training strategy is extremely important in determining a device's ultimate contribution to the UPT program.

A study which evaluated a new device for twin-engine transition and instrument training, Device 2B30 (GAT-2), (Caro, Isley, and Jolley, 1973) stressed the importance of a training program developed specifically for a particular device. It was found that a 40 percent reduction in flight training hours could be realized by developing a training program tailored to the capabilities of the new device instead of using the existing program which was designed for use with another device.

A new "breed" of high fidelity helicopter flight simulator (e.g., Device 2B24) has emerged as a major flight training medium for training rotary wing skills. Caro (1972) found that after an average time of 42 hours and 20 minutes of training in Device 2B24 and the UH-1 aircraft, students could pass the instrument check given in the UH-1. This included in-the-air transition and the checkride which required an average of 6 hours and 27 minutes in the UH-1. Previously, instrument training required 26 hours in the 1CA-1 trainer and 60 hours in the TH-13 helicopter.

Simulation in the strike community (VA/VF) has not been able to substitute significant amounts of synthetic training for in-flight training of tactical tasks. This is due to the wide variety of tasks to be trained, the diverse visual simulation requirements, and the requirements to simulate G cues (proprioceptive cues). However, Shumway (1974) in discussing visual simulation and life cycle costing has presented some interesting estimates for the potential reductions in the training costs and flying

performance under stress, inside/outside accommodation, and three dimensional spatial perception with piloting success should be determined. A substantial research effort for developing special abilities testing is discussed in appendix B.

Synthetic devices have been used successfully in conjunction with other tests for selection of zero time prospective airline pilots. Lufthansa Airlines, for example, requires all candidates to undergo extensive screening examinations. These cover: (1) written examination in conversational English and translation to and from German, (2) mental arithmetic, (3) general education, (4) mathematics with special emphasis on logical thinking, (5) comprehension of technical matters, (6) written psychological tests, (7) athletics, where each applicant's reaction, courage, and behavior within a group are tested, (8) tests of basic technical knowledge and physics, and (9) Link trainer introduction and Link trainer tests in order to establish the candidates' ability to solve multiple problems simultaneously and to test "stereoscopic conception" (Reese, 1971). The simulator time consists of training and testing periods in an instrument mode without any outside reference. The rigorous selection process used by Lufthansa has resulted in a total attrition rate for all causes of only 6 percent after beginning flight training. Only 1-1/2 to 2 percent of this attrition is attributed to lack of aeronautical ability (Reese, 1971).[9] Although the exact contribution of the synthetic trainer testing is not known, its potential for selection is clear.

A recent Air Force research project (McDonnell-Douglas, 1975) evaluated the use of synthetic devices for the selection of pilots. The project involved the use of a general aviation trainer to predict pilot candidate success. Candidates received 5 hours of training in the device. Through the use of automated instructional techniques, candidates were initially given instruction on basic flight controls and aircraft instrumentation. They then performed various tracking tasks in which difficulty was automatically increased or decreased as a function of their level of performance (i.e., adaptive). Performance in the device was used to predict later performance in Air Force UPT. To date, comparisons have been made with performance in the T-41 and T-37 aircraft, and will be made to T-38 training (advanced) phase performance. The initial results indicated a potential for perceptual-motor testing as a strategy for prediction of piloting success. Thus far, predictions concerning subsequent success have correlated well with later actual performance. A discussion of this research program being conducted at Lackland Air Force Base, Texas is contained in appendix B.

Selection of pilot trainees through the use of synthetic devices could be accomplished at a center established specifically for this purpose or in conjunction with the AOC School, Environmental Indoctrination or Primary

[9] Personal Communication with Mr. W. Ennis, General Manager of PSA Airline Training Center at Phoenix (Lufthansa pilot training)

SELECTION

Inadequate selection of candidates for flying training can result in high attrition rates and consequently a waste of training resources. Consider, for example, that more than one-third of Navy UPT resources are dedicated to training pilots for carrier assignments. For this demanding and high risk assignment, it is necessary to insure that only those students who possess the requisite degree of aeronautical skills, motivation, and psychological makeup required to perform in the carrier environment are selected. Similarly, efficiency and effective utilization of resources demand that trainee abilities be properly matched to the requirements of the other pipelines. A means for early identification of potential attrites and for effecting the best fit for each community should be available and selections made on this basis.

The current pipeline selection procedure involves evaluating all students over a brief period of academic and primary flight training. This cursory and necessarily subjective judgment of flying skills, and to a lesser extent academic performance, becomes the basis for the determination of a career. Presently selection is made at approximately 17 hours of flight training. This conventional selection process has a number of inherent weaknesses. Unfortunately, previous flight experience may mask true aeronautical ability in an early selection process. An examination of a recent (1974) report from NAS Chase Field for basic and advanced jet training revealed that all flight deficiency attrites had previous flight experience.[8] Several studies reported in Smode, Hall, and Mayer (1966) indicate that previous experience in light aircraft provides an advantage in the initial stages of training, particularly in the time to solo.

The current CNATRA LRPTS plan proposes increasing the selection period from 17 to 65 hours of flight training. Undoubtedly selection validity will be improved as the effects of previous flight experience will be minimized due to the longer period available to assess the developing abilities of the student regardless of previous flight experience. The weaknesses of the present selection system are reflected in basic and advanced jet attrition. More importantly, they are reflected by attrition in the jet replacement training (RAG) squadrons where training costs may exceed one-half million dollars per pilot. The high cost of training demands a constant search for improved selection procedures.

SYNTHETIC SELECTION. Objective testing conducted in synthetic training devices is an alternative to the current in-the-air subjective selection process. The concept of utilizing devices to objectively test particular skills that correlate with general flying ability or success in specific aircraft communities offers potential for improved selection. The correlation of abilities such as peripheral vision, dynamic visual acuity,

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[8] COMTRAWINGTHREE ltr 01 of 20 Aug 74

the conventional in-the-air evaluations of the past. The selection system is expected to provide a measurement of general piloting ability not masked by previous flight experience as presently occurs. Concurrent with the use of simulator selection, the devices will be used to provide initial orientation and for training certain basic piloting skills.

DEVELOPMENT OF TRAINING PATHS OR TRACKS. The commonality analysis in conjunction with the training requirements identified by community, was used to specify the optimum (training effective) paths, transition points, and branching points in the system design. The procedures for conducting the commonality analysis are discussed in section III. The numerical ratings for each two community comparison (i.e., jet/multi-engine, jet/helo and multi-engine/helo) were summed and converted to percentages for a computer sort by degree of commonality. These data were then used to determine which tasks represented general skills required of all pilots and which tasks represented specific requirements of a single community. Tasks which had a composite rating of 61 percent[7] or higher were considered to be sufficiently common to all communities to warrant their inclusion in a general curriculum. An additional constraint placed on task selection for inclusion in the general curriculum was that it exhibit at least 50 percent commonality in any two group comparison. To illustrate, all tasks selected for general training exhibited the following minimum values:

Jet/Multi-engine	Jet/Helo	Multi-engine/Helo	Jet/Multi-engine/Helo
50%	50%	50%	61%

Skills identified as common form the nucleus or core of the general training track. At the completion of common core training the single track is branched to establish separate tracks for helicopter and jet/multi-engine training. Common training for prospective jet and multi-engine pilots continues until the point where skills to be trained are no longer common. Then a separate track must be established for multi-engine pilots.

Transition Points. Each training requirement was analyzed to determine the equipment required to accomplish the necessary training. At the point where the media; i.e., training device or aircraft no longer provides a training transfer advantage, transition to a higher order of trainer must be considered. The transition may be to a more sophisticated synthetic trainer or to a more advanced training aircraft. These points, while identified in the training system models, must necessarily be estimated at this stage of system design. These estimates will be refined in Phase II after in-depth analysis and the characteristics of all aircraft and synthetic trainers to be used in the system are known. Training times used for the proposed models were estimated from those contained in current syllabi.

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[7] Close examination of these data indicated this value to be the logical breakpoint.

SECTION IV

PRELIMINARY FUTURE UNDERGRADUATE PILOT TRAINING SYSTEM MODELS

This section presents both a recommended "optimal" system and an alternate lower risk design for cost-effective achievement of future UPT training requirements. These designs are preliminary. They will be refined and modified as necessary during the TAEG Phase II study which will involve an in-depth analysis of system components and more precise identification of system requirements. The models and information presented in this section are all concerned with the long term.

SYSTEM DESIGN CONCEPTS AND PHILOSOPHY

Design of a training system model responsive to the operational needs of the post-1975 period required a systematic "front end" analysis of the operational missions to determine the present operational requirements. To the present skill requirements were added or deleted requirements generated by aircraft entering or leaving the inventory. The operational skill requirements were then analyzed to determine UPT requirements. (The process of translating operational skill requirements into UPT requirements has been described in section III.)

After identification of training requirements by community (i.e., jet, rotary wing, and multi-engine), a system model was developed. A number of requirements must be satisfied for the model to be valid. The model must specify the optimal path or paths for achievement of identified requirements. It must also have sufficient flexibility to accommodate changes in pilot production rates, training requirements, instructional technology, and improved selection techniques. The model must be capable of being subjected to a detailed economic analysis to determine the resources required, component costs, and feasible trade-offs. Finally, the model must provide capabilities for predicting piloting success, selecting for pipeline assignment, and providing training for the varied operational assignments--a capability unique to Navy UPT. Unlike the Air Force and Army, Navy UPT must produce relatively equal numbers of jet, rotary wing, and multi-engine pilots.

The system designs developed in this study have not been constrained by existing or planned training equipment. However, certain existing and planned training equipment could be used in either of the long-term models proposed and discussed later in this section.

The first model presented is innovative and consequently involves a greater development effort and risk factor than that of conventional pilot training systems. The design utilizes relatively simple flight simulators to test for general piloting abilities in a ground environment instead of

It does appear that a reduction of in-flight instrument training requirements could be made in the jet pipeline. For example, basic instrument training is still included in the advanced jet syllabus. These skills should have been acquired prior to arriving at this phase; if not, they should be refreshed in the flight simulator. Recent improvements in the fidelity of simulation in Device 2F90 (TA-4 OFT) and the new sophisticated 2F101 (T-2C OFT) should provide a significant reduction of in-flight instrument training requirements. The in-flight training time saved could be used to emphasize undertrained aspects or to train tasks not presently included in the syllabus. The impact of training technology on undergraduate jet training is also discussed in section IV of this report.

Training of Prospective S-3 Pilots. Current syllabi and CNATRA LRPTS provide for the prospective VS pilots who will fly the S-3 to be selected from the jet pipeline instead of from the multi-engine pipeline as in the past. These pilots will receive the full T-2C and TA-4 jet syllabus. Examination of the operational requirements for the S-3A pilot makes this plan questionable. Based on the examination of the jet training requirements shown in table 3, it is suggested that training the prospective S-3 pilots in the TA-4 is not cost effective. A recommended approach for training prospective S-3 pilots is contained in section IV and is discussed in appendix C of this report.

The operational requirements of the S-3 pilot do not include overland low level navigation, air to air gunnery, strafing, or extensive use of rockets or bombs. The S-3 is not equipped with guns. Extensive tactical formation training is not required. Only that required to operate in the carrier environment is needed.

The prospective S-3 pilot requires extensive all-weather training, understanding of complex navigation systems, crew coordination, ground training in ASW fundamentals, acoustic and nonacoustic sensors, and carrier operations. Transition to a swept wing aircraft that operates at considerably higher approach speeds, and is otherwise unlike the aircraft to which he will be assigned is questioned as being either cost or training effective. An extended T-2C syllabus would better prepare the prospective S-3 pilot. The T-2C is a twin jet with a straight wing and has approximately the same approach speed as the S-3. Its flight characteristics are basically similar to the S-3. The inability to decelerate the S-3 rapidly and the slow spool up time of its engines have been used as justification for utilization of the demanding TA-4. Information received indicates that both problems are currently being corrected by the manufacturer.

TABLE 4. ROTARY WING TRAINING REQUIREMENTS COMMONALITY COMPARISON WITH FIXED WING TRAINING REQUIREMENTS BY MISSION PHASE (continued)

	COMMON COGNITIVE/ PSYCHOMOTOR TASKS
Post Landing	
Air Taxi	No
Post Mission	Yes
Abnormal & Special Procedures	No
Emergencies	No
Contact Training Tasks	
Low Altitude Precision Maneuvers	
Squares	No
Figure Eight	No
Turn on Spot	No
Basic Control Tasks	
Turns	Yes
Altitude Control	No
Landing Practice	No
Landing Patterns	No
Formation Flight	Yes
Basic IFR Tasks	
Communications	Yes
Navigation	
Basic Control	
Needle Calibration	Yes
Partial Panel	Yes
Unusual Attitude Recovery	Yes
Confidence Maneuvers/Patterns	Yes
Basic Radio Instrument Procedures	
Orientation	Yes
Bracketing/Tracking	Yes
Holding	Yes
Crew Coordination	Yes
Carrier Operation	
Carrier Landings	No
CCA	Yes
Collision Avoidance	Yes
Decision Making	Yes

TABLE 4. ROTARY WING TRAINING REQUIREMENTS COMMONALITY COMPARISON WITH FIXED WING TRAINING REQUIREMENTS BY MISSION PHASE

MISSION SEGMENT	COMMON COGNITIVE/ PSYCHOMOTOR TASKS
Mission Preparation	Yes
Pre-Takeoff	
NATOPS System Checks	No
Air Taxi	No
Takeoff	
Normal Takeoff to Hover	No
Normal Takeoff from Hover	No
Normal Takeoff from Ground	No
Sliding Takeoff	No
Max Power Takeoff	No
Confined Area Takeoff	No
Climb/Departure	
Transition to Forward Flight from Hover	No
Climb - VFR	No
IFR	Yes
IFR Departure	Yes
Cruise	Yes
Tactical Operations	No
Descent/Approach	
VFR	No
IFR	Yes
Final Approach/Missed Approach/Landing	
Final Approach - VFR	No
IFR	Yes
Missed Approach/Waveoff	
VFR	No
IFR	Yes
Landing	
Sliding	No
Vertical	No

have a high commonality between rotary and fixed wing. Other fixed wing training tasks may contribute to overall aeronautical knowledge or general ability, but they do not contribute directly to the development of skills required to pilot rotary wing aircraft. For example, aerobatic skills are not required to pilot a helicopter under operational conditions, but they may enhance the pilot's confidence in his ability to handle his aircraft in unusual attitude situations. Certain of these tasks may be retained for indoctrination and/or for selection purposes to discern piloting abilities until such time as synthetic selection techniques are validated and replace the aircraft as the primary selection tool. Logically, instrument (and related) tasks should form the core of the common fixed/rotary wing curriculum.

Table 4 compares rotary wing and fixed wing requirements.

MULTI-ENGINE TRAINING REQUIREMENTS. In the post-1975 period, the principal prospective assignment of multi-engine graduates will be to Navy Patrol Squadrons, which fly the P-3 aircraft. A small number of multi-engine pilots will be required for the Carrier Onboard Delivery (COD) and Early Warning operations as long as propeller aircraft remain in the Fleet. Examination of the existing multi-engine syllabi reveals that formation flight is still required of all pilots. This is considered a questionable requirement for the post-1975 period as the principal recipients of multi-engine trained pilots do not fly formation operationally. The present multi-engine syllabus is directed at transition of neophytes into multi-engine aircraft and the development of instrument skills. Heavy emphasis is placed on aircraft training. This may be unavoidable at the present time because of the poor quality of the flight simulators available for training. The practice of teaching basic instruments in the aircraft is also questioned for the advanced stage of training. The principal added requirements for the post-1975 period are envisioned to be those concerned with jet/turbo-prop operations, use of sophisticated navigation systems/flight director systems, Instrument Landing Systems (ILS) approaches and possibly Area Navigation (RNAV). The allocation of training tasks to the synthetic trainer and to the aircraft will be examined in depth in the Phase II study. A discussion of the philosophy of training for multi-pilot aircraft is contained in section IV of this report.

JET TRAINING REQUIREMENTS. The basic and advanced jet UPT programs were examined to determine their responsiveness to operational skill requirements. At this stage of the study the current training requirements appear valid for the prospective strike pilot. However, prospective S-3 pilots could benefit from a syllabus more appropriate to their operational assignments. No significant training requirements that require modification to the jet undergraduate syllabus to accommodate the F-14 and AV-8 were identified.

Post Mission - Post mission reports and duties are highly similar.

Abnormal and Special Procedures - Tasks trained in this phase are specific to aircraft and mission.

Emergency Procedures - Some transfer can occur from training in the handling of emergencies. However, the characteristics, or symptoms, and responses required are specific to a given aircraft.

Contact Training Tasks - Initial indoctrination to the air environment; i.e., learning to maintain the aircraft in a level attitude and making turns, are tasks common to both rotary and fixed wing aircraft. The controls used to change altitude, apply power, and achieve basic control are different. Basic training in formation flight with regard to relative motion, simple maneuvering, and maintaining position are similar, and fixed wing training can be expected to transfer to rotary wing. These basic maneuvers other than formation flight need only be trained in an orientation phase.

Basic IFR Tasks - The tasks of controlling the aircraft on the basis of instrument cues are similar. The communications, radio navigation and instrument procedures prescribed by Federal Aviation Administration (FAA) and Chief of Naval Operations (CNO) regulations are common to both rotary and fixed wing aircraft, with only airspeed being a differential factor.

Crew Coordination - Crew coordination requirements are similar between multi-piloted fixed wing and rotary wing aircraft. However, the present fixed wing training given in tandem aircraft provides little transfer to rotary wing crew coordination requirements.

Carrier Operations - Carrier Operations, other than CCA approaches, are dissimilar for fixed and rotary wing aircraft.

Collision Avoidance - The principles of scan technique and collision avoidance are similar for both fixed and rotary wing aircraft.

Decision Making - The principles of decision making are similar for all communities, but opportunity for extensive decision making by both multi-engine and rotary wing pilots is delayed due to the procedure of operationally assigning rotary and multi-engine pilots to copilot duties until sufficient experience and flight time have been acquired for upgrading to Aircraft Commander.

The Commonality Analysis and the examination of training requirements suggest that instrument taining tasks (i.e., basic instruments, radio instruments, and instrument flight under FAA and CNO regulations)

the interval from fixed wing training to operational aircraft would probably negate any transfer value from early fixed wing training.

The IFR climb/departure tasks are similar in compliance with instrument flight rules, communications, navigation, and control of the aircraft in carrying out a clearance in a safe manner.

Cruise - Cruise tasks concerned with navigation and communications are basically similar under VFR and IFR conditions.

Tactical Operations - The tactical operational requirements of rotary wing are so specific to rotary wing aircraft that training in fixed wing provides no conceivable transfer to rotary wing.

Descent/Approach - VFR and Positive Control under VFR conditions are conducted in an entirely different environment for the rotary wing aircraft. Descent does not require use of lift/drag devices and occurs in a different altitude structure.

IFR descent/approach has high commonality in the use of the communications and navigation procedures as well as the principles of controlling the aircraft under close tolerance conditions without reference to contact flight cues.

Final Approach/Missed Approach/Landing - Final approach under visual flight rules is normally helicopter peculiar, including the direction of turns, pattern altitudes, and airspeeds.

Waveoff under VFR conditions requires rotary wing peculiar maneuvers and patterns.

A missed approach under IFR conditions has a high similarity in communications, navigation, and control of the aircraft by reference to instruments.

Landing, either VFR or IFR, is peculiar to the rotary wing aircraft, particularly at UPT level where the aircraft is not equipped with wheels. The rotary wing aircraft uses a variety of approaches and landings in UPT in preparation for specific rotary wing operational requirements.

Post Landing - The principal training task of air taxiing the helicopter is different from ground taxi of a fixed wing aircraft. The rotary wing aircraft does not use brakes or steerable nosewheel for steering; instead the cyclic is used. Each operational wheel-equipped helicopter has distinctly different taxiing techniques.

Since this study is concerned with identification of valid training requirements and cost effective methods for achieving them, it was considered essential that the training requirements of rotary wing pilots be compared to the training requirements of fixed wing pilots to determine which skills were required by each and to assess the degree of commonality of certain other skills.

After the rotary wing, jet, and multi-engine training requirements were identified (tables 1, 2, and 3), the Commonality Analysis technique, previously discussed, was used as a vehicle for comparing rotary wing to fixed wing requirements (jet and multi-engine). The comparison was made in the same order as the training requirements presented in tables 1, 2, and 3 (i.e., by mission phase).

Comparison of Fixed and Rotary Wing Training Requirements. Each training requirement for rotary wing pilots was compared to fixed wing pilot training requirements. A comparison of rotary and fixed wing requirements is presented below:

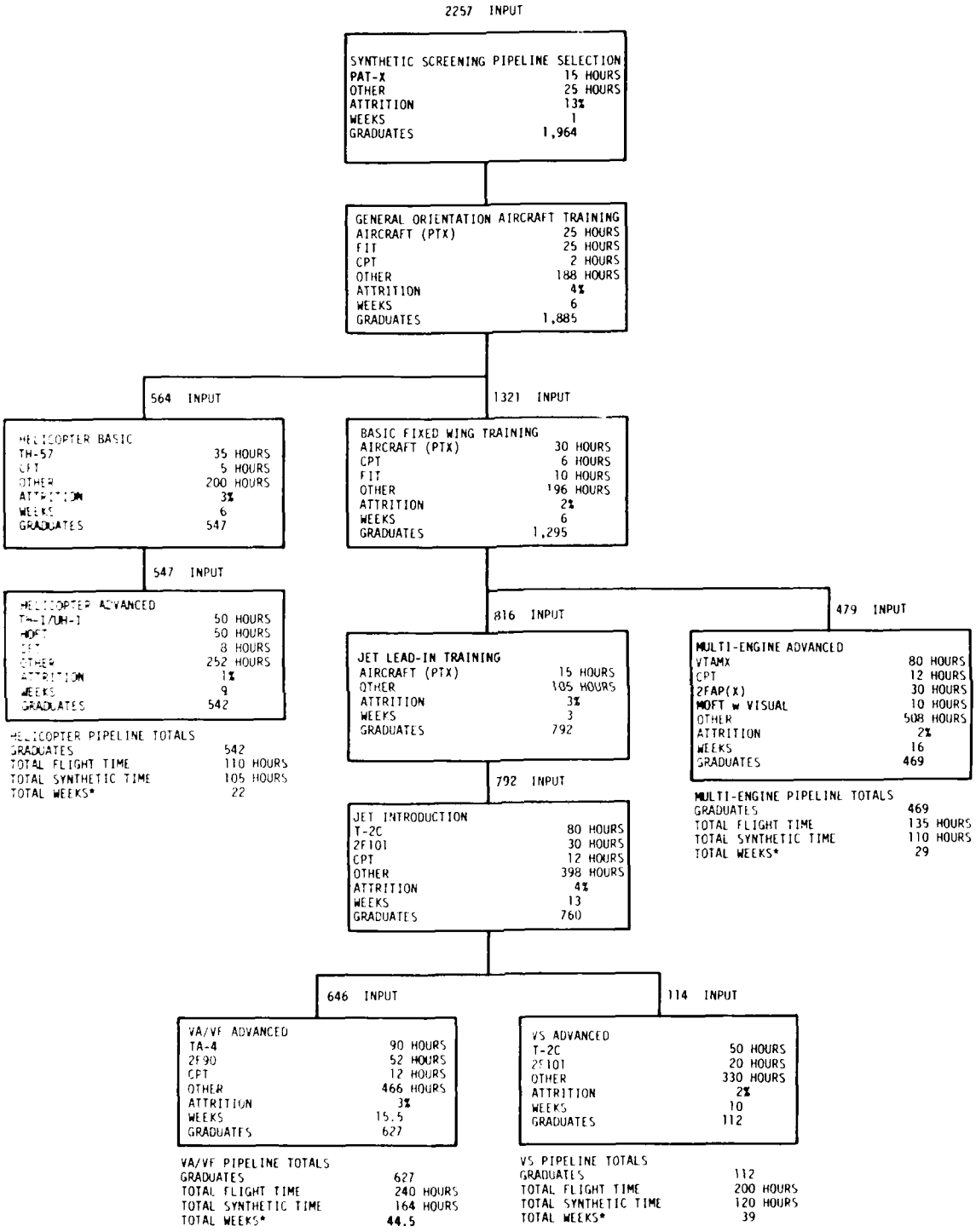
Mission Preparation - The tasks concerned with mission preparation such as navigation planning, weather briefings, filing of flight plans, yellow sheets and associated forms are essentially the same for all aircraft. Different airframes necessitate a degree of variance during preflight procedures.

Pre-Takeoff - The tasks associated with starting an aircraft and with system checks are similar. The principal skill of taxiing is not common. In UPT the helicopter air taxies; the fixed wing aircraft taxies on the ground. At the operational level, the helicopter with its many configurations utilizes techniques peculiar to each.

Takeoff - The controls, cues, and responses involved in rotary wing takeoff are completely different from those of fixed wing aircraft for a vertical takeoff or even for a sliding or running takeoff. The rotary wing pilot must acquire skill in various profiles such as takeoff to hover, from hover, and sliding takeoff in addition to normal takeoff from the ground.

During an instrument takeoff the cues received by the rotary wing pilot are substantially different and require different responses; for example, no airspeed at liftoff with nose low indication on the horizon bar of the gyro.

Climb/Departure - The rotary wing aircraft may begin climb from a hover, from the ground, or via a sliding takeoff. Unlike fixed wing aircraft, the UPT helos have no wheels to raise or lift devices, such as flaps to clean up. In training for eventual operational helicopters, most of which are equipped with wheels,



*AVIATION OFFICER CANDIDATE SCHOOL (11 WEEKS) AND ENVIRONMENTAL INDOCTRINATION (3 WEEKS) NOT INCLUDED.

Figure 3. Optimized Flight Training System Model Utilizing Sophisticated Synthetic Selection Techniques (SPOT)

symbolizes the philosophy of the synthetic testing phase: Synthetic Screening, Pipeline Suitability Prediction, Orientation and Training. The unique features of the model are explained below.

SYNTHETIC SELECTION PHASE. Relatively low cost aviation trainers are envisioned for use in the synthetic selection and training phases. These trainers will require the addition of a digital computer for recording student performance data and management of training, controlling automated training, and for performing various functions, such as establishing initial conditions. The addition of a cylindrical visual screen will permit conducting collision avoidance/scan training during the selection testing phase.

Implementation of the SPOT Concept. The synthetic testing and selection phase will be concerned primarily with the identification of general piloting ability for the purpose of predicting suitability for a piloting career. The previously described aviation trainers, configured to the primary training aircraft and integrated with a computer, will be used for testing of general ability. Students would be trained and tested on the automated adaptive devices for a period of 10 to 15 hours. Data will be gathered on a typical Navy input population and used to predict general flying abilities. The period of synthetic testing and training would be followed by approximately 25 hours in the primary training aircraft. This time would be used for training in general aviation skills and to validate predictions. Upon completion of this phase, pipeline selections would be made on the basis of predictions from the synthetic phase and on the demonstrated general skills exhibited during the initial flight phase. After validation of the synthetic testing and selection phase on a substantial Navy population, this phase would be used as a basis for pipeline selection and attriting candidates prior to beginning in-flight training. Continuous liaison has been and will continue to be maintained with the Naval Aerospace Medical Research Laboratory (NAMRL). Validation of the synthetic testing concept on a Navy population will of course be coordinated with or conducted by NAMRL. A discussion of synthetic selection and testing is contained in appendix B.

The concept of testing for special abilities related to success in various aircraft communities has been investigated by the study team. To date, a taxonomy of these abilities has not been established. Identification of special abilities and appropriate tests for them could lead to refinement of pipeline selection and improved identification of potential attrites. The synthetic testing devices utilized in SPOT offer a means for gathering data and researching the development of special abilities tests without interfering with training. Data can be collected while training and testing are being conducted. Relevant assumptions and data are presented and the elements of a long-term research program for test development are discussed in appendix B.

General Orientation Training. After completion of the synthetic selection and training phase each trainee would receive approximately 25 hours of flight training. This phase is a departure from past practices. No

attempt would be made to solo the student in this phase which would also eliminate the requirement for extensive spin and stall practice, emergency landing practice, or proficiency in landing and takeoff. Training would be concerned with the general skills required of all pilots that are expected to transfer to all aircraft communities. The principal concentration of training would be in basic control skills and integrated contact/instrument training. As previously mentioned, this period would serve to validate the predictions from the synthetic testing and selection phase and identify those personnel who cannot adapt to the flight environment due to a fear of flying or for physiological reasons. At the completion of this phase, trainees selected for rotary wing training would enter the rotary wing track. Thereafter they would receive a concentrated synthetic and in-flight training regime designed to provide the skills required of pilots entering the rotary wing operational community. No further attempt would be made to train them in skills identified as primary requisites for fixed wing pilots only. The remaining trainees successfully completing the General Orientation phase would proceed to Basic Fixed Wing.

Basic Fixed Wing Training. This 30-hour phase of training is concerned with training of skills identified as required of all fixed wing pilots. Here the fixed wing pilot would solo for the first time. The student would receive training in precision control required of all fixed wing pilots such as takeoff and landing under various conditions, required spins and stalls, and emergencies. The earlier general skills learned would be refined with concentration on instrument proficiency. At the completion of this phase, those judged to be best adapted and desiring jet training would continue to the jet lead-in. The remaining successful candidates would proceed to advanced multi-engine training.

Jet Lead-In Training. Trainees selected for Jet Lead-In would be subjected to a period of intensive training designed to demonstrate the environment that the prospective pilot of a jet aircraft may expect. The period would be used to identify those who do not have the reaction time, skill, and stamina required of pilots expected to command high performance carrier jet aircraft. The marginal pilot should not pass into the jet community. Elimination of the marginal pilot here can save millions of dollars and more importantly--lives. Trainees successfully completing this phase will proceed to the Jet Introduction training in the T-2 or its successor.

Jet Introduction and Advanced. As discussed previously no dramatic changes have been proposed for Jet Introduction (strike intermediate). However, a significant change has been proposed for advanced jet training. Figures 3 and 4 show a division in the advanced jet pipeline for a separate track or branch for prospective Carrier Anti-submarine Warfare Squadron (VS) pilots.

ADVANCED TRAINING FOR PROSPECTIVE VS (S-3) PILOTS. With the advent of the S-3, prospective VS pilots are scheduled to receive advanced training in the TA-4 instead of the TS-2. This means that these pilots will be trained to the same requirements as prospective strike pilots. A comparison of mission requirements reveals almost no commonality between the VS and the VF/VA communities.

A detailed examination of the present basic/intermediate jet syllabus, conducted in the T-2C, indicates that the aircraft and the skills trained are more appropriate to the VS mission than the present advanced jet syllabus and the advanced jet trainer, the TA-4. The T-2, like the S-3 has two engines and a straight wing. Both exhibit moderate performance characteristics and have similar carrier approach speeds.

In contrast, advanced training in the TA-4 with its single engine, swept wing, and high performance is concerned primarily with development of skills appropriate to the strike community. Operation of the aircraft at the edge of the envelope and in an aggressive manner is the watchword of the strike community. The time spent in transitioning to the TA-4, most of the tactical training, and the extensive formation flying are of questionable value in development of the skills required for the prospective VS pilot.

The S-3 aircraft is primarily a platform for an airborne Anti-Submarine Warfare (ASW) system which must be placed in position for detection, tracking and destruction of submarines. Training should emphasize around the clock, all weather operations and stress the importance of training pilots to fly the aircraft smoothly so that a stable platform is provided the tactical crew to perform its mission.[11] Preparation for these mission requirements can best be given at the undergraduate level in the present T-2C or its replacement. The proposed branch in the jet pipeline would utilize the basic/intermediate jet trainer for an advanced VS syllabus stressing instrument training, day and night; carrier instrument procedures; additional day mirror landing practice (MLP) and carrier landings.

Neither the past multi-engine syllabus or the present jet syllabus provides training in the tactical skills required of the VS pilot. The branched syllabus with its concentration on all weather operations could probably include some low overwater training. Contact with the Fleet Introduction Team and the replacement squadron indicates that academic training in the basics of radar, Magnetic Anomaly Detection (MAD), inertial navigation, data link, oceanography, and associated ASW tactics would benefit the prospective VS pilot. This could be accomplished concurrently with an extended T-2C syllabus. Elimination of ground training associated with learning of TA-4 systems information and strike tactics would provide the required training hour availability.

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[11] Will the training of prospective VS pilots in strike aircraft and strike tactics encourage the abuse of the S-3? The dangers of overstressing the S-3 and cautions concerning its utilization are discussed by Christianson (1975).

ALTERNATE STATE OF THE ART MODEL (ALTERNATE NO. 1)

Figure 4 presents a model of an alternate system with a lower risk factor and a reduced payoff. It differs essentially from the SPOT system in the area of selection. In this model, performance in the 65 hour primary phase will be used as the principal source of data for pipeline selection. This phase is basically similar to the extended primary phase proposed by Komanski, Picton and Camp (1974). Thereafter, significant reductions of in-flight training are forecast for the rotary wing, multi-engine and prospective VS tracks. The system is compatible with certain existing and planned training aircraft and devices. The reductions in training time were obtained by realistic identification of the training requirements by aircraft communities. The training strategies have been discussed earlier in connection with the synthetic selection model (figure 3).

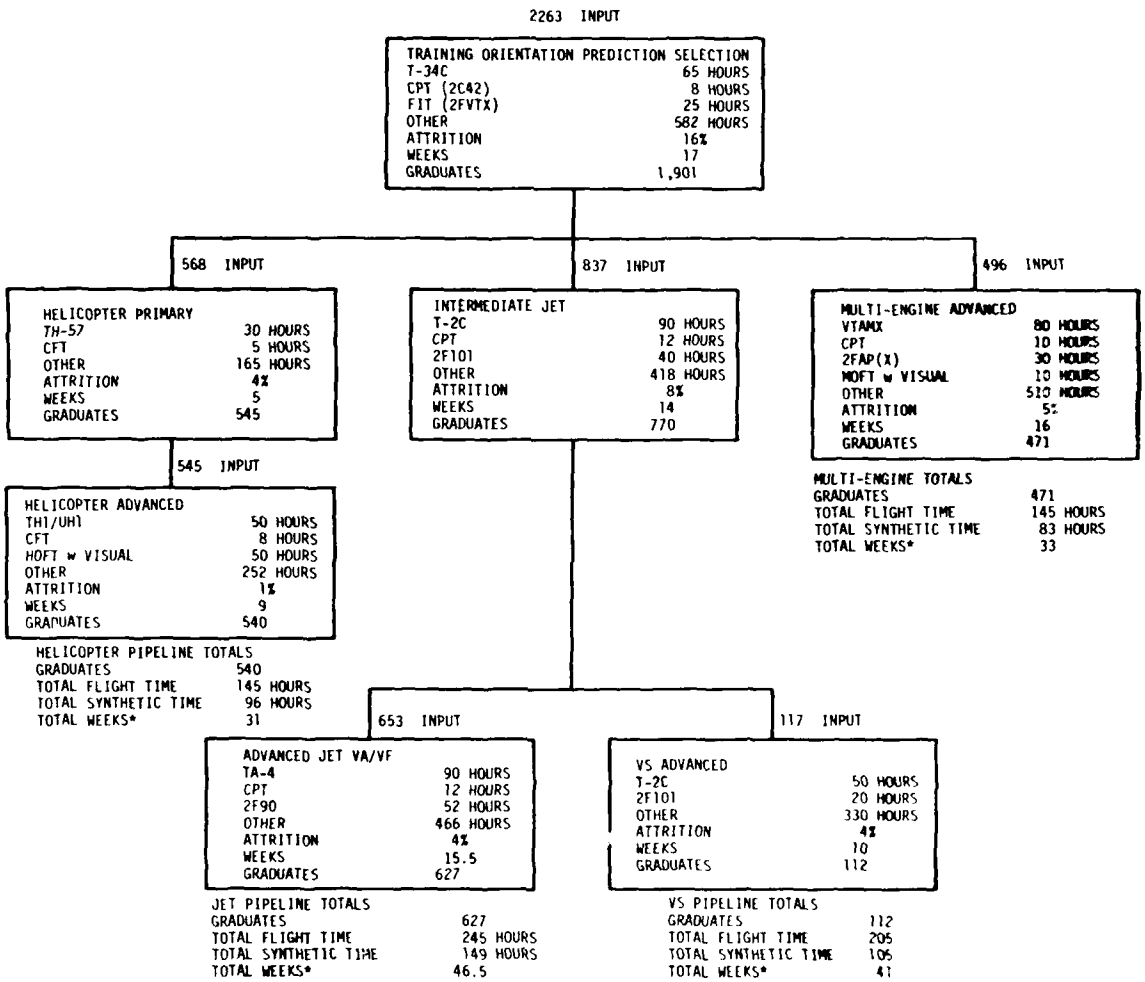
TRAINING EQUIPMENT

Training system models have been developed on the premise that training will be directed toward the accomplishment of valid training requirements for realistic program objectives. The effectiveness of the concept is dependent upon the use of synthetic and in-flight trainers specifically designed to support training of identified requirements. The use of synthetic training as a viable substitute for in-flight and not as an adjunct must be accepted.

Characteristics of present and planned aircraft and present synthetic trainers were examined for capability and applicability to achieve future training requirements. The deficiencies in present training equipment have long been recognized by CNATRA. A continuing effort by CNATRA to upgrade the quality of training aircraft and synthetic training equipment has resulted in receipt of such devices as the 2F101, improved software for the 2F90, and the planned introduction of the T-34C and VTAM(X).

A detailed identification of specific training equipments and their characteristics must necessarily wait until completion of the in-depth analysis of Phase II. At that time each behavioral objective, the media required for training it, and the performance standard, as appropriate, will be specified.

Achieving effective development of piloting skills and knowledges requires integration of academic, synthetic, and in-flight training. The rule of using the simplest media that will effectively accomplish the training task has often been ignored. Unfortunately the mistaken idea exists that the higher the fidelity of a training device to its operational counterpart, the better the training it will provide. Simple, low fidelity devices offer advantages over the aircraft or a complex flight simulator for orienting pilots to a new cockpit, teaching nomenclature, checklists, cockpit checkouts, and procedures (see for example, Smode, 1971). It has been noted in observations of both Fleet and UPT that the utilization of



*AVIATION OFFICER CANDIDATE SCHOOL (11 WEEKS) AND ENVIRONMENTAL INDOCTRINATION (3 WEEKS) NOT INCLUDED.

Figure 4. Alternate State of the Art Model (Alternate No. 1)

synthetic trainers generally is proportional to the sophistication of the device and to the supervision of the training. Many nondynamic devices such as cockpit familiarization, procedures, and orientation trainers are either unused or used only in an unsupervised manner. These devices could and should be used to replace initial cockpit checkouts done in aircraft, often under extremes of temperature and noise. High fidelity flight simulators are used for training tasks which should be accomplished in simpler trainers. The accelerating cost of high fidelity simulators makes this type utilization questionable from a cost-effectiveness standpoint and precludes their use for training of more essential tasks. Thus, in the Phase II study, TAEG will also address training media utilization to insure training tasks are assigned to the appropriate media.

PRIMARY/EXTENDED PRIMARY TRAINING EQUIPMENT. A recent Naval Training Equipment Center (NTEC) study presents a training situation analysis of the proposed T-34C extended primary training (Komanski, Picton, and Camp, 1974). The spectrum and utilization strategy of devices proposed in the present study differ to some degree from those proposed by Komanski, et al., but the requirements for synthetic training of certain skills is consistent. The major differences concern introduction of certain training events and specific characteristics of the proposed trainers.

The T-34C as a Primary or Extended Primary Trainer. The reported flight characteristics of the T-34C are expected to provide the capability for meeting the requirements of the proposed training system models. However, in examining various flight training programs, it was noted that for earlier phases of training the aircraft performance characteristics did not appear to be as important as in the sophistication of the avionics (see section II). An inexpensive airframe well-equipped with appropriate and reliable avionics can provide training in the skills that will transfer, particularly the control and instrument skills.

Synthetic Training Support for Primary/Extended Primary. The devices envisioned to support primary phases of the proposed system models are relatively unsophisticated. They include cockpit familiarization/procedures and off-the-shelf instrument trainers with a two degree of freedom motion system. However, the instrument trainer must be modified to provide the configuration and performance simulation of the primary training aircraft. The proposed array of devices would eliminate a requirement for development of an expensive operational flight trainer.

MULTI-ENGINE TRAINING EQUIPMENT. Replacement of the TS-2 as the advanced multi-engine trainer is considered essential to the development of a training system responsive to today's as well as future pilot training requirements. The VTAM(X) aircraft concept appears to provide the capability to meet the identified training requirements for prospective multi-engine pilots.

Synthetic Training Support for Advanced Multi-Engine. The following type of synthetic training support is envisioned to support VTAM(X) training. Cockpit familiarization/procedures trainers will be required for teaching nomenclature, checklists, and procedures. Two classes of flight simulators are considered necessary for training those skills which require dynamic simulation. A mix of off-the-shelf instrument trainers configured to VTAM(X) and a limited number of higher fidelity devices are required to provide a wide spectrum of cost-effective training capability. The so-called off-the-shelf instrument trainers configured to the VTAM(X) would have only two degrees of freedom of motion. They would be used for teaching transition and instrument skills. The second class of devices would be higher fidelity devices with four degrees of freedom motion systems and narrow angle visual systems. The additional degrees of motion would facilitate training tasks requiring asymmetrical thrust. The visual system would permit more effective training of tasks associated with instruments such as instrument takeoffs, landings, breakouts, and possibly some VFR tasks. The number of high fidelity trainers required would be small as only a limited number of advanced multi-engine training requirements need high fidelity simulation with a full range of motion and visual cues. The number of trainers required of each type have been identified and the costs were included in the economic analyses.

JET TRAINING EQUIPMENT. The aircraft used in the jet pipeline are among the more modern in the present aircraft inventory. Proposed replacement aircraft are not included in the alternate system model due to the feasibility of extending the life of the aircraft to 1985 and beyond through a SLEP. The deficiencies in training capabilities can be overcome by training strategies and adequate synthetic training support. A definitive identification of characteristics for replacements of TA-4 and T-2C will be addressed in Phase II.

Synthetic Training Support for Jet Training (Basic and Advanced). Addition of cockpit procedures trainers to support jet training would reduce the requirements for OFTs and reduce training costs. Device 2F101, used to support T-2 training, is modern and is expected to provide adequate flight simulator support for the remaining life of the T-2C. Addition of a relatively low cost computer generated narrow angle visual system should enhance the training capability of this device. One system has been priced in the system models to support advanced jet training in the T-2C for prospective VS pilots. A part-task visual system would meet the training requirements for a number of tasks in the proposed VS track.

The recently developed software changes for device 2F90 are expected to improve the simulated aircraft flying qualities of that trainer. However, the design limitations of the device limit the number of tasks that can be trained.

ROTARY WING TRAINING EQUIPMENT (PRIMARY AND ADVANCED TRAINING). The TH-57 is the introductory rotary wing trainer. As such, it is reported by the users to be very effective. The advantages of improved performance of this turbine powered helicopter and its demonstrated reliability and availability suggest that it is an appropriate aircraft for the present training tasks. The principal disadvantage of the aircraft is its lack of adequate instrumentation for instrument training. The LRPTS and the systems proposed herein all include an introduction of the student to integrated contact/instruments in the expanded T-34 (Primary) syllabus prior to beginning training in the helicopter.

During the period that students are engaged in Primary Helicopter training, the previously learned instruments skills are likely to erode to some degree. Investigation reveals that an instrument package is available for the TH-57 but its training worth and effect on aircraft performance have not yet been determined. The effect of the added weight is not known.

TH-57 aircraft training is not supported by dynamic synthetic trainers. An investigation of the feasibility of providing a low cost instrument trainer to introduce helicopter instrument skills and to maintain previously learned instrument skills should be undertaken. The present familiarization trainer for the TH-57 is used on a voluntary basis by students. Utilization of the device under supervision for training cockpit checkouts and various procedures would remove this activity from the aircraft where it is presently conducted, often under extremes of temperature and noise.

The TH-1/UH-1, an operational helicopter, used by the Army, and to a lesser extent by the Marines, appears to be a reliable vehicle for qualifying undergraduate pilots for designation as helicopter pilots and as helicopter instrument pilots. The aircraft has been in service for a number of years. There appears to be adequate numbers available to the Navy to meet foreseeable requirements. The turbine-powered aircraft is unlike the aircraft used in operational missions of both Navy and the Coast Guard. Selection of a twin-turbine replacement aircraft with stabilization equipment could enhance undergraduate rotary wing training but would increase training costs.

Synthetic Training Support for Advanced Helicopter Training. The present advanced training syllabus allocates a significant amount of in the air training to instrument tasks. These tasks should be trained in a modern flight simulator and reinforced and checked in the air. The validity of this has been demonstrated by Caro (1972). The limited availability of navigation and approach facilities coupled with protracted transit time between facilities for in-flight training of instrument tasks makes synthetic training the most viable alternative.

Most in-flight instrument training requires using the aircraft as a flight simulator in which IFR conditions must be simulated. Quite often the approach cannot be carried to actual minimums or must be offset. More tasks can be trained per unit of time in a simulator than in the aircraft. Time can be compressed and the delays required for clearance or preparation for a maneuver in an aircraft are eliminated. Shumway (1974) has estimated that 10 approaches can be accomplished in the simulator for every 4 accomplished in the aircraft.

Helicopter flight simulators, particularly those now being developed with visual systems, provide realistic simulated instrument conditions. The capability of carrying approaches to completion has significant added value over the present in-flight simulation of instrument conditions. The present helicopter instrument trainer, Device 2B18, used for support of advanced training, receives high utilization; but problems have been reported concerning the fidelity of simulation and the cockpit configuration. A flight simulator of the caliber of the Coast Guard Variable Cockpit Training System (VCTS) would provide greatly increased training capability. This capability could be further enhanced by a narrow angle visual system to provide training in certain visual tasks and expand the instrument training capability.

MULTI-ENGINE AND ROTARY WING IN-FLIGHT TRAINING TIME

Figures 3 and 4 show that the TAEG proposed systems provide less hours for in-flight training. When a significant number of tasks that can be trained synthetically are removed from the in-flight syllabi, time becomes available for training tasks presently undertrained or not being trained. The proposed systems should provide pilots better trained for operational requirements.

This does not imply a lowering of standards--instead, the proposed training strategy is intended to meet valid, realistic training objectives. The thrust of the multi-engine and rotary wing proposals is to meet these objectives utilizing a training strategy that will provide the required skills trained to a large extent in synthetic equipment but validated in the air.

SECTION V

ECONOMIC ANALYSIS OF UNDERGRADUATE PILOT TRAINING SYSTEM ALTERNATIVES

This section compares the costs of three alternative UPT systems. Previous sections have described these three alternatives in the following order: the CNATRA LRPTS, SPOT, and Alternative Model (Alternate 1). All alternatives are expected to produce pilots trained to proficiency levels equal to or exceeding those of the present system.

ANALYSIS PROCEDURE

A TAEG-developed economic analysis model was used as the basic cost analysis tool. The model was modified and tested to assure compatibility with the inputs peculiar to analysis of UPT. The search for data inputs required liaison with various codes within the Naval Air Systems Command (NAVAIRSYSCOM), CNO, CNET, and CNATRA. Team members utilized data from the CNET Resources Management Model and conferred with staff members on costing the various elements of the model.

The following activities were required for the initial analysis:

1. Data on current resources and operating costs were obtained from CNET and CNATRA.

2. Resources required to support alternative systems were identified.

3. Constant resource costs such as cost of carrier operations were factored out of all systems as not necessary for the Phase I analysis.

4. Computer programs were run for all systems and subsystems.

5. The data were then analyzed to determine the comparative costs of training using each alternative, the resources required (number of aircraft and synthetic trainers required, etc.), and percent cost savings achievable.

The number of computer runs (in excess of 400) precluded their inclusion here, but they are being retained for use in Phase II and are available for inspection. All costs are based on constant 1975 dollars. No adjustments in data are made for inflation. Costs over individual program planning period were discounted at the rate of 10 percent.

ASSUMPTIONS. The analysis is based on a level throughput with a required Pilot Production Rate (PPR) of 1750 students. Figure 5 depicts the percentage of graduates required from each of the pipelines. Undoubtedly, annual fluctuations in throughputs will occur resulting in periods where

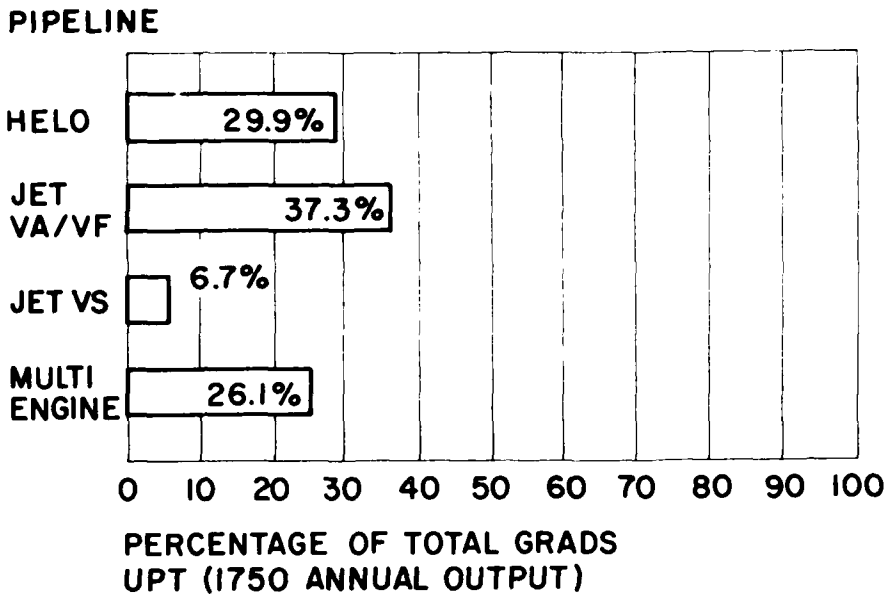


Figure 5. Frequency Distribution of Undergraduate Pilot Training Graduates (Among the Four Pipelines)

facilities are under utilized and other periods when it may be necessary to increase the intensity of utilization. After the analysis was well underway and computer programs run, information was received concerning a revision in the PPR.[12] The current PPRs are 1545 for FY 76 and 1318 for FY 77. Computer runs for the reduced PPR in one pipeline of the long-term system were made to determine cost impact. The analysis revealed that there was approximately a five percent difference in cost per graduate for both discounted and non-discounted costs between a 1750 PPR and a 1318 PPR. The decrease approximated the size of the decrease in the output; i.e., system cost decrease of 33 percent with a system output decrease of 34 percent.

Limitations The purpose of the Phase I economic analyses was to provide a base for comparative analysis in accordance with discussions at the pre-study meeting held at CNATRA.[13] Analyses data inputs include principal direct costs. These costs permit comparisons between the various system alternatives by either cost of training per pilot/per system or training resources required (aircraft, synthetic trainers, instructors). The data are preliminary and complete confidence with the estimates is not suggested. However, the relative magnitude of costs between systems is believed to be quite accurate. Criteria for developing cost estimates were uniform for all systems and are considered valid for comparative judgments. Total costs for systems and subsystems will be determined in Phase II after detailed system definition has been completed. This will permit development of budget estimates. A list of the cost factors and other input data including source and method of computation are included in appendix G.

DISCUSSIONS AND ANALYSIS

A reduction in the resources required for training depends primarily on the realization of a number of changes in the training system. First, more vigorous determination must be made of the necessary skills which pilots should possess given the type of operational units to which they will be assigned. The program would then focus on these skill areas, eliminating superfluous and unnecessary training. Second, more vigorous and reliable screening procedures would be implemented with the objective of lowering the attrition rate, especially in the later phases of training. A substantial reduction in the attrition rate would have implications for resources required for training. Third, management and training strategies would be changed to utilize the less expensive training equipment to

[12] CNATRA, N-2 memo of 31 Jan 75
[13] CNATRA-TAEG meeting of 2 Oct 1973

train those basic skills which have a high degree of commonality among the various types of aircraft. Fourth, and perhaps most significant, would be the expanded utilization of synthetic training devices. The expanded use of such devices can reduce the requirements for in-flight training in certain communities by 30 percent or more. These reductions translate into reduced requirements for aircraft and other support equipment. Not only are the fixed costs of training substantially reduced but significant savings in various (or operating) costs are possible. A part of these latter savings would be from reduced fuel costs. While the use of synthetic training would substantially reduce training costs, there is evidence to indicate that this can be accomplished with no degradation of training quality.

ANALYSIS OF LONG-TERM ALTERNATIVES

SPOT and Alternative 1, long-term alternatives to the LRPTS model, were discussed in section IV. The evaluation of each of the three alternatives included cost of aircraft acquisition, synthetic training devices, fuel, operations and maintenance, instructional materials, facilities, equipment, personnel, and students. Although the planning period of 15 years exceeds the life expectancy of some of the training aircraft, the cost of SLEP was not included. Service Life Extension Program costs are extremely difficult to estimate since these costs are highly dependent upon requirements of each specific siutation. The omission of SLEP costs will bias the cost estimates in favor of those systems which extensively utilize existing training aircraft. The cost of the alternative which is heavily dependent upon aircraft for training; i.e., the LRPTS, would be understated relative to those systems which are more heavily dependent on synthetic training devices.

The aircraft manning requirements for support were included in the cost analysis. Total manning requirements are dependent upon the type of aircraft and on the number of aircraft. Differences do exist in the type and number of aircraft required for the long-term alternatives. Those alternatives which do more of their training in the aircraft would have the highest manning requirement. With respect to the various training systems considered in this analysis, the LRPTS and Alternative 1 would be expected to have higher manning costs than SPOT.

The present cost of the three alternatives as computed for a 15-year planning period demonstrated that SPOT would be the least expensive followed by Alternative 1 and finally LRPTS. The present cost for SPOT was $310.7 million less than LRPTS and $158.7 million less than Alternative 1. The present cost of Alternative 1 was $152 million less than LRPTS. See table 5 for Cost Comparisons of Long-Term Systems. Relative Cost Comparisons are shown in table 6.

GLOSSARY (continued)

FEC . . . . . National Aviation Facilities Experimental Center

MRL . . . . . Naval Aerospace Medical Research Laboratory

TOPS . . . . . Naval Air Training and Operating Procedures Standardization

E . . . . . Nap of the Earth

EC . . . . . Naval Training Equipment Center

T . . . . . Operational Flight Trainer

MN . . . . . Operation and Maintenance Navy

S . . . . . Officer Training School

R . . . . . Precision Approach Radar

R . . . . . Pilot Production Rate

A . . . . . Pacific Southwest Airlines

AV . . . . . Area Navigation

TC . . . . . Reserve Officer Training Corps

. . . . . Rotary Wing

R . . . . . Search and Rescue

TS . . . . . Synthetic Flight Training System

-3 PLUS . . . . . Advanced Version of SH-3 ASW Helicopter

D . . . . . Standard Instrument Departure

EP . . . . . Service Life Extension Program

R . . . . . Stimulus, Organism/Operator, Response

OT . . . . . Synthetic Screening, Pipeline Suitability Prediction, Orientation and Training

S . . . . . Student Predictor Score

ASH . . . . . Navy Pilots given non-operational assignments after completing UPT

GLOSSARY (continued)

DME . . . . . Distance Measuring Equipment

FAA . . . . . Federal Aviation Administration

FAR . . . . . Flight Aptitude Rating

FCLP . . . . . Field Carrier Landing Practice

FIP . . . . . Flight Indoctrination Program

FLIR . . . . . Forward Looking Infra-Red

FW . . . . . Fixed Wing

GAT . . . . . General Aviation Trainer (Trademark of device manufactured by Simulation Products Division, Singer Corporation)

GCA . . . . . Ground Controlled Approach

GCT . . . . . General Classification Test

G . . . . . Acceleration

HP . . . . . Horsepower

HSX . . . . . Helicopter Anti-Submarine Experimental (Lamps Concept Helicopter)

IFR . . . . . Instrument Flight Rules

ILS . . . . . Instrument Landing System

LAMPS . . . . . Light Airborne Multi-Purpose System

LRPTS . . . . . Long Range Pilot Training System

LSE . . . . . Landing Signal Enlisted

MAD . . . . . Magnetic Anamoly Detection

MECH . . . . . Mechanical Comprehension Test of Classification Battery

MLP . . . . . Mirror Landing Practice

GLOSSARY

ab initio pilot . . . . . No previous flying time

ACLS. . . . . Automatic Carrier Landing System

ACM . . . . . Air Combat Maneuvering

ADF . . . . . Automatic Direction Finder

AFA . . . . . Air Force Academy

AFGE . . . . . Advanced Flight Grade Estimate

AFOQT . . . . . Air Force Officer Qualification Test

AGL . . . . . Above Ground Level

AOA . . . . . Angle of Attack

AOC . . . . . Aviation Officer Candidate

AQT . . . . . Aviation Qualification Test

ARI . . . . . Arithmetic Test of Enlisted Classification Battery

ARTCC . . . . . Air Route Traffic Control Center

ASR . . . . . Airport Surveillance Radar

AWCLS . . . . . All Weather Carrier Landing System (see ACLS)

CCA . . . . . Carrier Controlled Approach

CCTS . . . . . Combat Crew Training School

CFT . . . . . Cockpit Familiarization Trainer

CNATRA . . . . . Chief of Naval Air Training

CNET . . . . . Chief of Naval Education and Training

CNO . . . . . Chief of Naval Operations

COD . . . . . Carrier On Board Delivery

CPT . . . . . Cockpit Procedures Trainer

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- Initiate the development of a synthetic screening, pipeline suitability prediction, orientation, and training concept capability for Navy UPT. The proposed selection system is explained in appendix B. Installation of the system could be accelerated by validating the synthetic selection process with data gathered on Navy UPT students.

provide an effective system for meeting the pilot training requirements of the post-1975 period.

The SPOT offers a potential savings of $300 million and 180 aircraft over the 15 year period analyzed.[14] These savings can be realized through the incorporation of synthetic selection and application of the "systems approach" to training system design in which realistic training requirements are identified, and training is directed toward accomplishment of the requirements. "Need to Know" is substituted for "Nice to Know."

- The insistence upon an all-conditions visual system to duplicate the real world is impeding the substitution of synthetic training for in-flight training. A part task visual attachment would provide training in takeoff, transitions between IFR and VFR, and landing. This would substantially increase the effectiveness of devices such as the 2F101 in that most instrument training tasks could be accommodated.

- The practice of providing advanced training for prospective VS pilots in the TA-4 does not appear to be either cost or training effective (see sections III, IV, V and appendix C).

RECOMMENDATIONS

The present TAEG study effort should be continued (Phase II) to translate and refine the selected long-term system model into a viable system for the conduct of UPT.

SPECIFIC RECOMMENDATIONS. A number of specific recommendations are proposed as a result of this current phase of study. They are:

- Examine the feasibility of reducing fixed wing training for rotary wing pilots. Limit fixed wing training of rotary wing pilots to those tasks necessary for pipeline selection and those tasks identified as having high positive transfer.

- Delete training in nonoperationally related skills for prospective multi-engine pilots.

- Tailor the advanced VS curriculum to provide operationally related skill training. Conduct advanced training for prospective VS pilots in the T-2C.

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[14] Estimated savings are based on calculations developed from data received during the course of this study. Data sources are discussed in the text and the inputs to the cost model are identified in appendix G.

SECTION VI

CONCLUSIONS AND RECOMMENDATIONS

Conclusions and recommendations concerned with the development of a training system for the post-1975 period are presented in this section. General comments have been made throughout this report identifying areas in the present system that warrant consideration for change.

The preliminary nature of the Phase I study necessarily limits the recommendations at this time. What is clear, however, is that much can be done to improve the state of UPT both from cost and training effectiveness standpoints.

CONCLUSIONS

- Analysis of rotary wing UPT training requirements suggests that fixed wing training should be limited to those tasks necessary for pipeline selection and tasks identified as having high positive transfer.

- The rationale that providing extensive training for rotary wing pilots in fixed wing aircraft is less expensive than rotary wing training is questioned. Reduction of fixed wing training for rotary wing pilots is considered to be a viable long term goal.

- Current assignment/reassignment policies invalidate the requirement for dual qualification for rotary wing pilots. Migration from rotary to fixed wing billets is negligible.

- A significant number of the required skills for rotary wing and multi-engine pilots can be trained in a synthetic environment and validated in the air without compromising safety. Undergraduate pilot training graduates are assigned to copilot billets under supervision of a qualified plane commander until the extensive NATOPS requirements for upgrading to plane commander are met.

- The SPOT model utilizing a unique selection technique can improve the present selection system. A growing body of evidence indicates that standard samples of flight tasks administered automatically in a synthetic ground trainer offer potential for predicting general flying abilities and predicting potential attrites due to flight deficiencies. The ability to measure student performance objectively should result in reduced overall attrition after beginning flight training, reduced training costs, and upgrading the quality of graduates. The testing of those perceptual motor abilities correlated with piloting success should be accomplished in a standardized and controlled synthetic environment. The SPOT is expected to

The economic analysis contained in Phase I was developed to permit a logical comparison between the alternative systems. Exactitude is not possible until after the determination of the terminal objectives and the completion of a detailed media analysis to determine exact numbers and kinds of resources required. During Phase II a system simulation model will be developed and utilized for the detailed examination, evaluation and manipulation under stated conditions.

The simulation model will be used to test and identify feasible alternatives within the system. The results will be used in conjunction with the economic model to determine the most economically efficient design of the selected system. Both models will be provided as management tools with associated computer programs.

TABLE 7. AIRCRAFT REQUIRED FOR 1750 PPR

Training System	T-34C	TH-57	TH-1/UH-1	T-2C	TA-4	VTAM(X)
LRPTS	267	31	68	164	156	65
ALT 1	225	32	53	162	131	56
SPOT	169	36	49	139	121	53

TABLE 6. PERCENT RELATIVE COST PER PIPELINE GRADUATE USING LRPTS AS A BASE

Pipeline	SPOT (Percent)	ALT 1 (Percent)	LRPTS (Percent)
Helicopter	63.9	81	100
VA/VF	89.3	98	100
VS	60.1	66.8	100
Multi-Engine	78	87.3	100

Aircraft resource requirements for the alternative systems are displayed in table 7. Inspection of this table reveals that progression from the current system through the various alternatives to SPOT requires fewer and fewer aircraft. Reductions in fewer aircraft can be translated directly into significant cost savings.

SUMMARY

The present cost of the alternatives represent that amount of funds which would be required on "day one" to implement and operate the system over the entire planning period, assuming that all funds could be invested to yield a 10 percent return until required. Many of the resources, which are common to all alternatives, have not been included. Thus, the absolute cost levels on which this analysis is based will understate the requirements for training funds. The reader is therefore cautioned not to use the magnitude of the absolute costs for judging the validity of the analysis.

The significance of the analysis findings cannot be overstated since sound economic analytic techniques were utilized throughout the analysis. The alternative 1 system indicates a savings of $152 million and 92 aircraft while the SPOT system offers a $310.7 million and 184 aircraft savings over the presently proposed LRPTS during a 15-year period.

Once decisions are made as to which system is preferred, then incremental and operational costs in a format required for budget submission can be developed (budget dollars). Budget limitations may force a redefinition of objectives but through an iterative process both a feasible and efficient alternative can be developed. It is anticipated that such an analysis will be done in Phase II of this study.

TABLE 5. COST COMPARISON OF LONG-TERM SYSTEMS
PPR OF 1750

Present Cost of Alternative(1)					
System	Helo	Jet VA/VF	Jet VS	Multi-Engine	Total
LRPTS	279,344,588	867,532,342	154,965,904	245,560,161	1,547,402,995
ALT 1	226,475,692	850,970,401	103,612,244	214,297,720	1,395,356,057
SPOT	178,494,615	775,002,211	93,198,450	190,251,434	1,236,646,710
		(Savings)			
ALT 1 VICE LRPTS	52,868,896	16,561,941	51,353,660	31,262,441	152,046,938
SPOT VICE LRPTS	100,849,973	92,530,131	61,767,454	55,308,727	310,756,285
SPOT VICE ALT 1	49,981,077	75,968,190	10,413,794	24,046,286	158,709,347

Note: Costs included are Direct Training, Direct Support, Progressive Rework, and Student Compensation.

(1) The costs for the systems were time phased, discounted, and a present cost for each alternative was computed. The Present Cost of alternative is a measure of the amount of funds necessary to fund the system over the 15-year period assuming that excess funds could be invested (with a 10 percent yield) until needed.

GLOSSARY (continued)

TACAN . . . . . Ultra-high-frequency Tactical Air Navigation System

TAEG . . . . . Training Analysis and Evaluation Group

TECEP . . . . . Training Effectiveness, Cost Effectiveness Prediction Model

UPT . . . . . Undergraduate Pilot Training

USAF . . . . . United States Air Force

UTTAS . . . . . Utility Tactical Transport Aircraft System

VCTS . . . . . Variable Cockpit Training System

VFA(X) . . . . . Navy Fighter Attack Experimental

VFR . . . . . Visual Flight Rules

VOR . . . . . Very High Frequency Visual-Omnirange Navigation System

VP . . . . . Patrol Plane

VS . . . . . Carrier Anti-Submarine Warfare Squadron

VTAM(X) . . . . . Designation for proposed aircraft concept for use as UPT advanced multi-engine trainer

APPENDIX A

ACTIVITIES CONSULTED DURING THE COURSE OF THIS STUDY

In the course of the analysis effort the team visited the following activities to obtain data on UPT, simulation state-of-the-art, research on pilot training, and future training requirements.

Air Force Human Resources Laboratory
Williams Air Force Base, Arizona

Air Force Human Resources Laboratory
Lackland Air Force Base,
San Antonio, Texas

American Airlines Flight Academy
Fort Worth, Texas

Braniff Airlines
Dallas, Texas

Chief of Naval Air Training Staff
Naval Air Station
Corpus Christi, Texas

Chief of Naval Operations
- Undergraduate Flight Training (OP-591)
- Aviation Training Device Requirements (OP-596)
- Manpower Programs (OP-597)

Washington, D.C.

Chief of Naval Personnel
Air Combat Units Placement Branch (PERS-433)
Washington, D.C.

Commander Naval Air Force, Pacific
(Replacement Training Squadrons)

HS-10	VA-127
HSL-31	VA-128
VF-121	VA-125
VF-124	VAQ-129
VA-122	

Flight Safety International Academy (ab initio training)
Vero Beach, Florida

Human Resources Research Office
Division No. 6
Fort Rucker, Alabama

Headquarters, U.S. Marine Corps
Code AAZ
Washington, D.C.

Marine Air Group 26
Marine Corps Air Station
New River, North Carolina

Naval Aerospace Medical Research Laboratory
Naval Air Station
Pensacola, Florida

Pacific Southwest Airline Training Center
(Lufthansa ab initio pilot training)
Goodyear, Arizona

Second Marine Air Wing
Marine Corps Air Station
Cherry Point, North Carolina

Training Air Wing THREE, Training Squadron TWENTY-FOUR
and TWENTY-SIX
Naval Air Station, Chase Field
Beeville, Texas

Training Air Wing FOUR, Training Squadron TWENTY-EIGHT
and THIRTY-FOUR
Naval Air Station
Corpus Christi, Texas

Training Air Wing FIVE, Training Squadron TWO and THREE,
Helicopter Training Squadron EIGHT and EIGHTEEN
Naval Air Station, Whiting Field
Milton, Florida

U.S. Army Aviation School
Fort Rucker, Alabama

U.S. Coast Guard Aviation Training Center
Mobile, Alabama

VA-174
Naval Air Station, Cecil Field
Jacksonville, Florida

APPENDIX B

THE SYNTHETIC SCREENING, PIPELINE SUITABILITY PREDICTION, ORIENTATION AND TRAINING CONCEPT

The current Navy undergraduate pilot selection procedure is conducted in two phases. The first, or pre-induction phase, is concerned with physical and mental (paper and pencil) examinations. The second, or post-induction phase, is accomplished after commencement of flight training and focuses on the student's in-flight performance. This appendix centers on the post-induction testing requirements and amplifies the discussion of synthetic testing proposed as an integral part of the optimized Long-Term Training System (SPOT) described in section IV of this report.

The synthetic testing phase of SPOT is predicated on the employment of low fidelity, inexpensive flight simulators. These simulators will be configured to and exhibit the flight characteristics of the primary training aircraft. They are envisioned as the principal vehicle for evaluating prospective aviators via objective performance sampling of their perceptual-motor abilities. The devices will be used to obtain performance samples on a series of tasks similar to those required in flight (e.g., level flight, turns, climbs, descents, various patterns, and tracking tasks).

The present selection procedures are limited by their inability to accurately differentiate between abilities of individuals. Currently students are evaluated on the basis of observed performance in the air during the first 17 hours of flight training. Some are eliminated; the remaining are assigned to the three pipelines. For the trainee with previous flight experience, the evaluation reflects those already learned contact flight skills as well as those acquired in the primary phase. As a result the trainee with previous flight experience will likely have better flight grades and consequently have greater opportunity for assignment to the jet pipeline. Unfortunately, his true ability may not be manifest until he encounters the more demanding requirements of high performance jet aircraft and difficult tactical tasks. In the past, a correction factor was applied to the grades of students with previous flight experience to counteract that advantage prior to pipeline assignment. However, this practice has been discontinued.[15]

Failure to identify accurately the capability of the trainee prior to the jet pipeline assignment has resulted in high attrition rates during basic and advanced UPT as well as in replacement pilot training. For example, an examination of the attrites due to flight deficiencies at one jet training wing revealed that of the trainees eliminated for flight deficiencies during 1974, all had previous flight experience (two had commercial licenses).[16]

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[15] Personal communication with Ms. R. Ambler, Naval Aerospace Medical Research Laboratory.

[16] COMTRAWINGTHREE ltr 01 of 20 Aug 75.

Improved screening should result from the CNATRA proposed extension of the primary phase to approximately 65 hours. This phase would be flown in the modern and higher performance T-34C. However, the emphasis is still focused on subjective in-flight evaluation. While the extended primary phase will undoubtedly improve pipeline selection, it appears that a more cost-effective selection and training program could be designed around ground-based devices.

EXPERIENCE AND RESEARCH RELEVANT TO SYNTHETIC TESTING OF GENERAL PILOTING ABILITIES

A growing body of evidence suggests that objective testing of piloting abilities in a realistic and well controlled synthetic environment can identify potential eliminees early in the program with greater accuracy. Also, those individuals with superior perceptual-motor skills can be similarly identified, which in turn facilitates pipeline assignments. The use of synthetic testing techniques is not new, having been successfully employed by the Royal Canadian Air Force as far back as World War II (Melton, 1947). They have more recently been used with success by KLM (Gobel, Baum, and Hagin, 1971) and Lufthansa Airlines (Reese, 1971).

Ongoing research is currently underway in both civilian and military communities. Research conducted by the Aviation Research Laboratory of the University of Illinois using civilian student pilots has demonstrated that simulators can be used for assessment of pilot ability potential as well as for training of in-flight tasks. Povenmire and Roscoe (1969) found:

> There was a significant positive correlation of 0.50 between assessment based on two hours of training time in ground based trainers and actual hours to pass the flight check....

Several studies sponsored by the U.S. Air Force tested perceptual-motor skills in relatively unsophisticated flight simulators in an attempt to predict subsequent piloting success. Gobel, Baum, and Hagin (1971) measured the performance of student pilots who received 6 one-hour testing periods in a GAT-1 simulator.[17] Tasks included external cue tracking and internal cue maneuvers such as slow flight and ILS. The conclusions were:

> Based on the analysis of the subjective data; i.e., the GAT-1, T-41, and T-37 instructors' and check pilots' overall proficiency evaluations, it was

[17] The GAT series are general aviation trainers. The GAT-1 simulates a single engine light aircraft; the GAT-2, a piston powered light twin, and the GAT-3, a light twin engine business jet. Reference to general aviation trainers and GAT, a registered trademark of Singer-General Precision Inc., does not constitute an official endorsement or approval by the Navy Department of a commercial product.

found that GAT-1 performance was significantly correlated (+0.50) with the T-41 final check performance. Additionally, GAT-1 performance rating also correlated, though less well, with the T-37 (twin-engine jet trainer) criterion performance under conditions of intervening T-41 training.

A second study for the Air Force (LeMaster and Gray, 1974) developed a screening procedure for UPT based upon the use of synthetic trainers (GAT-3). Undergraduate pilot training candidates, naive to flying, were evaluated on their performance in selected samples of basic instrument flying. The study found that performance in the GAT was correlated with subsequent performance in the T-37 aircraft. The study did not predict attrition due to causes other than flying deficiency.

A third research effort utilized the Automated Pilot Aptitude Measurement System (APAMS) developed by McDonnell Douglas. The APAMS hardware includes the GAT-1, a mini-computer, various audio-visual equipments, a synthetic voice generator, and secondary task equipment. Pre-test training, instruction, and feedback are automated. Student performance is automatically recorded. This study used learning samples taken on 178 students before they entered the flying phase of UPT. Samples were taken during 5 one-hour test sessions in a modified GAT-1. Subjects were instructed to fly prescribed patterns by reference to basic instruments while receiving feedback of performance information concerning position and attitude on a cockpit CRT and from a synthetic voice generation system. A secondary task requiring the subjects to extinguish a light via depressing an appropriate response button in addition to controlling the simulated aircraft was introduced in later sessions. This provided an additional stress loading on the subject (McDonnell Douglas, 1975).

Performance in the device was compared to subsequent performance in the T-41 primary trainer, the T-37 basic jet trainer and will be compared with performance in the T-38 advanced jet trainer when subjects have completed this phase. A positive correlation coefficient of 0.44 was found between performance in the GAT and successful completion of the basic jet phase (McDonnell Douglas, 1975). These results, while obtained on a limited sample, are most promising.

Liaison with the Army Research Institute indicates that consideration is being given by the Army for a research program similar to APAMS for the screening of prospective helicopter pilots.[18] The program will employ Device 2B24, a sophisticated UH-1 flight simulator, which has a number of automated and adaptive capabilities well suited to performance testing (see Regan and Amico, 1971).

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[18] Personal communication with Dr. Robert Eastman, Army Research Institute, Fort Rucker, Alabama.

Experience and research have demonstrated the potential of assessing generalized flight abilities (perceptual-motor, procedural and cognitive) in a ground environment. This has provided the guidelines for the development of an operational system to test prospective Naval aviators. Each candidate should undergo synthetic screening to assess piloting potential. This screening should partial out previous civilian flight experience to insure that pipeline selections are based on measured true ability.

FUNCTIONAL CHARACTERISTICS OF THE AUTOMATED SYNTHETIC SELECTION DEVICE. The device proposed for this capability is envisioned to perform the following functions:

1. Conduct automated objective testing and scoring of perceptual-motor abilities of prospective pilots.

2. Provide automated information on device operation and pre-test instruction.

3. Provide automated aural and visual performance feedback to subject.

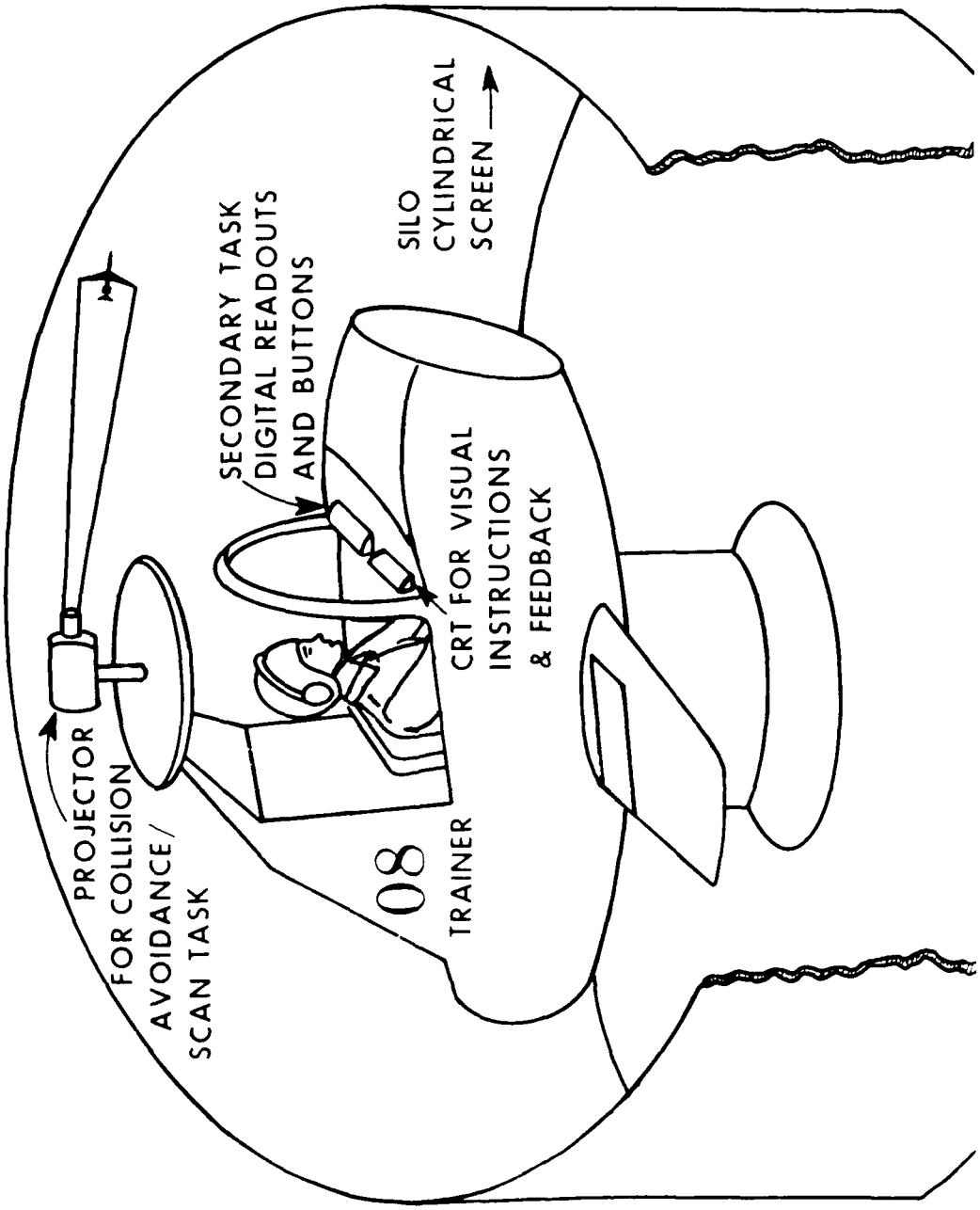
4. Provide automated adaptive functions.

5. Provide secondary task function for stress inducement.

6. Provide collateral training functions for such tasks as collision avoidance/scan training.

Functional Description of the Automated Synthetic Selection Device. An artist's concept of the synthetic selection device is shown in figure B-1. An unsophisticated flight simulator configured to the cockpit of the primary flight trainer provides moderate fidelity simulation of the aircraft flight characteristics. The simulator comprises a simple motion system, visual information displays, secondary task display, a voice generator, and a central computer. The central digital computer provides for the automated functions of problem initialization, control of scenarios for flight tasks, performance feedback, adaptive effects, testing and scoring, and control of target visual presentation.

Ancillary Training Role. The previously cited APAMS system study noted that while the syllabus used for testing was not designed to train the students as pilots, it proved extremely effective (McDonnell Douglas, 1975). It is expected that the instruction in basic control tasks and instruments will transfer to later training tasks. The device with its automated instructional capability is considered to be an appropriate vehicle for the proposed collision avoidance/scan training discussed in appendix C. It must be stressed that these collateral training functions are not a part of the synthetic testing phase. Collision avoidance/scan training appears to have potential for future inclusion in the testing battery. However, data must first be obtained to determine the screening value of these tasks.


AUTOMATED SYNTHETIC SELECTION DEVICE
PROJECTOR FOR COLLISION AVOIDANCE/ SCAN TASK
SECONDARY TASK DIGITAL READOUTS AND BUTTONS
SILO CYLINDRICAL SCREEN
CRT FOR VISUAL INSTRUCTIONS & FEEDBACK
08 TRAINER

A RESEARCH PROGRAM ON SPECIAL ABILITIES TESTING FOR PIPELINE SELECTION

Certain specialized abilities appear to be related to piloting success in particular pipelines/communities, although they may be required of all aviators to a lesser extent. It is reasonable to determine if a demonstrated unusual competence in time sharing (internal and external scan), precision control in tracking tasks, complex instrument procedures and monitoring, spatial orientation, operating under continued high stress, leadership, among others, can be identified as related to success in a particular community. For example, is a high degree of skill in time sharing closely related with success in the jet community because of the greater tactical lookout requirements? Is there a correlation between motor coordination using external references with success in the rotary wing community considering the requirements of maneuvering in proximity to various obstacles at sea or over terrain? Are complicated instrument procedures following and monitoring endurance related to success in the multi-engine community?

Unfortunately, these hypothesized ability-success relationships are not yet well understood. However, they suggest a number of intriguing research questions. The synthetic ground based trainer is particularly appropriate for examining and evaluating these special ability relationships. A long term systematic research effort is proposed to study special abilities. As previously discussed, this effort would be coordinated and/or conducted by NAMRL. Once developed, special abilities testing in conjunction with general abilities testing should further improve the accuracy of pipeline assignments (matching the man to the job).

APPENDIX C

SOME ISSUES PERTINENT TO UNDERGRADUATE PILOT TRAINING

A number of pertinent ancillary issues emerged during the course of this study which invited consideration and discussion beyond the depth feasible in the body of the report. They are presented in the interest of identifying areas for potential reduction of training costs, improved training effectiveness, or as solutions to existing training deficiencies. Several concepts offer potential for training improvement but require further investigation. Training equipment, training strategies, and training requirements appropriate to future UPT are discussed in this appendix.

NEW TRAINING REQUIREMENTS AND/OR EQUIPMENT

A number of new training requirements were identified in section III. These fall into two categories: those that could be incorporated without major equipment change and those that would require significant equipment changes. Several training requirements or equipment changes require in-depth discussion and are included in this section. These are discussed next.

Area Navigation System (RNAV). This system utilizes VOR/DME stations to establish waypoints (phantom VOR's) that permit navigating off existing airways and approaches to geographical locations not served by a navigation/approach facility. The system utilizes an electronic process for navigation along parallel routes, non-radial routes, reduction of cross-course errors and can provide simultaneous approaches to a single navigation aid. RNAV may offer advantage to the undergraduate pilot training process by permitting more effective utilization of airspace and radio navigation facilities. At the present time, as far as can be determined, TACAN has not yet been approved for area navigation purposes by the FAA.

The potential of such a system for establishing "training" airways should be explored. Theoretically, a single TACAN station could be used for RNAV approaches to fictional landing fields for training in various type approaches. At the present time, the number of instrument approaches that can be accomplished by a student is relatively small due to unavailability of the facility, in-transit time, requirements for offset approaches, waveoffs, or artificial minimums.

For example, a TACAN, such as serves NAS Chase Field, could provide simultaneous approaches to a number of geographical locations in the vicinity. Surveys of planned geographic locations would insure that approaches would not physically interfere with each other and could be carried out to minimums.

Information received on the T-34C indicates that the aircraft will be wired to accept RNAV avionics at some future date. It is not known if RNAV

capability is planned on the same basis for the VTAM(X). The feasibility of equipping other training aircraft such as the TH/UH-1, T-2C, and TA-4 should be explored. The savings in helicopter transit time could be especially significant. Equipment expenditures would be offset by savings in fuel and by improved training. The RNAV system can also be used for teaching radial intercepts, holding, and orientation. FAA Handbook 7110.18 of 27 February 1970 and the NATOPS Instrument Flight Manual of 15 June 1972 provide data on RNAV and its utilization. Figure C-1 is a copy of a certified RNAV approach to Sanford, Florida. The approach utilizes the Orlando VOR/DME navigation facility. RNAV simulation could and should be incorporated in synthetic trainers if and when incorporated in Naval aircraft.

Instrument Landing System (ILS) Approach Training. The Navy commitment to GCA has previously restricted the use of ILS equipment and ILS approach training. Even though it is not a Navy primary landing system, ILS training should be examined. Aircraft such as the P-3, KC-130, and others are equipped with ILS equipment and frequently utilize Air Force and FAA installations equipped with ILS. The newer carrier aircraft such as F-14, S-3, A-7, etc., are equipped with the Automatic Carrier Landing System (ACLS). These systems use the ILS type cockpit course and glide slope indicators. While the ACLS is not compatible with FAA equipment, training in ILS as a shore-based substitute should benefit carrier pilots. (Note the Air Force is equipping single piloted aircraft and a number of training aircraft with ILS; i.e., T-37.)

Certainly the prospective multi-engine pilots should receive training in ILS at the undergraduate level. Addition of ILS training to helicopter training should also be considered, as these aircraft occasionally use non-Navy facilities.

Radar Altimeter Warning System. Examination of the capabilities of the T-2C aircraft revealed that the aircraft has no radar altimeter or radar altimeter warning system. This does not appear to significantly affect the training capability of the aircraft for its present mission. However, if the aircraft is accepted as an advanced trainer for prospective VS pilots, consideration should be given to incorporation of a radar altimeter or radar altimeter and warning system. As previously discussed, operational needs require the VS pilot to be proficient in all weather day and night operations. For these conditions, a radar altimeter, preferably with the warning capability, is almost a mandatory equipment requirement. This addition would significantly extend training capability of the T-2C.

TRAINING REQUIREMENTS. In examining current and future training requirements, it was noted that several presently trained skills are of sufficient importance to warrant emphasis as separate and identifiable training requirements. Collision Avoidance/Scan Training and Decision Making are in this category.

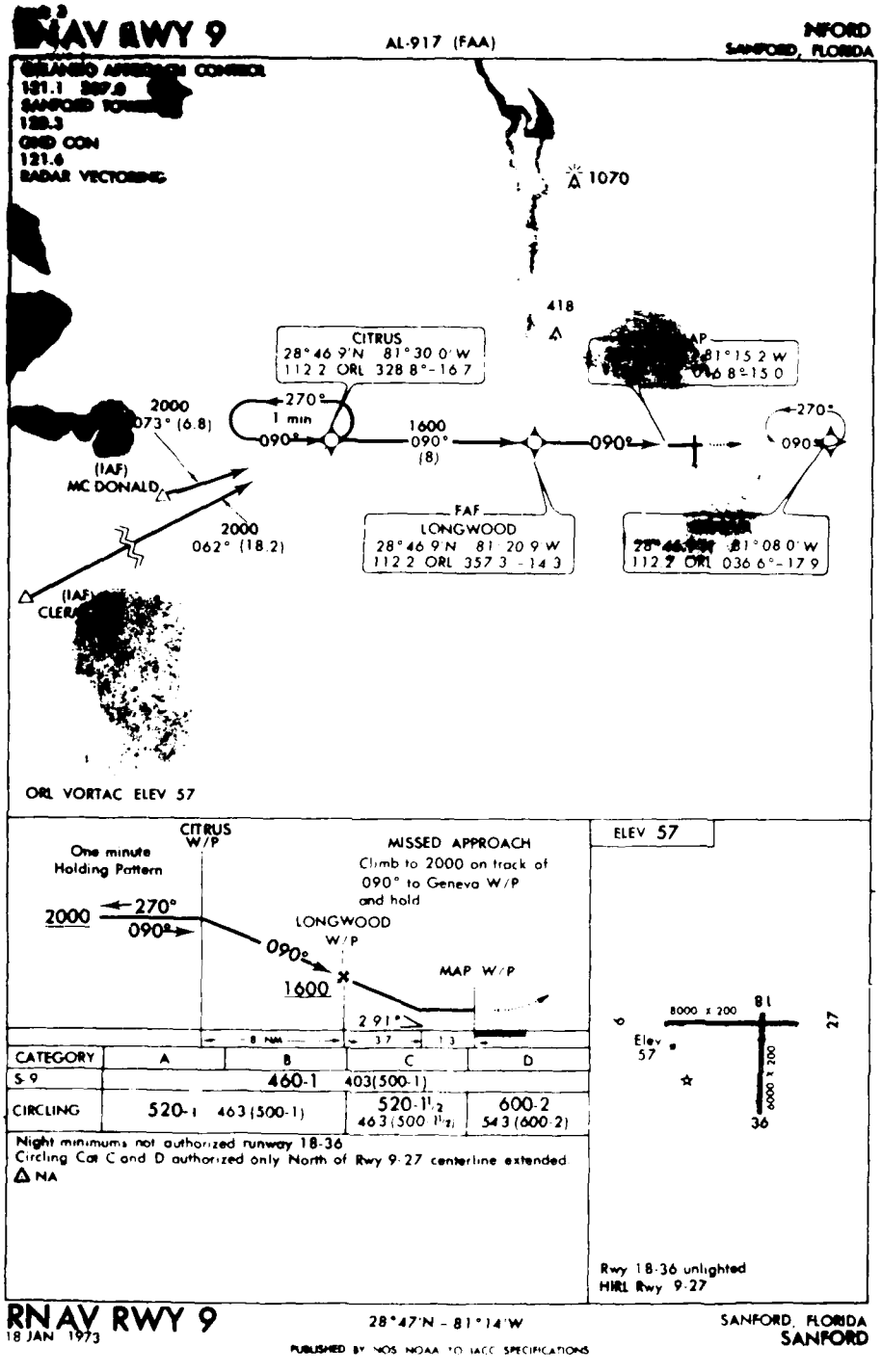


Figure C-1. RNAV Approach to Sanford, Florida

Certain current training philosophies are questioned. While they have been mentioned in foregoing sections, an in-depth discussion is provided here. Such policies as the requirement for "dual qualification for rotary wing pilots" are included. Several collateral issues such as Instructor Training and Quality of Graduates are also included.

Collision Avoidance. Midair collisions are increasing as the number of aircraft utilizing available airspace increases. Saturation of available airspace results in pressure on the military to release airspace and reduce exceptions to federal regulations in accomplishing mission requirements. During the period 1938 to 1971, 701 midair collisions occurred. These resulted in 1,465 fatalities (Harnly, 1974). It has been predicted that the incidence of midair collisions will increase to 128 per year by 1980 and to 833 by 1995 (Goodyear, 1970). These predictions, of course, are dependent upon the anticipated growth of aviation and on the progress in development of prevention measures. The Federal Aviation Administration (FAA) has estimated that traffic handled by the FAA Air Route Traffic Control Centers (ARTCC) will increase as follows (National Aviation System Plan 1973 - 1982):

Air Carrier	33 percent
General Aviation	231 percent
Military	4 percent

While the increase in military traffic is not large, the traffic that is forecasted to impinge on military flights, particularly in controlled airspace, is formidable.

The number of near misses reported to the FAA, Air Force, and Navy is large; however, the reported near misses have been estimated to be only a fraction of those that actually occurred. Most of the 1968 midair collisions reported for civil aviation occurred at or near uncontrolled airports in VFR conditions (Midair Collisions in U.S. Civil Aviation - 1968, July 1969). Data reported on military nonformation midair collisions also indicate that the majority of these collisions occur in the vicinity of airports, during daylight hours, and under VFR conditions. A significant percentage involved at least one student pilot (Harnly, 1974).

The Air Force suffered 228 midair collisions in a 14-year period ending 1973. Twenty-three percent of these collisions occurred during nonformation flights (Harnly, 1974). Naval aircraft have been involved in 84 midair collisions during a 5-year period ending calendar year 1974. Fifteen percent involved nonformation flight.[19]

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[19] Personal Correspondence, Facilities Analyst, Naval Safety Center, 25 Feb 75.

The principal solutions to collision prevention are collision avoid-
ce hardware, increased positive control and collision avoidance training.
rdware has been and is being developed; but it alone is not the solution,
r is it expected to be mandatory equipment for all aircraft. Increased
sitive control is being resisted. Adherence to the "see and be seen"
le, and collision avoidance training emphasizing scan techniques can
gnificantly reduce the incidence of midair collisions. Collision
oidance research has been conducted at the FAA National Aviation Facili-
es Experimental Center (NAFEC), Atlantic City, New Jersey and for the
val Training Equipment Center at Marine Corps Air Station, El Toro,
lifornia.

The NAFEC study (Sulzer & Crook, 1968) was concerned with the evalua-
on of low cost collision avoidance ground training equipment. A simu-
tor configured to a Cessna-182 aircraft was used in conjunction with a
rtial sphere dome visual system. A slide projection system was used to
oject images of a head-on jet silhouette. Subjects were required to fly
mulated cross country flights utilizing VOR, ADF, low frequency ranges,
d ILS. While following the prescribed flight path, they were required
meet certain tolerances for airspeed, altitude, heading; monitor engine
struments for malfunctions; and search for visual targets. Forty tar-
ts were presented to each subject during each of 10 training sessions
ich lasted from 35 to 40 minutes per session.

The study of a limited number of subjects (15) indicated that signifi-
nt improvement in collision avoidance skills could be achieved in about
ur sessions. The conclusions of Sulzer and Crook (1968) are:

1. Time sharing practice in a ground pilot trainer, with low cost visual projection equipment added, is effective in improving visual detection of intruder aircraft. This improvement in external search is not accompanied by any marked reduction in flight control or instrument scan.

2. Most improvement in search performance occurs during the first four practice sessions. Some degree of overlearning occurring after that initial improvement may improve retention of the time-sharing habit.

3. Particular improvement in search performance is achieved for targets appearing off to the sides.

4. Total flight hours logged is not a good predictor of external search performance.

AD-A152 978 ALTERNATIVE SYSTEM DESIGNS FOR NAVY UNDERGRADUATE PILOT TRAINING POST 1975(U) TRAINING ANALYSIS AND EVALUATION GROUP (NAVY) ORLANDO FL R F BROWNING ET AL. JUN 75 2/2

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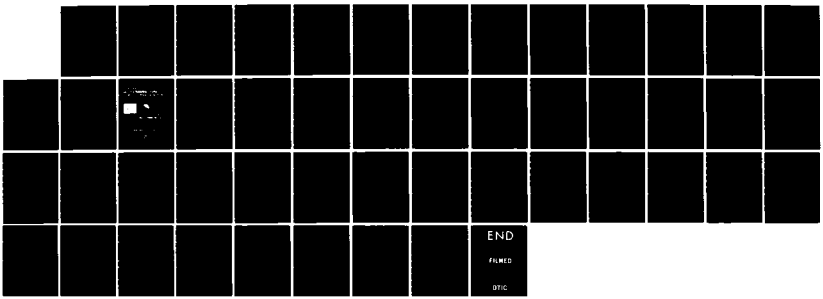
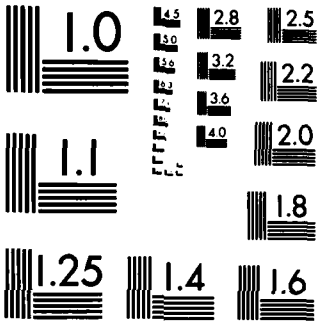




MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

In a study for the Naval Training Device Center, Gabriel, Burrows, and Abbott (1965) conducted a study of visual time-sharing. Sixty Marine A-4 pilots were divided into two groups. One group was given 8 time-sharing sessions in a simple, generalized visual flight simulator and then compared with a control group on performance in a highly specific A-4 operational flight trainer with a visual display. The results indicated that improved ability to detect collision hazards could be accomplished without compromising performance in other flight tasks. The study also found that previous piloting experience gave no assurance of having acquired optimum scan patterns.

Internal/external scan was listed as an undertrained task by the jet, prop, and helo communities in the CNATRA Phase I Report on the results of the Undergraduate Pilot Training Task Inventory. While the number of midair collisions in the Navy has shown a steady decrease in the past five years, the need for collision avoidance and scan training has not decreased. The increasing traffic, loss of aircraft (56 in five years) and lives (26 in five years) suggest that collision avoidance and scan training should be incorporated as a separate training requirement in UPT.

An analysis of the curriculum, to determine an appropriate time for this training, indicates the feasibility of scheduling scan and collision avoidance training concurrent with the proposed synthetic selection phase before beginning in-flight training. A detailed discussion of the selection phase is contained in appendix B. The devices used in the selection process could also be used for scan/collision avoidance training.

The midair collisions concerned with formation flying have not been discussed in this report other than noting their numbers. While collision avoidance and scan training is primarily directed toward non-formation collisions, it should have a secondary impact on other time-sharing pilot requirements and possibly reduce formation collisions; i.e., lookout doctrine, terrain avoidance, and hostile threat detection.

Decision Making. Decision making is defined as, "The thinking processes that lead to the selection of one alternative from among a 'known' set of response alternatives. These processes include the identification of potential alternatives, prioritizing the alternatives, and the selection of the desired alternative. The selection process may include computation and other logical operations for combining information." [20] CNATRA is currently addressing methods of training decision making abilities and has in conjunction with another TAEG project developed guidelines for training. The need for emphasis on development of decision making skills and exercising initiative was identified in the CNATRA Phase I Report (1974). Data obtained from the inventory questionnaires indicate that UPT graduates when confronted with loss of instructor supervision or positive control are not equipped to independently make correct and timely decisions.

[20] USAF AFSC-T2a-72-000 Vol 2 appendix C p. 18

In the current training situation undergraduate pilots are constantly under the supervision of an instructor and/or positive control from some ground agency. This situation has reduced the opportunity for exercise of initiative and the requirement to make decisions.

The importance of this training is such that it suggests that Decision Making should be identified as a distinct training requirement and addressed as such. The methods and media may range from the classroom and simple paper and pencil tests to the use of flight simulators and the aircraft.

INSTRUCTOR TRAINING

Instructor training for UPT stresses preparation for instructing in the air with little attention given to effective instruction techniques in the flight simulator or other synthetic training devices. During on-site visits, it was noted that in some training squadrons flight instructors do not instruct the UPT student in the familiarization/procedures trainers or the instrument/flight simulators. Other training squadrons require that certain simulator flights be conducted by qualified flight instructors. Recently a small cadre of flight instructors were trained on the 2F101 by the contractor. They, in turn, are training the other squadron instructors. This is an improvement over past practices but too small in numbers to assure quality instruction. Effective utilization of such a complex device demands that well trained instructors be utilized if the full potential of this device is to be realized. Adequate instructor training in the utilization of synthetic trainers can provide improved training at lower cost.

A number of the devices observed, utilized enlisted instructors. The credibility of using nonpilot enlisted instructors for pilot training must be challenged. Such practices prolong the full acceptance of synthetic training as a viable substitute for in-flight training. The nonpilot may not be able to properly diagnose why a student got into trouble or how best to recover from it. Regardless of his dedication to his job, the enlisted instructor cannot speak authoritatively as a pilot and flight instructor and there is reticence on the part of the student to accept him fully.

In summary, the issues on the utilization of synthetic trainers center on the following: using the capabilities and understanding the limitations of synthetic trainers and how best to use devices to teach tasks associated with flight. The airplane is a poor trainer for many tasks, and this should be understood by all connected with training. The added cost of instructor training and utilization of pilot instructors for synthetic training will be regained in improved instruction and efficiency. Most of the instructors encountered during visits to the training sites evidenced a genuine interest in improving their instructor competence and expressed interest in training that would enable them to do a better job.

QUALITY OF GRADUATES

Considerable emphasis has been placed on increased cost-effectiveness of UPT but not too much on the cost of attrition after graduation. In studying the operational follow-on to UPT, it was noted that the most significant attrition occurs in the jet replacement squadrons. The attrition figures quoted for recent jet UPT graduates are far in excess of those in other operational communities, and the attrition rate for the pilots given non-operational assignments after completion of UPT is considerably higher. The UPT attrite is expensive, but it is only a fraction of the cost of an attrite at the replacement squadron level. It has been estimated that it cost a minimum of $500,000 to train an F-4 pilot in the RAG. A pilot attrited at the replacement squadron is lost to the Navy; he does not have the option of another operational community. It is only in the RAG that the UPT graduate is confronted with the demanding task of operating a high performance jet in the operational carrier environment, particularly the demands of night carrier qualifications.

Reduction in postgraduate attrition can only come from improved UPT quality. Improved quality of UPT graduates must result from more effective selection and more stringent performance requirements. The cost of operational jet training demands that the marginal performer not be allowed to complete UPT.

Dual Qualification Requirement. Migration between communities is one reason stated for requiring all rotary wing pilots to receive fixed wing training. Discussions with appropriate codes in CNO and BUPERS indicate that this is probably not a valid reason for continuing this practice. The identified migrations encountered during this study were negligible. No cases were identified in which a rotary wing pilot was required to transition to fixed wing during his first assignment.

The number of rotary wing pilots for both the Navy and Marine Corps leaving active duty after one tour approximates 40%. This means that these pilots were trained for a dual qualification that they were never required to use. In the case in which a rotary wing pilot is assigned to a fixed wing billet on a second or later tour, transition can be accomplished. Providing dual qualifications for all rotary wing pilots for the rare possibility that a few may require it does not appear to be cost effective.

FUNCTIONAL CONTEXT TRAINING REQUIREMENTS AS OPPOSED TO CONVENTIONAL REQUIREMENTS

On-site observations and examination of the various syllabi for UPT revealed a strong emphasis on students achieving high proficiency on various practice patterns such as CHARLIE and OSCAR (CNATRAINST 1542 Series).

The rationale of this strong emphasis is questioned. Are these patterns emphasized because of their training value or because of tradition? The CHARLIE pattern has been used for at least 30 years. It was first introduced to teach pilots to make speed changes, altitude changes, etc., to develop basic instrument skills and to develop coordination of skills such as control of airspeed and transition to and from level flight to climb or glide in preparation for flyiny radio ranges and letdowns. Originally, the lack of available radio facilities, aircraft equipment, and adequate simulation probably justified this emphasis.

It is suggested that these patterns be examined for their real contribution to the development of basic instrument skill. In all probability they could be taught entirely in an adequate flight simulator, if required. For the skills that purport to transfer to operational instrument flying, it is suggested that they be taught and practiced in a functional context; that is, for slow flight, practice this while flying a holding pattern. For partial panel, learn the skill while making a letdown and approach. Inquiries concerning the requirement of partial panel patterns disclosed no instance where the student was required to make a partial panel approach. It is not disputed that these patterns are of some benefit; what is questioned is the proportionality or the benefit to the time spent in training them, particularly in the aircraft.

In Phase II of this study, TAEG will examine each required skill to determine how the skills can best be trained in a functional context.

APPENDIX D

MISSION PHASE

This appendix defines the mission phases which were used to organize the CNATRA Task Inventory items into chronological order. Piloting tasks were organized into 10 principal "phases of flight" (figure D-1). Additional phases were added to accommodate other type tasks; e.g., emergencies, enroute or enabling objectives, carrier and shipboard operations.

1.0 MISSION PREPARATION - Phase I of the mission begins when the pilot receives word that a mission has been ordered (typically when the flight schedule is posted) and ends when all crew members have boarded the aircraft for that mission. All tactical planning, flight planning, preflight inspections, and readiness checks are accomplished during this mission phase.

2.0 PRE-TAKEOFFS - After all crewmembers are aboard the aircraft, the PRE-TAKEOFF phase of flight begins. This phase ends when the aircraft receives takeoff clearance from the control tower (or any other appropriate local traffic control authority). Thus, engine starting and other system activation procedures occur during this phase, as well as taxiing the aircraft from the parking ramp to the active runway.

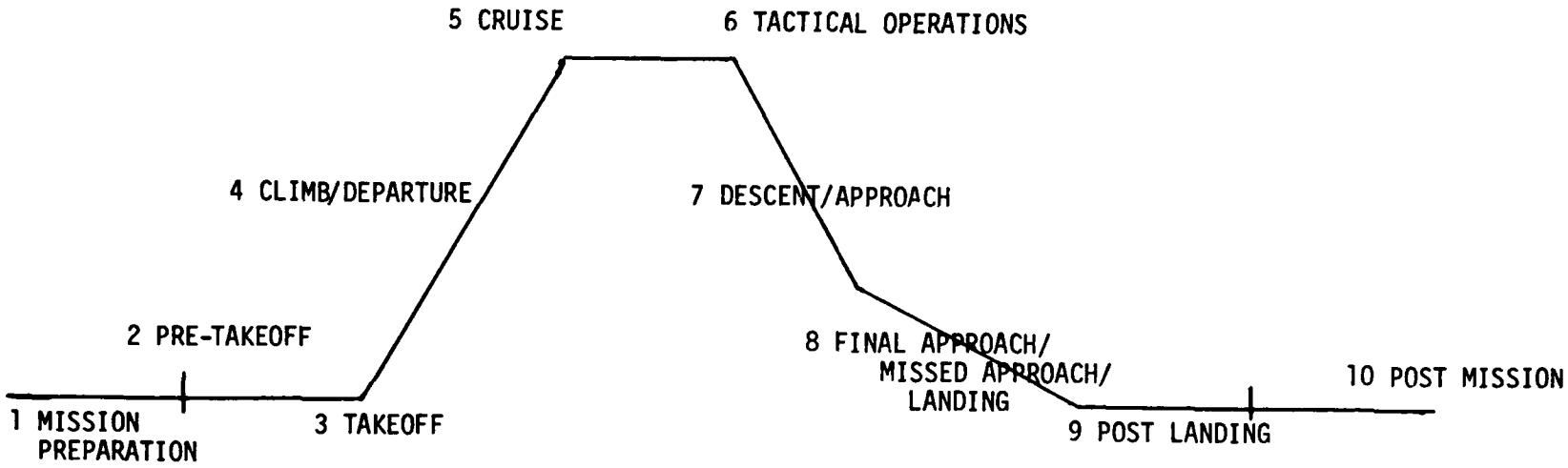
3.0 TAKEOFF - All activities which take place between the time the aircraft has received clearance to takeoff and the time that the aircraft is "safely airborne" (in the NATOPS sense) are considered to occur during the TAKEOFF mission phase.

4.0 CLIMB-DEPARTURE - When the landing gear handle is placed in the "UP" position, the climb departure phase is considered to have begun. This particular phase of flight ends when the aircraft is established on course, at cruise altitude. Included here, as in some earlier mission phases, are navigation and communications tasks in addition to basic aircraft control tasks.

5.0 CRUISE - This phase of flight covers all aircraft operations which occur between the time the aircraft has been established on course in cruise configuration and the time when tactical operations are begun. Included in this phase are VFR and IFR control tasks, communications, navigation, and other tasks incident to cruise operations.

6.0 TACTICAL OPERATIONS - All aircraft operations relating to the tactical mission of the aircraft are to be covered during this phase of flight. Included in this phase are tactical formations, gunnery, weapons delivery, air combat maneuvering, low level navigation, ASW tactics, etc.

7.0 DESCENT-APPROACH - The descent-approach phase commences when the aircraft has received an appropriate descent clearance from ATC or appropriate authority. All procedures and operations which occur from the time the



11 ABNORMAL/SPECIAL PROCEDURES
12 EMERGENCY PROCEDURES
13 BASIC CONTACT TASKS
14 BASIC IFR TASKS
15 CREW COORDINATION

16 CARRIER OPERATIONS
17 SHIPBOARD OPERATIONS
18 FLIGHT SUPPORT
19 COLLISION AVOIDANCE/SCAN
20 DECISION MAKING

Figure D-1. Mission Profile Used for Mission Analysis

clearance is received until the aircraft arrives at the final approach fix are included; e.g., outer marker inbound in the case of an ILS approach.

8.0 FINAL APPROACH/LANDING/MISSED APPROACH - Final approach begins when the aircraft departs the radio facility inbound or when informed by GCA and is terminated by a missed approach or landing. The landing terminates when the aircraft vacates the duty runway. If a missed approach is required, then all activities which occur between the point where the missed approach is begun and the time when clearance to proceed to an alternate airport or begin another approach is received are included (at this point, of course, we would enter the CLIMB-DEPARTURE phase again).

9.0 POST LANDING - All procedures which occur between the time the aircraft leaves the duty runway and the time the Secure Checklist has been completed are included in this phase.

10.0 POST MISSION - This phase includes post flight activities including post-flight inspections, logging procedures, and debriefing.

11.0 ABNORMAL AND SPECIAL PROCEDURES - This phase contains certain maneuvers not normally included in the normal flight profile; e.g., approach to stalls, spin prevention/recovery, control of aircraft during high angle of attack buffet, and special procedures such as crosswind landings, practice shutdown of an engine in-flight.

12.0 EMERGENCIES - A description of the activities of the pilot/copilot during emergency operations (per NATOPS) are included in this section.

13.0 CONTACT TASKS - The tasks included in this category are basic/intermediate tasks or enabling objectives learned enroute to development of mission skills or terminal objectives. These tasks are exclusive of the mission requirements and included only in a training context.

14.0 IFR TASK - Training tasks or enabling objectives for mission instrument tasks.

15.0 CREW COORDINATION - This phase includes only those tasks involved with crew coordination in multi-piloted aircraft.

16.0 CARRIER OPERATIONS - This phase includes those tasks unique to operating aircraft from an aircraft carrier. Tasks such as catapult take-off, arrested landings, marshalling procedures, and CCA are included.

17.0 SHIPBOARD OPERATIONS - Only includes tasks relevant to VTOL and helicopter operations from ships other than CV such as destroyers, LPH, LHA.

18.0 FLIGHT SUPPORT TASKS - This phase is used to identify areas of knowledge relevant to flight but not taught in synthetic or flight trainer; e.g., navigation techniques, theory of flight, meteorology. This phase is included for allocation to training areas.

19.0 COLLISION AVOIDANCE/SCAN TRAINING - Collision avoidance has been identified as a future training requirement. It is expected to increase in importance with the increase of air traffic congestion, coupled with the increased complexity of aircraft, and the importance of time sharing scan within and without the cockpit.

20.0 DECISION MAKING - "The thinking processes that lead to the selection of one alternative from among a 'known' set of response alternatives. These processes include the identification of the potential alternatives, prioritizing the alternatives, and the selection of the desired alternative. The selection process may include computation and other logical operations for combining information." [21]

[21] USAF 1972 Vol. II C18

APPENDIX E

ROTARY WING OPERATIONAL REQUIREMENTS

In section III the methodology for determining the UPT requirements is explained. As discussed in that section the operational requirements were first determined. These were then examined to identify which should be trained in UPT. The principal rotary wing requirements by mission phase are contained in this appendix as an example. A comparison of table E-1 with table 1 of section III will show that a number of operational requirements have not been included as training requirements. This is due to equipment requirements such as a two-engine helicopter if engine out training was included. Water landings are not included in the list of UPT requirements due to lack of equipment and also due to the requirement being specific to certain communities that operate helicopters equipped for water landings and/or water taxi. These requirements can best be met at a replacement squadron. Tasks contained in the list of UPT requirements that address enabling objectives for skills learned enroute to a terminal objective are not included in the list of operational requirements (e.g., parallel heading square).

TABLE E-1. ROTARY WING OPERATIONAL REQUIREMENTS

MISSION SEGMENT

Mission Preparation

Ground Operations

Pre-Takeoff

Systems Checks (NATOPS)
**Ground Taxi
Air Taxi
**Water Taxi

Takeoff

**Running Takeoff (rolling) High Gross Weight - Day/Night

Normal Takeoff to Hover, from Hover - Day/Night
VFR/IFR

Normal Takeoff from Ground - Day/Night
VFR/IFR

Max Power Takeoff from Ground - Day/Night
VFR/IFR

**Max Power Takeoff Overwater - Day/Night
VFR/IFR

Confined Area Takeoff - Day/Night

Crosswind Takeoff

Climb/Departure

Transition to Forward Flight from Hover - Day/Night

Climb
VFR/IFR

Instrument Departure
SID - TACAN/VOR
RADAR

Cruise

VFR/IFR Navigation

Tactical Operations

SAR Operations - Day/Night
Hoisting Over Land
**Hoisting Over Water

TABLE E-1. ROTARY WING OPERATIONAL REQUIREMENTS (continued)

External Load Operations

Heavy Lift

Confined Area Operations

**Night Landing Zone Operations

Slope Landings

**Weapons Delivery

Tactical Navigation and Approaches
- *Nap of the Earth (NOE) (Marine)
- Low Level Tactical Navigation (contact, 500' AGL)
- *Contour (Marine)

**ASW Tactics - Day/Night
IFR/VFR

Tactical Formation/Rendezvous

<u>Descent/Approach</u>

Descent - Day/Night
VFR/IFR

Approach - Day/Night
VFR/IFR
- TACAN/VOR
- ADF
- RADAR
- Holding

<u>Final Approach/Missed Approach/Landing</u>

Final Approach - Day/Night (Normal, Steep, Spiral)
VFR/IFR
- TACAN/VOR
- ADF
- GCA - ASR/PAR
- ILS

Missed Approach - Day/Night
VFR/IFR

Landing - Day/Night
- Vertical Landing to Hover/to Landing
- Run On/Sliding
- Max Gross Weight
- Touch and Go
- **Water Landing

TABLE E-1. ROTARY WING OPERATIONAL REQUIREMENTS (continued)

High Speed Quick Stop
High Speed Approach to Spot
Pinnacle Landing
Crosswind Landing

Post Landing

Taxi - Air/Ground

Post Mission

Ground Operations

Abnormal and Special Procedures

Blade Stall Recognition/Corrective Action
Unusual Attitude Recovery
Boost Off Operations

Emergencies

Engine Fire - Start/In-flight/Post-Flight
Engine Failure - Hover/In-flight
Systems Failures
**Loss of one engine in twin-engine helicopters
Ground Resonance Recognition/Recovery
Loss of Tail Rotor - Partial/Complete - Low/High Speed
Ditching/Crash Landing
Lost Plane/Emergency Communications
Autorotation (Forced Landing)
With Power Recovery
To Flare Landing
To Run On Landing

Crew Coordination

Pilot Tasks
Copilot Tasks
NATOPS Procedures

Carrier Operations

Vertical Takeoff - Day/VFR
*Vertical Takeoff - Night/IFR
*Plane Guard
*Hover Overwater
Approach to Moving Deck
CCA
*Vertical Landing Night

4B 3	66	ADVISE OTHER PILOT OF AIRCRAFT ATTITUDE, ALTITUDE AND POSITION	1
4B 3	66	DURING INSTRUMENT CONDITIONS.	2
4B 4	66	APPLY CHALLENGE AND REPLY CONCEPT WHEN COMPLETING CHECKLISTS.	1

MISSION SEGMENT NO. 01. MISSION PREPARATION
ROLE 3-NAVIGATOR
DUTY A- COMPLY WITH INSTRUMENT NAVIGATION PROCEDURES AND FLIGHT PLANNING REQUIREMENTS

TASK			
3A 5	63	PREPARE LOW-LEVEL NAVIGATION ROUTE (SAND BLOWER, MINING).	1

MISSION SEGMENT NO. 08. FINAL APPROACH, LANDING, MISSED APP
ROLE 1-CONTROLLER OF AIRCRAFT
DUTY C- CONTROL AIRCRAFT DURING DAY/NIGHT IFR OPERATIONS

TASK			
1C16	63	CONTROL HEADING OF AIRCRAFT DURING PRECISION APPROACH.	1

MISSION SEGMENT NO. 01. MISSION PREPARATION
ROLE 2-ENVIRONMENTAL ANALYSIS
DUTY C- COMPLY WITH THE PRINCIPLES OF SURVIVAL

TASK			
2C 5	61	AWARE OF AVAILABLE SURVIVAL EQUIPMENT AND ITS PROPER EMPLOYMENT.	1
2C 5	61	(CONTENTS OF VARIOUS SURVIVAL KITS, ETC.).	2
2C 6	61	INSPECT AND ENSURE THE COMPLETENESS AND SERVICEABILITY OF	1
2C 6	61	SURVIVAL EQUIPMENT.	2

DUTY D- APPLY THE VARIOUS AERODYNAMIC PRINCIPLES AND CONSIDERATIONS AFFECTING FLIGHT AND MANEUVERING

TASK			
2D 7	61	APPLY THE AERODYNAMIC PRINCIPLES OF WEATHER EFFECTS (FROST,	1
2D 7	61	ICING, TURBULENCE) TO AIRCRAFT PERFORMANCE.	2

MISSION SEGMENT NO. 08. FINAL APPROACH, LANDING, MISSED APP
ROLE 1-CONTROLLER OF AIRCRAFT
DUTY C- CONTROL AIRCRAFT DURING DAY/NIGHT IFR OPERATIONS

TASK			
1C20	61	CONTROL HEADING OF AIRCRAFT DURING NON-PRECISION APPROACH.	1

MISSION SEGMENT NO. 13. CONTACT TASKS
ROLE 1-CONTROLLER OF AIRCRAFT
DUTY A- CONTROL AIRCRAFT DURING DAY VFR SHOREBASED OPERATIONS

TASK			
1A 8	61	CONTROL AIRCRAFT DURING BASIC TRANSITIONS FROM ONE FLIGHT	1
1A 8	61	ATTITUDE TO ANOTHER (CLIMB, LEVEL-OFF, DESCENT, TURNS).	2
1A 9	61	MAINTAIN AIRCRAFT IN STABILIZED CLIMB/DESCENT.	1
1A10	61	MAINTAIN AIRCRAFT IN CONSTANT RATE OF TURN.	1
1A11	61	MAINTAIN AIRCRAFT IN CONSTANT RATE CLIMBING/DESCENDING TURN.	1

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SION SEGMENT NO. 01.  MISSION PREPARATION
E 2-ENVIRONMENTAL ANALYSIS
Y B- ASSESS METEORLOGICAL CONDITIONS AFFECTING FLIGHT
ASK
1 2     72  EVALUATE EXISTING WEATHER CONDITIONS TO DETERMINE ACCEPTABILITY  1
1 2     72  FOR PROPOSAL FLIGHT.                                             2

SION SEGMENT NO. 04.  CLIMB, DEPARTURE
E 1-CONTROLLER OF AIRCRAFT
Y C- CONTROL AIRCRAFT DURING DAY/NIGHT IFR OPERATIONS
ASK
: 3     69  CONTROL AIRCRAFT DURING INSTRUMENT DEPARTURE                      1
: 3     69  USING RADIO NAVIGATIONAL AIDS.                                   2

SION SEGMENT NO. 11.  ABNORMAL AND SPECIAL PROCEDURES
E 1-CONTROLLER OF AIRCRAFT
Y C- CONTROL AIRCRAFT DURING DAY/NIGHT IFR OPERATIONS
ASK
:10     69  CONTROL AIRCRAFT DURING UNUSUAL ATTITUDE RECOVERY.                1

SION SEGMENT NO. 07.  DESCENT, APPROACH
E 3-NAVIGATOR
Y B- NAVIGATE USING RADIO AIDS (TACAN, ADF)
ASK
3 8     66  COMPLY WITH HOLDING PATTERN ENTRY PROCEDURES.                    1
3 9     66  COMPLY WITH HOLDING PATTERN CLEARANCE.                           1
316     66  PERFORM TACAN APPROACH.                                          1
317     66  PERFORM TACAN ARCING.                                            1
325     66  PERFORM ADF APPROACH.                                            1

SION SEGMENT NO. 15.  CREW COORDINATION
E 3-NAVIGATOR
Y B- NAVIGATE USING RADIO AIDS (TACAN, ADF)
ASK
311     66  MONITOR/BACK-UP OTHER PILOT'S/LEAD'S/CREWMEMBER'S NAVIGATION.    1
E 4-COMMUNICATOR
Y A- COMMUNICATE USING RADIO
ASK
A 9     66  MONITOR OTHER PILOT/CREWMEMBER/FLIGHT LEADER DURING              1
A 9     66  RADIO COMMUNICATIONS.                                            2
Y B- COMMUNICATE USING ICS
ASK
B 1     66  DIRECT OTHER PILOT/CREWMEMBERS IN PERFORMING                     1
B 1     66  EMERGENCY PROCEDURES.                                            2
B 2     66  ADVISE OTHER PILOT/CREWMEMBERS OF AIRCRAFT SYSTEM MALFUNCTIONS.  1
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ROLE 5-SYSTEMS MANAGER
DUTY E- DETERMINE SYSTEM MALFUNCTIONS AND APPLY PROPER
        TROUBLESHOOTING AND/OR NATOPS EMERGENCY PROCEDURES
  TASK
  5E 1     75  CONFIRM SYSTEM MALFUNCTION BY CROSS-CHECKING                  1
  5E 1     75  WITH OTHER INDICATIONS.                                       2
  5E 2     75  DETERMINE PROPER TROUBLESHOOTING AND TAKE CORRECTIVE ACTION TO 1
  5E 2     75  ELIMINATE AIRCRAFT SYSTEMS MALFUNCTION.                       2
  5E 3     75  APPLY APPROPRIATE EMERGENCY PROCEDURES AS REQUIRED.           1


MISSION SEGMENT NO. 13.  CONTACT TASKS
ROLE 1-CONTROLLER OF AIRCRAFT
DUTY A- CONTROL AIRCRAFT DURING DAY VFR SHOREBASED OPERATIONS
  TASK
  1A14     75  APPLY APPROPRIATE RUDDER CONTROL TO MAINTAIN BALANCED FLIGHT    1
  1A14     75  IN VARIOUS FLIGHT ATTITUDES.                                   2
ROLE 2-ENVIRONMENTAL ANALYSIS
DUTY A- COMPLY WITH THE PHYSIOLOGICAL PRINCIPLES AFFECTING
        PILOT PERFORMANCE
  TASK
  2A12     75  SCAN OUTSIDE COCKPIT USING A LOOKOUT PATTERN. (FOCUS,          1
  2A12     75  PERIPHERAL VISION, TIME-SHARE).                               2
ROLE 3-NAVIGATOR
DUTY B- NAVIGATE USING RADIO AIDS (TACAN, ADF)
  TASK
  3B 2     75  INTERPRET AIRWAYS CHARTS                                       1
ROLE 5-SYSTEMS MANAGER
DUTY A- CONFORM TO THE NATOPS PROGRAM
  TASK
  5A 5     75  ACTIVATE, SECURE AND OPERATE AIRCRAFT SYSTEMS IN ACCORDANCE WITH 1
  5A 5     75  NATOPS CHECKLIST/PROCEDURES. (PRE-START, START,               2
  5A 5     75  PRETAXI, SHUTDOWN, ETC.).                                     3
DUTY D- ASSESS AIRCRAFT SYSTEMS OPERATION/CAPABILITIES
  TASK
  5D 6     75  MONITOR ENGINE, HYDRAULIC AND ELECTRICAL SYSTEMS FOR PROPER    1
  5D 6     75  INFLIGHT OPERATION.                                           2
  5D 7     75  APPLY PROPER INFLIGHT FUEL MANAGEMENT TECHNIQUES              1
  5D 7     75  (CONSUMPTION, TRANSFER, DUMP).                                2


MISSION SEGMENT NO. 14.  INSTRUMENT TASKS
ROLE 1-CONTROLLER OF AIRCRAFT
DUTY B- CONTROL AIRCRAFT DURING NIGHT VFR SHOREBASED OPERATIONS
  TASK
  1B 4     75  CONTROL AIRCRAFT DURING UNUSUAL ATTITUDE RECOVERY.            1
DUTY C- CONTROL AIRCRAFT DURING DAY/NIGHT IFR OPERATIONS
  TASK
  1C 9     75  CONTROL AIRCRAFT DURING STRAIGHT AND LEVEL FLIGHT.            1
```

SSION SEGMENT NO. 11. ABNORMAL AND SPECIAL PROCEDURES
LE 2-ENVIRONMENTAL ANALYSIS
TY A- COMPLY WITH THE PHYSIOLOGICAL PRINCIPLES AFFECTING
PILOT PERFORMANCE

TASK			
2A 8	77	IDENTIFY SYMPTOMS OF VERTIGO/DISORIENTATION AND	1
2A 8	77	INITIATE CORRECTIVE ACTION.	2

SSION SEGMENT NO. 14. INSTRUMENT TASKS
LE 1-CONTROLLER OF AIRCRAFT
TY A- CONTROL AIRCRAFT DURING DAY VFR SHOREBASED OPERATIONS

TASK			
1A20	77	CONTROL AIRCRAFT DURING UNUSUAL ATTITUDE RECOVERY.	1

TY C- CONTROL AIRCRAFT DURING DAY/NIGHT IFR OPERATIONS

TASK			
1C 5	77	CONTROL AIRCRAFT DURING BASIC TRANSITIONS FROM ONE FLIGHT	1
1C 5	77	ATTITUDE TO ANOTHER (CLIMB, LEVEL-OFF, DESCENT, TURNS).	2
1C 6	77	MAINTAIN AIRCRAFT IN STABILIZED CLIMB/DESCENT.	1
1C 8	77	MAINTAIN AIRCRAFT IN CONSTANT RATE CLIMBING/DESCENDING TURN.	1
1C21	77	CONTROL AIRCRAFT DURING PARTIAL PANEL OPERATIONS.	1

SSION SEGMENT NO. 08. FINAL APPROACH, LANDING, MISSED APP
LE 3-NAVIGATOR
TY B- NAVIGATE USING RADIO AIDS (TACAN, ADF)

TASK			
3B10	75	COMPLY WITH INSTRUMENT MISSED APPROACH PROCEDURES.	1

SSION SEGMENT NO. 12. EMERGENCIES
LE 4-COMMUNICATOR
TY A- COMMUNICATE USING RADIO

TASK			
4A11	75	COMPLY WITH LOST COMMUNICATION PROCEDURES.	1

TY C- COMMUNICATE USING AUDIO/VISUAL MEANS

TASK			
4C 9	75	USE HEFOE SIGNALS.	1
4C11	75	COMMUNICATE WITH GROUND PARTIES USING STANDARD AIR-TO-GROUND	1
4C11	75	DISTRESS SIGNALS (AIRCRAFT, ATTITUDE, CONFIGURATION,	2
4C11	75	ENGINE, ETC.).	3
4C12	75	COMMUNICATE NOFOR SITUATION TO RADAR OPERATOR BY FLYING	1
4C12	75	"LOST-COMMUNICATION" TRIANGLE.	2
4C13	75	COMMUNICATE NOFOR AND EMERGENCY SITUATION TO RADAR OPERATOR	1
4C13	75	VIA APPROPRIATE TRANSPONDER CODES.	2

MISSION SEGMENT NO. 10. POST MISSION
ROLE 5-SYSTEMS MANAGER
DUTY B- RECORD APPROPRIATE ENTRIES ON MAINTENANCE/OPERATIONS
FORMS AND RECORDS

TASK			
5B 2	83	RECORD SYSTEMS DISCREPANCIES/MALFUNCTIONS ON THE YELLOW SHEET.	1

MISSION SEGMENT NO. 13. CONTACT TASKS
ROLE 1-CONTROLLER OF AIRCRAFT
DUTY A- CONTROL AIRCRAFT DURING DAY VFR SHOREBASED OPERATIONS

TASK			
1A53	83	TRIM AIRCRAFT FOR VARIOUS ATTITUDES.	1

ROLE 5-SYSTEMS MANAGER
DUTY A- CONFORM TO THE NATOPS PROGRAM

TASK			
5A 4	83	USE NATOPS CHECKLISTS.	1

MISSION SEGMENT NO. 14. INSTRUMENT TASKS
ROLE 1-CONTROLLER OF AIRCRAFT
DUTY C- CONTROL AIRCRAFT DURING DAY/NIGHT IFR OPERATIONS

TASK			
1C 7	83	MAINTAIN AIRCRAFT IN CONSTANT RATE OF TURN.	1

MISSION SEGMENT NO. 05. CRUISE
ROLE 2-ENVIRONMENTAL ANALYSIS
DUTY B- ASSESS METEORLOGICAL CONDITIONS AFFECTING FLIGHT

TASK			
2B 3	77	MONITOR AND EVALUATE OBSERVED METEORLOGICAL CONDITIONS WHICH	1
2B 3	77	MAY AFFECT FLIGHT.	2
2B 4	77	ASSESS THE FEASIBILITY OF CONTINUING FLIGHT THROUGH OBSERVED	1
2B 4	77	OR UPDATED WEATHER.	2

MISSION SEGMENT NO. 06. TACTICAL OPERATIONS
ROLE 4-COMMUNICATOR
DUTY A- COMMUNICATE USING RADIO

TASK			
4A 7	77	COMMUNICATE WITH TACTICAL CONTROLLING AGENCIES.	1

ROLE 5-SYSTEMS MANAGER
DUTY B- RECORD APPROPRIATE ENTRIES ON MAINTENANCE/OPERATIONS
FORMS AND RECORDS

TASK			
5B 1	B3	DETERMINE SYSTEMS HISTORY AND STATUS FROM PREVIOUS YELLOW SHEET	1
5B 1	B3	DISCREPANCIES/CORRECTIVE ACTIONS.	2

MISSION SEGMENT NO. 02. PRE-TAKEOFF
ROLE 4-COMMUNICATOR
DUTY C- COMMUNICATE USING AUDIO/VISUAL MEANS

TASK			
4C 4	B3	COMMUNICATE WITH GROUND PERSONNEL/TAXI DIRECTOR (ASHORE) USING	1
4C 4	B3	VISUAL SIGNALS (HEAD, HAND, LIGHT, ETC.).	2

MISSION SEGMENT NO. 04. CLIMB; DEPARTURE
ROLE 1-CONTROLLER OF AIRCRAFT
DUTY C- CONTROL AIRCRAFT DURING DAY/NIGHT IFR OPERATIONS

TASK			
1C 4	B3	CONTROL AIRCRAFT DURING INSTRUMENT DEPARTURE	1
1C 4	B3	USING RADAR VECTORS.	2

ROLE 3-NAVIGATOR
DUTY B- NAVIGATE USING RADIO AIDS (TACAN, ADF)

TASK			
3B14	B3	PERFORM TACAN SID.	1
3B23	B3	PERFORM ADF SID.	1

ROLE 4-COMMUNICATOR
DUTY A- COMMUNICATE USING RADIO

TASK			
4A 2	B3	COMMUNICATE USING IFR ATC PROCEDURES WITH	1
4A 2	B3	APPROACH/DEPARTURE CONTROL.	2

MISSION SEGMENT NO. 05. CRUISE
ROLE 4-COMMUNICATOR
DUTY A- COMMUNICATE USING RADIO

TASK			
4A 3	B3	COMMUNICATE USING IFR ATC PROCEDURES WITH	1
4A 3	B3	APPROPRIATE CONTROLLING AGENCIES WHILE ENROUTE.	2

MISSION SEGMENT NO. 06. TACTICAL OPERATIONS
ROLE 4-COMMUNICATOR
DUTY A- COMMUNICATE USING RADIO

TASK			
4A 5	B3	COMMUNICATE USING STANDARD BREVITY CODE/TACTICAL PHRASEOLOGY	1
4A 5	B3	(ROGER, WILCO, TALLEYHO, ETC.).	2

ROLE 3-NAVIGATOR
DUTY B- NAVIGATE USING RADIO AIDS (TACAN, ADF)

TASK			
3B 6	100	PERFORM RADIAL/BEARING INTERCEPTS.	1
3B 7	100	PERFORM BRACKETING/TRACKING ON A RADIAL/BEARING.	1
3B12	100	DETERMINE POSITION USING TACAN OR ADF.	1
3B13	100	VISUALIZE GEOGRAPHIC ORIENTATION DURING INSTRUMENT FLIGHT.	1
3B20	100	DETECT 40 DEGREE LOCK-OFF USING TACAN.	1
3B26	100	PERFORM TIME/DISTANCE CHECK USING ADF.	1

MISSION SEGMENT NO. 11. ABNORMAL AND SPECIAL PROCEDURES
ROLE 2-ENVIRONMENTAL ANALYSIS
DUTY A- COMPLY WITH THE PHYSIOLOGICAL PRINCIPLES AFFECTING PILOT PERFORMANCE

TASK			
2A 9	92	IDENTIFY THE SYMPTOMS OF AEROEMBOLISM (AIR BENDS)	1
2A 9	92	AND INITIATE CORRECTIVE ACTION.	2

MISSION SEGMENT NO. 12. EMERGENCIES
ROLE 4-COMMUNICATOR
DUTY A- COMMUNICATE USING RADIO

TASK			
4A 8	92	COMMUNICATE DURING EMERGENCY SITUATIONS USING PROPER PROCEDURES.	1

MISSION SEGMENT NO. 01. MISSION PREPARATION
ROLE 3-NAVIGATOR
DUTY A- COMPLY WITH INSTRUMENT NAVIGATION PROCEDURES AND FLIGHT PLANNING REQUIREMENTS

TASK			
3A 3	88	PERFORM IFR/VFR PREFLIGHT PLANNING.	1

MISSION SEGMENT NO. 05. CRUISE
ROLE 3-NAVIGATOR
DUTY B- NAVIGATE USING RADIO AIDS (TACAN, ADF)

TASK			
3B 5	86	PERFORM AIRWAYS ENROUTE NAVIGATION.	1

MISSION SEGMENT NO. 01. MISSION PREPARATION
ROLE 3-NAVIGATOR
DUTY A- COMPLY WITH INSTRUMENT NAVIGATION PROCEDURES AND FLIGHT PLANNING REQUIREMENTS

TASK			
3A 8	83	SELECT APPROPRIATE SIDS, EN ROUTE/AREA CHARTS, AND APPROACH	1
3A 8	83	PLATES FOR PROPOSED FLIGHT.	2

5B 4	100	RECORD REQUIRED ENTRIES ON AIRCRAFT SERVICING FORMS	1
5B 4	100	(E.G., FUEL CHITS, ETC.).	2

MISSION SEGMENT NO. 12. EMERGENCIES
ROLE 2-ENVIRONMENTAL ANALYSIS
DUTY A- COMPLY WITH THE PHYSIOLOGICAL PRINCIPLES AFFECTING
PILOT PERFORMANCE

TASK			
2A13	100	DEMONSTRATE SOUND JUDGMENT AND COMPOSURE DURING SIMULATED	1
2A13	100	EMERGENCY SITUATIONS.	2

MISSION SEGMENT NO. 13. CONTACT TASKS
ROLE 1-CONTROLLER OF AIRCRAFT
DUTY A- CONTROL AIRCRAFT DURING DAY VFR SHOREBASED OPERATIONS

TASK			
1A56	100	CONTROL AIRCRAFT IN ACCORDANCE WITH REGULATIONS CONCERNING	1
1A56	100	ALTITUDE AND LATERAL SEPARATION FROM CLOUDS, AND OTHER AIRCRAFT	2
1A56	100	(AS OUTLINED IN OPNAV 3710, FAR, FLIP, ETC.).	3

ROLE 3-NAVIGATOR
DUTY A- COMPLY WITH INSTRUMENT NAVIGATION PROCEDURES AND
FLIGHT PLANNING REQUIREMENTS

TASK			
3A 2	100	COMPLY WITH CURRENT FAA/OPNAV REGULATIONS.	1

DUTY B- NAVIGATE USING RADIO AIDS (TACAN, ADF)

TASK			
3B 1	100	COMPLY WITH INSTRUCTIONS FROM CONTROLLING AGENCIES.	1

DUTY D- NAVIGATE USING DEAD RECKONING (DR) TECHNIQUES

TASK			
3D 1	100	DETERMINE POSITION USING DR TECHNIQUES (USE COURSE,	1
3D 1	100	GROUND SPEED, WIND, ETC.).	2
3D 2	100	NAVIGATE POSITION-TO-POSITION USING DR TECHNIQUES.	1
3D 3	100	VERIFY DR POSITION USING AVAILABLE NAVIGATIONAL AIDS.	1
3D 4	100	CALCULATE SPEED AND HEADING CORRECTIONS NECESSARY TO REGAIN	1
3D 4	100	PRE-PLANNED ETA/COURSE.	2

ROLE 4-COMMUNICATOR
DUTY A- COMMUNICATE USING RADIO

TASK			
4A 4	100	COMMUNICATE USING VFR RADIO PROCEDURES WITH APPROPRIATE	1
4A 4	100	CONTROLLING AGENCIES (TOWER, GROUND CONTROL, FSS).	2

MISSION SEGMENT NO. 14. INSTRUMENT TASKS
ROLE 1-CONTROLLER OF AIRCRAFT
DUTY C- CONTROL AIRCRAFT DURING DAY/NIGHT IFR OPERATIONS

TASK			
1C26	100	INITIATE TRANSITION TO INSTRUMENT ATTITUDE REFERENCE WHEN	1
1C26	100	CONFRONTED WITH IFR CONDITIONS.	2

MISSION SEGMENT NO. 05. CRUISE
ROLE 2-ENVIRONMENTAL ANALYSIS
DUTY B- ASSESS METEORLOGICAL CONDITIONS AFFECTING FLIGHT

TASK			
2B 6	100	MONITOR AND UPDATE WEATHER FORECASTS UTILIZING TERMINAL	1
2B 6	100	AND EN ROUTE FACILITIES.	2

ROLE 3-NAVIGATOR
DUTY A- COMPLY WITH INSTRUMENT NAVIGATION PROCEDURES AND FLIGHT PLANNING REQUIREMENTS

TASK			
3A10	100	REVISE OR RE-FILE FLIGHT PLAN WHILE AIRBORNE.	1

DUTY B- NAVIGATE USING RADIO AIDS (TACAN, ADF)

TASK			
3B18	100	CALCULATE DIRECT ROUTING FROM ONE FIX TO ANOTHER ON SAME TACAN	1
3B18	100	STATION. (POINT-TO-POINT)	2
3B19	100	COMPUTE GS USING DME WHILE TRACKING A RADIAL.	1

MISSION SEGMENT NO. 06. TACTICAL OPERATIONS
ROLE 3-NAVIGATOR
DUTY B- NAVIGATE USING RADIO AIDS (TACAN, ADF)

TASK			
3B21	100	USE AIR-TO-AIR FEATURE OF TACAN.	1
3B22	100	USE TACAN TO EFFECT RENDEZVOUS.	1
3B27	100	USE UHF (DF) TO EFFECT RENDEZVOUS.	1

MISSION SEGMENT NO. 07. DESCENT, APPROACH
ROLE 3-NAVIGATOR
DUTY B- NAVIGATE USING RADIO AIDS (TACAN, ADF)

TASK			
3B 3	100	INTERPRET APPROACH PLATES.	1

MISSION SEGMENT NO. 08. FINAL APPROACH, LANDING, MISSED APP
ROLE 1-CONTROLLER OF AIRCRAFT
DUTY C- CONTROL AIRCRAFT DURING DAY/NIGHT IFR OPERATIONS

TASK			
1C24	100	COMPLY WITH PUBLISHED MINIMUMS.	1

MISSION SEGMENT NO. 10. POST MISSION
ROLE 5-SYSTEMS MANAGER
DUTY B- RECORD APPROPRIATE ENTRIES ON MAINTENANCE/OPERATIONS FORMS AND RECORDS

TASK			
5B 3	100	LOG FLIGHT/INSTRUMENT TIME, TYPE OF APPROACH, FLIGHT CODE	1
5B 3	100	AND OTHER APPROPRIATE ITEMS ON YELLOW SHEET IN ACCORDANCE WITH	2
5B 3	100	CURRENT OPNAVINST 3710.7.	3

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          %                    *** JET-HELO-PROP COMPARISON ***
       COMMONALITY

MISSION SEGMENT NO. 01.  MISSION PREPARATION
ROLE 3-NAVIGATOR
DUTY A- COMPLY WITH INSTRUMENT NAVIGATION PROCEDURES AND
        FLIGHT PLANNING REQUIREMENTS
  TASK
  3A 4    100  USE NAVIGATION COMPUTER (E-6B; E-10; CR-2)                    1
  3A 6    100  PREPARE AND FILE DD-175.                                      1
ROLE 2-ENVIRONMENTAL ANALYSIS
DUTY B- ASSESS METEORLOGICAL CONDITIONS AFFECTING FLIGHT
  TASK
  2B 1    100  INTERPRET METEORLOGICAL CHARTS AND TELETYPE REPORTS           1
  2B 1    100  (FORECASTS, SEQUENCE REPORTS, WW, ETC.).                      2
DUTY D- APPLY THE VARIOUS AERODYNAMIC PRINCIPLES AND
        CONSIDERATIONS AFFECTING FLIGHT AND MANEUVERING
  TASK
  2D 1    100  APPLY THE AERODYNAMIC PRINCIPLES OF WEIGHT AND BALANCE        1
  2D 1    100  TO AIRCRAFT PERFORMANCE.                                      2
ROLE 4-COMMUNICATOR
DUTY C- COMMUNICATE USING AUDIO/VISUAL MEANS
  TASK
  4C10    100  OPERATE IFF/SIF BY SELECTING PROPER MODE/CODE/IDENT.          1


MISSION SEGMENT NO. 02.  PRE-TAKEOFF
ROLE 3-NAVIGATOR
DUTY B- NAVIGATE USING RADIO AIDS (TACAN, ADF)
  TASK
  3B 4    100  INTERPRET SIDS.                                               1
ROLE 4-COMMUNICATOR
DUTY A- COMMUNICATE USING RADIO
  TASK
  4A 1    100  COMMUNICATE WITH CLEARANCE DELIVERY/COPY CLEARANCE.           1
ROLE 5-SYSTEMS MANAGER
DUTY C- AWARE OF COCKPIT EQUIPMENT/AIRCRAFT SYSTEMS OPERATION
  TASK
  5C 1    100  AWARE OF THE GYRO COMPASS, ITS CHARACTERISTICS AND THE NECESSITY 1
  5C 1    100  OF CROSS-CHECKING WITH THE STANDBY COMPASS.                   2
  5C 2    100  AWARE OF THE PITOT-STATIC SYSTEM OPERATION AND ITS            1
  5C 2    100  ASSOCIATED INSTRUMENTS.                                       2
  5C 3    100  AWARE OF THE ATTITUDE GYRO SYSTEM AND ITS LIMITATIONS.        1
```

phase it will be necessary to have the assistance of subject matter experts for the detailed task analysis work required and for refining the commonality analysis. The mission and commonality analyses will provide the basis for determining enabling objectives, terminal objectives, performance standards, and specification of the appropriate media. It is only then that specific times to train can be determined. The system configuration will of course require adjustments as the syllabi are validated.

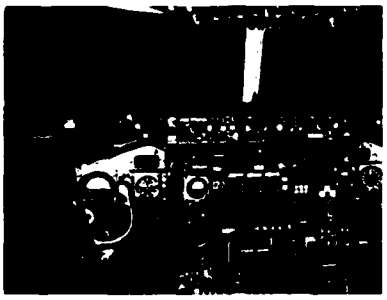
NEED TO QUANTITATIVELY DIFFERENTIATE SKILLS

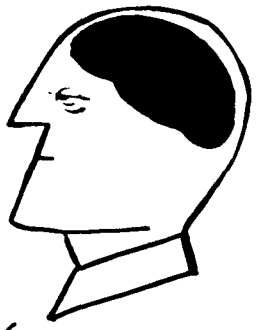
SKILLS COMMONALITY ANALYSIS
STIMULUS OPERATOR RESPONSE

CUES FROM
EQUIPMENT & ENVIRONMENT
CONTROL, DISPLAYS, OUTSIDE

COGNITIVE
INFO. PROCESSING
DECISION MAKING

CONTROL OUTPUTS
MANIPULATION, HANDLING
VERBALIZATION, ETC.





(COMPARISON)

PIPELINE / COMMUNITIES

TASKS

JET/ME			JET/ME %	JET/HELO			JET/HELO %	M-E/HELO			M-E/HELO %
S	O	R		S	O	R		S	O	R	

COMMONALITY SCALE

4 = IDENTICAL
3 = SUBSTANTIAL COMMONALITY
2 = MODERATE COMMONALITY
1 = MINOR COMMONALITY
0 = NO COMMONALITY

Figure F-1. "SOR" Model

APPENDIX F

COMMONALITY ANALYSIS

In this analysis, classifications are based on the commonality of procedural, cognitive or motor skills that transfer to the next level of training, between aircraft, or to the operational situation. As explained in section III all task statements from the CNATRA Task Inventory were placed in a structured order and in the chronology of a typical mission. Each task statement was then examined using the relatively simple Stimulus--Organism--Response paradigm to determine the commonality between the various aircraft communities for the cues, mediation required, and the response. Figure F-1 depicts the process. Commonality was rated from 0 to 4 on a 5 point rating scale. The task statements were rated between pairs of communities (jet to helo, jet to multi-engine, and helo to multi-engine). The percent commonality was then computed and the tasks were arranged in order based on percent commonality from highest to lowest. A printout of the analysis of commonality between all communities is included in this appendix.

Rationale for Commonality Analysis. The commonality analysis graphically identifies which skill requirements are needed by all pilots and which are needed by only one or more communities. Obviously, vertical takeoffs are not a requirement for multi-engine and jet pilots (other than AV-8 pilots); therefore, this task should not be included in a general pipeline. Since aerobatics are not required of rotary wing pilots, why should they receive training for this skill? A rationale for including aerobatics or precision flying has been that it may add to the overall piloting abilities. It was necessary to examine these tasks to determine which are valid training requirements and the cost/training effectiveness of including them in general requirements for each pipeline/community.

Construction of Training Tracks. The results of the commonality analysis, examination of the various NATOPS manuals, current syllabi, discussions with operational and undergraduate instructors and other research were used to construct the system models. As an initial cut those tasks whose commonality was 61 percent or greater were included in the general or primary track and classified as skills that are required of all pilots (figures 3 & 4). This was determined to be the optimum branching point for separation of rotary wing pilots into a separate track (see section III for a discussion of this). Subsequently the multi-engine branching point was determined by comparison of the commonality between the multi-engine and jet. A commonality of 50 percent was chosen for this point. Obviously the rating of any particular task can be argued, but the initial analysis serves to identify the categories of tasks that are common between communities and which are required of all pilots.

Application of the Results. The mission analysis and the commonality analysis provide the framework for the detailed analytic work required in Phase II. Both are accepted task analytic techniques. In the second

TABLE E-1. ROTARY WING OPERATIONAL REQUIREMENTS (continued)

Vertical Landing - Day
Hover Over Deck

*Shipboard Operations (non-carrier)

Vertical Replenishment
Vertical Takeoff
Approach - Day/Night
Landing - Day/Night
Approach to Moving Deck
Hover Over Deck

*Collision Avoidance

Decision Making

Without Positive Control
With Degraded Systems

* Not presently trained or only partially trained in UPT

** Operational task that would require a major revision to UPT or major airframe change.

1A12	61	CONTROL AIRCRAFT DURING STRAIGHT AND LEVEL FLIGHT.	1
1A13	61	MAINTAIN APPROPRIATE INTERNAL/EXTERNAL SCAN.	1

MISSION SEGMENT NO. 02. PRE-TAKEOFF
ROLE 5-SYSTEMS MANAGER
DUTY D- ASSESS AIRCRAFT SYSTEMS OPERATION/CAPABILITIES

TASK			
5D 3	58	ASSESS AIRCRAFT SYSTEMS DURING ENGINE START.	1

MISSION SEGMENT NO. 06. TACTICAL OPERATIONS
ROLE 5-SYSTEMS MANAGER
DUTY E- DETERMINE SYSTEM MALFUNCTIONS AND APPLY PROPER TROUBLESHOOTING AND/OR NATOPS EMERGENCY PROCEDURES

TASK			
5E 5	58	ASSESS IMPACT OF DEGRADED SYSTEM/SUBSYSTEM ON AIRCRAFT AND	1
5E 5	58	MISSION CAPABILITY.	2

MISSION SEGMENT NO. 08. FINAL APPROACH, LANDING, MISSED APP
ROLE 1-CONTROLLER OF AIRCRAFT
DUTY A- CONTROL AIRCRAFT DURING DAY VFR SHOREBASED OPERATIONS

TASK			
1A49	58	CONTROL AIRCRAFT DURING CROSSWIND APPROACH.	1
1A52	58	CONTROL AIRCRAFT DURING STRAIGHT-IN LANDING APPROACH.	1

MISSION SEGMENT NO. 12. EMERGENCIES
ROLE 5-SYSTEMS MANAGER
DUTY E- DETERMINE SYSTEM MALFUNCTIONS AND APPLY PROPER TROUBLESHOOTING AND/OR NATOPS EMERGENCY PROCEDURES

TASK			
5E 6	58	USE AUX RECEIVER DURING LOST COMMUNICATIONS.	1

MISSION SEGMENT NO. 13. CONTACT TASKS
ROLE 3-NAVIGATOR
DUTY C- NAVIGATE USING VISUAL/CONTACT TECHNIQUES

TASK			
3C 1	58	INTERPRET TOPOGRAPHICAL CHARTS (ONC, TPC, HO, ETC.)	1
3C 2	58	DETERMINE POSITION USING VISUAL REFERENCES (DAY).	1
3C 3	58	DETERMINE POSITION USING VISUAL REFERENCES (NIGHT).	1
3C 4	58	VERIFY VISUAL POSITION USING AVAILABLE RADIO NAVIGATIONAL AIDS.	1
3C 5	58	DETERMINE WIND DIRECTION AND VELOCITY FROM A VISUAL REFERENCE	1
3C 5	58	(SMOKE, WATER, ETC.).	2

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MISSION SEGMENT NO. 03.  TAKEOFF
ROLE 1-CONTROLLER OF AIRCRAFT
DUTY A- CONTROL AIRCRAFT DURING DAY VFR SHOREBASED OPERATIONS
  TASK
  1A 2     55  CONTROL AIRCRAFT DURING TAKE-OFF ROLL IN VARIOUS          1
  1A 2     55  WIND CONDITIONS.                                          2
DUTY B- CONTROL AIRCRAFT DURING NIGHT VFR SHOREBASED OPERATIONS
  TASK
  1B 1     55  CONTROL AIRCRAFT DURING TAKE-OFF IN VARIOUS WIND CONDITIONS.  1

MISSION SEGMENT NO. 04.  CLIMB, DEPARTURE
ROLE 1-CONTROLLER OF AIRCRAFT
DUTY B- CONTROL AIRCRAFT DURING NIGHT VFR SHOREBASED OPERATIONS
  TASK
  1B 3     55  CONTROL AIRCRAFT DURING CLIMBOUT.                        1

MISSION SEGMENT NO. 05.  CRUISE
ROLE 3-NAVIGATOR
DUTY A- COMPLY WITH INSTRUMENT NAVIGATION PROCEDURES AND
        FLIGHT PLANNING REQUIREMENTS
  TASK
  3A 9     55  MAINTAIN FUEL/TIME LOGS (HOWGOZITS).                     1

MISSION SEGMENT NO. 08.  FINAL APPROACH, LANDING, MISSED APP
ROLE 1-CONTROLLER OF AIRCRAFT
DUTY A- CONTROL AIRCRAFT DURING DAY VFR SHOREBASED OPERATIONS
  TASK
  1A40     52  CONTROL LINE-UP OF AIRCRAFT DURING LANDING APPROACH.     1

MISSION SEGMENT NO. 01.  MISSION PREPARATION
ROLE 2-ENVIRONMENTAL ANALYSIS
DUTY D- APPLY THE VARIOUS AERODYNAMIC PRINCIPLES AND
        CONSIDERATIONS AFFECTING FLIGHT AND MANEUVERING
  TASK
  2D 8     50  APPLY THE AERODYNAMIC PRINCIPLES OF DENSITY ALTITUDE     1
  2D 8     50  TO AIRCRAFT PERFORMANCE.                                 2
ROLE 5-SYSTEMS MANAGER
DUTY D- ASSESS AIRCRAFT SYSTEMS OPERATION/CAPABILITIES
  TASK
  5D 1     50  CALCULATE AIRCRAFT TAKE-OFF PERFORMANCE DATA             1
  5D 1     50  USING NATOPS FLIGHT MANUAL.                              2
  5D 2     50  CALCULATE AIRCRAFT INFLIGHT PERFORMANCE DATA USING NATOPS FLIGHT 1
  5D 2     50  MANUALS (CRUISE PERFORMANCE, VN ENVELOPE, MAXIMUM RANGE, ETC.)  2
```

MISSION SEGMENT NO. 02. PRE-TAKEOFF
ROLE 2-ENVIRONMENTAL ANALYSIS
DUTY C- COMPLY WITH THE PRINCIPLES OF SURVIVAL

TASK			
2C 7	50	ENSURE THAT CREWMEMBERS/PASSENGERS ARE AWARE OF	1
2C 7	50	THE AVAILABILITY AND PROPER USE OF SURVIVAL EQUIPMENT AND	2
2C 7	50	EMERGENCY EGRESS PROCEDURES.	3
2C 9	50	AWARE OF EMERGENCY EGRESS PROCEDURES (DITCHING, BAILOUT).	1

ROLE 5-SYSTEMS MANAGER
DUTY A- CONFORM TO THE NATOPS PROGRAM

TASK			
5A 7	50	AWARE OF NATOPS CHECKLIST ENGINE RUN-UP PROCEDURES TO ASSESS	1
5A 7	50	POWER PLANT CAPABILITY.	2

MISSION SEGMENT NO. 04. CLIMB; DEPARTURE
ROLE 1-CONTROLLER OF AIRCRAFT
DUTY A- CONTROL AIRCRAFT DURING DAY VFR SHOREBASED OPERATIONS

TASK			
1A 6	50	CONTROL AIRCRAFT DURING CLIMBOUT.	1

MISSION SEGMENT NO. 05. CRUISE
ROLE 2-ENVIRONMENTAL ANALYSIS
DUTY B- ASSESS METEORLOGICAL CONDITIONS AFFECTING FLIGHT

TASK			
2B 5	50	DETERMINE APPROPRIATE COURSE DEVIATION IN THE PRESENCE OF	1
2B 5	50	SIGNIFICANT WEATHER.	2

MISSION SEGMENT NO. 06. TACTICAL OPERATIONS
ROLE 1-CONTROLLER OF AIRCRAFT
DUTY A- CONTROL AIRCRAFT DURING DAY VFR SHOREBASED OPERATIONS

TASK			
1A24	50	CONTROL AIRCRAFT DURING LOW LEVEL FLIGHT.	1

DUTY B- CONTROL AIRCRAFT DURING NIGHT VFR SHOREBASED OPERATIONS

TASK			
1B 7	50	CONTROL AIRCRAFT DURING LOW-LEVEL FLIGHT.	1

DUTY C- CONTROL AIRCRAFT DURING DAY/NIGHT IFR OPERATIONS

TASK			
1C25	50	PERFORM OVERWATER LOW-LEVEL INSTRUMENT FLIGHT.	1

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MISSION SEGMENT NO. 08.  FINAL APPROACH, LANDING, MISSED APP
ROLE 1-CONTROLLER OF AIRCRAFT
DUTY A- CONTROL AIRCRAFT DURING DAY VFR SHOREBASED OPERATIONS
  TASK
  1A35    50  CONTROL AIRCRAFT DURING LANDING APPROACH IN VARIOUS        1
  1A35    50  CONFIGURATIONS (180 TO FINAL).                             1
  1A36    50  CONTROL AIRCRAFT ON GLIDE SLOPE DURING LANDING APPROACH.   1
DUTY B- CONTROL AIRCRAFT DURING NIGHT VFR SHOREBASED OPERATIONS
  TASK
  1B 9    50  CONTROL AIRCRAFT ON GLIDE SLOPE DURING LANDING APPROACH.   1
  1B10    50  CONTROL LINE-UP OF AIRCRAFT DURING LANDING APPROACH.       1
  1B14    50  CONTROL AIRCRAFT DURING CROSSWIND APPROACH AND LANDING.    1
DUTY C- CONTROL AIRCRAFT DURING DAY/NIGHT IFR OPERATIONS
  TASK
  1C13    50  CONTROL AIRCRAFT ON GLIDE SLOPE DURING PRECISION APPROACH. 1
  1C17    50  CONTROL AIRCRAFT ON GLIDE SLOPE DURING NON-PRECISION APPROACH. 1


MISSION SEGMENT NO. 12.  EMERGENCIES
ROLE 1-CONTROLLER OF AIRCRAFT
DUTY A- CONTROL AIRCRAFT DURING DAY VFR SHOREBASED OPERATIONS
  TASK
  1A54    50  CONTROL AIRCRAFT DURING VARIOUS EMERGENCIES WHILE         1
  1A54    50  TROUBLE-SHOOTING/COPING WITH THE SITUATION.               2


MISSION SEGMENT NO. 03.  TAKEOFF
ROLE 1-CONTROLLER OF AIRCRAFT
DUTY C- CONTROL AIRCRAFT DURING DAY/NIGHT IFR OPERATIONS
  TASK
  1C 1    47  CONTROL AIRCRAFT DURING INSTRUMENT TAKE-OFF.              1


MISSION SEGMENT NO. 12.  EMERGENCIES
ROLE 5-SYSTEMS MANAGER
DUTY E- DETERMINE SYSTEM MALFUNCTIONS AND APPLY PROPER
        TROUBLESHOOTING AND/OR NATOPS EMERGENCY PROCEDURES
  TASK
  5E 4    47  ASSIST OTHER PILOT/WINGMAN DURING THE EXECUTION          1
  5E 4    47  OF EMERGENCY PROCEDURES.                                  2
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MISSION SEGMENT NO. 08. FINAL APPROACH, LANDING, MISSED APP
ROLE 1-CONTROLLER OF AIRCRAFT
DUTY C- CONTROL AIRCRAFT DURING DAY/NIGHT IFR OPERATIONS

TASK			
1C22	44	CONTROL AIRCRAFT DURING INSTRUMENT MISSED APPROACH.	1
1C23	44	CONTROL AIRCRAFT DURING TRANSITION FROM INSTRUMENT TO CONTACT	1
1C23	44	CONDITIONS FOR LANDING.	2

DUTY A- CONTROL AIRCRAFT DURING DAY VFR SHOREBASED OPERATIONS

TASK			
1A45	41	CONTROL AIRCRAFT DURING TOUCH-AND-GO PATTERN.	1

DUTY B- CONTROL AIRCRAFT DURING NIGHT VFR SHOREBASED OPERATIONS

TASK			
1B13	41	CONTROL AIRCRAFT DURING TOUCH-AND-GO PATTERN.	1

MISSION SEGMENT NO. 12. EMERGENCIES
ROLE 1-CONTROLLER OF AIRCRAFT
DUTY A- CONTROL AIRCRAFT DURING DAY VFR SHOREBASED OPERATIONS

TASK			
1A51	41	CONTROL AIRCRAFT DURING PRECAUTIONARY LANDING PATTERN.	1

MISSION SEGMENT NO. 13. CONTACT TASKS
ROLE 1-CONTROLLER OF AIRCRAFT
DUTY A- CONTROL AIRCRAFT DURING DAY VFR SHOREBASED OPERATIONS

TASK			
1A55	41	FLY WITHIN SPECIFIED OPERATING LIMITATIONS OF THE AIRCRAFT	1
1A55	41	(I.E., LIMITATIONS OF SPEED, "G", INVERTED FLIGHT, ETC.)	2

MISSION SEGMENT NO. 08. FINAL APPROACH, LANDING, MISSED APP
ROLE 1-CONTROLLER OF AIRCRAFT
DUTY A- CONTROL AIRCRAFT DURING DAY VFR SHOREBASED OPERATIONS

TASK			
1A38	38	CONTROL AIRSPEED OF AIRCRAFT DURING LANDING APPROACH	1
1A38	38	(WITHOUT USE OF ANGLE-OF-ATTACK INDICATOR).	2
1A39	38	CONTROL POWER OF AIRCRAFT DURING LANDING APPROACH.	1
1A44	38	CONTROL AIRCRAFT DURING WAVE-OFF.	1
1A50	38	CONTROL AIRCRAFT DURING CROSSWIND TOUCHDOWN AND ROLL-OUT.	1

DUTY B- CONTROL AIRCRAFT DURING NIGHT VFR SHOREBASED OPERATIONS

TASK			
1B12	38	CONTROL AIRCRAFT DURING WAVE-OFF.	1

DUTY C- CONTROL AIRCRAFT DURING DAY/NIGHT IFR OPERATIONS

TASK			
1C14	38	CONTROL AIRSPEED OF AIRCRAFT DURING PRECISION APPROACH.	1
1C15	38	CONTROL POWER OF AIRCRAFT DURING PRECISION APPROACH.	1
1C18	38	CONTROL AIRSPEED OF AIRCRAFT DURING NON-PRECISION APPROACH.	1
1C19	38	CONTROL POWER OF AIRCRAFT DURING NON-PRECISION APPROACH.	1

MISSION SEGMENT NO. 01. MISSION PREPARATION
ROLE 2-ENVIRONMENTAL ANALYSIS
DUTY D- APPLY THE VARIOUS AERODYNAMIC PRINCIPLES AND
CONSIDERATIONS AFFECTING FLIGHT AND MANEUVERING

TASK			
2D 4	33	APPLY THE AERODYNAMIC PRINCIPLES OF LIFT/DRAG	1
2D 4	33	TO AIRCRAFT PERFORMANCE.	2
2D 5	33	APPLY THE AERODYNAMIC PRINCIPLES OF THRUST/WEIGHT RATIO	1
2D 5	33	TO AIRCRAFT PERFORMANCE.	2

ROLE 3-NAVIGATOR
DUTY A- COMPLY WITH INSTRUMENT NAVIGATION PROCEDURES AND
FLIGHT PLANNING REQUIREMENTS

TASK			
3A 7	33	PREPARE AND FILE ICAO FLIGHT PLAN.	1

MISSION SEGMENT NO. 02. PRE-TAKEOFF
ROLE 5-SYSTEMS MANAGER
DUTY D- ASSESS AIRCRAFT SYSTEMS OPERATION/CAPABILITIES

TASK			
5D 4	33	ASSESS AIRCRAFT SYSTEMS AS TO READINESS FOR FLIGHT	1
5D 4	33	PRIOR TO TAKE-OFF.	2
5D 5	33	ASSESS AIRCRAFT SYSTEMS DURING ENGINE RUN-UP AND TAKE-OFF.	1

MISSION SEGMENT NO. 06. TACTICAL OPERATIONS
ROLE 6-TACTICIAN
DUTY E- CONDUCT AIR COMBAT MANEUVERING (ACM)
DUTY- E. CONDUCT ANTI-SUBMARINE WARFARE (ASW)

TASK			
6E 7	33	PIG SURFACE CONTACTS VISUALLY USING PROPER RIGGING TECHNIQUES.	1

MISSION SEGMENT NO. 12. EMERGENCIES
ROLE 2-ENVIRONMENTAL ANALYSIS
DUTY A- COMPLY WITH THE PHYSIOLOGICAL PRINCIPLES AFFECTING
PILOT PERFORMANCE

TASK			
2A 6	33	MONITOR AND ASSESS LIFE SUPPORT SYSTEMS AND INITIATE THE	1
2A 6	33	APPROPRIATE ACTION IN CASE OF MALFUNCTION.	2

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MISSION SEGMENT NO. 02.  PRE-TAKEOFF
ROLE 1-CONTROLLER OF AIRCRAFT
DUTY A- CONTROL AIRCRAFT DURING DAY VFR SHOREBASED OPERATIONS
  TASK
  1A 1     27  CONTROL AIRCRAFT DURING GROUND TAXI OPERATIONS.          1

MISSION SEGMENT NO. 04.  CLIMB, DEPARTURE
ROLE 3-NAVIGATOR
DUTY B- NAVIGATE USING RADIO AIDS (TACAN, ADF)
  TASK
  3B30     27  PERFORM VOR SID.                                         1

MISSION SEGMENT NO. 12.  EMERGENCIES
ROLE 1-CONTROLLER OF AIRCRAFT
DUTY A- CONTROL AIRCRAFT DURING DAY VFR SHOREBASED OPERATIONS
  TASK
  1A41     27  CONTROL AIRCRAFT DURING LANDING APPROACH MINUS AN ENGINE  1
  1A41     27  (WHERE APPLICABLE).                                      2

MISSION SEGMENT NO. 16.  CARRIER OPERATION
ROLE 4-COMMUNICATOR
DUTY A- COMMUNICATE USING RADIO
  TASK
  4A 6     27  COMMUNICATE USING STANDARD PROCEDURES WITH SHIPBOARD CONTROLLING 1
  4A 6     27  AGENCIES DURING LAUNCH AND RECOVERY OPERATIONS.          2

MISSION SEGMENT NO. 03.  TAKEOFF
ROLE 1-CONTROLLER OF AIRCRAFT
DUTY A- CONTROL AIRCRAFT DURING DAY VFR SHOREBASED OPERATIONS
  TASK
  1A 4     25  CONTROL AIRCRAFT DURING ROTATION IN VARIOUS CONFIGURATIONS.  1
DUTY B- CONTROL AIRCRAFT DURING NIGHT VFR SHOREBASED OPERATIONS
  TASK
  1B 2     25  CONTROL AIRCRAFT DURING ROTATION IN VARIOUS CONFIGURATIONS.  1

MISSION SEGMENT NO. 08.  FINAL APPROACH, LANDING, MISSED APP
ROLE 1-CONTROLLER OF AIRCRAFT
DUTY A- CONTROL AIRCRAFT DURING DAY VFR SHOREBASED OPERATIONS
  TASK
  1A43     25  CONTROL AIRCRAFT DURING LANDING APPROACH                 1
  1A43     25  USING AN OPTICAL LANDING SYSTEM                           2
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ROLE 3-NAVIGATOR
DUTY B- NAVIGATE USING RADIO AIDS (TACAN, ADF)
  TASK
  3B34     25  PERFORM ILS APPROACH.                                    1
  3B35     25  PERFORM LOCALIZER APPROACH.                              1

MISSION SEGMENT NO. 12.  EMERGENCIES
ROLE 1-CONTROLLER OF AIRCRAFT
DUTY A- CONTROL AIRCRAFT DURING DAY VFR SHOREBASED OPERATIONS
  TASK
  1A 3     25  CONTROL AIRCRAFT DURING ABORTED TAKE-OFF.                 1

MISSION SEGMENT NO. 01.  MISSION PREPARATION
ROLE 2-ENVIRONMENTAL ANALYSIS
DUTY D- APPLY THE VARIOUS AERODYNAMIC PRINCIPLES AND
        CONSIDERATIONS AFFECTING FLIGHT AND MANEUVERING
  TASK
  2D 3     22  APPLY THE AERODYNAMIC PRINCIPLES OF WING/AIRFOIL CONFIGURATION   1
  2D 3     22  TO AIRCRAFT PERFORMANCE (FLAPS, SLATS, SLOTS,                    2
  2D 3     22  SWEPT-WING, ARMAMENT, ETC.).                                     3

MISSION SEGMENT NO. 04.  CLIMB, DEPARTURE
ROLE 1-CONTROLLER OF AIRCRAFT
DUTY A- CONTROL AIRCRAFT DURING DAY VFR SHOREBASED OPERATIONS
  TASK
  1A 5     22  CONTROL AIRCRAFT DURING CONFIGURATION CHANGE AFTER TAKE-OFF.   1
DUTY C- CONTROL AIRCRAFT DURING DAY/NIGHT IFR OPERATIONS
  TASK
  1C 2     22  CONTROL AIRCRAFT DURING CONFIGURATION CHANGE AFTER TAKE-OFF.   1

MISSION SEGMENT NO. 07.  DESCENT, APPROACH
ROLE 3-NAVIGATOR
DUTY B- NAVIGATE USING RADIO AIDS (TACAN, ADF)
  TASK
  3B24     22  PERFORM ADF PENETRATION.                                   1
  3B28     22  PERFORM VOR APPROACH.                                      1

MISSION SEGMENT NO. 08.  FINAL APPROACH, LANDING, MISSED APP
ROLE 1-CONTROLLER OF AIRCRAFT
DUTY A- CONTROL AIRCRAFT DURING DAY VFR SHOREBASED OPERATIONS
  TASK
  1A34     22  CONTROL AIRCRAFT DURING LANDING CONFIGURATION CHANGE.       1
  1A37     22  CONTROL AIRCRAFT USING ANGLE-OF-ATTACK INDICATOR DURING     1
  1A37     22  LANDING APPROACH.                                           2
DUTY C- CONTROL AIRCRAFT DURING DAY/NIGHT IFR OPERATIONS
  TASK
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1C12	22	CONTROL AIRCRAFT DURING LANDING CONFIGURATION CHANGE.	1

MISSION SEGMENT NO. 11. ABNORMAL AND SPECIAL PROCEDURES
ROLE 1-CONTROLLER OF AIRCRAFT
DUTY A- CONTROL AIRCRAFT DURING DAY VFR SHOREBASED OPERATIONS

TASK			
1A16	22	CONTROL AIRCRAFT DURING DIRTY STALL/STALL RECOVERY.	1
1A17	22	CONTROL AIRCRAFT TO PREVENT AN IMPENDING SPIN.	1

MISSION SEGMENT NO. 06. TACTICAL OPERATIONS
ROLE 6-TACTICIAN
DUTY E- CONDUCT AIR COMBAT MANEUVERING (ACM)
DUTY- E. CONDUCT ANTI-SUBMARINE WARFARE (ASW)

TASK			
6E 4	19	CONTROL AIRCRAFT WHILE PERFORM LOW ALTITUDE	1
6E 4	19	CLOVERLEAF MANEUVERS.	2
6E 5	19	CONTROL AIRCRAFT WHILE PERFORMING LOW ALTITUDE MAD	1
6E 5	19	TRAPPING MANEUVERS.	2

MISSION SEGMENT NO. 07. DESCENT, APPROACH
ROLE 1-CONTROLLER OF AIRCRAFT
DUTY C- CONTROL AIRCRAFT DURING DAY/NIGHT IFR OPERATIONS

TASK			
1C11	19	CONTROL AIRCRAFT DURING INSTRUMENT PENETRATION.	1

ROLE 3-NAVIGATOR
DUTY B- NAVIGATE USING RADIO AIDS (TACAN, ADF)

TASK			
3B15	19	PERFORM TACAN PENETRATION.	1

MISSION SEGMENT NO. 08. FINAL APPROACH, LANDING, MISSED APP
ROLE 1-CONTROLLER OF AIRCRAFT
DUTY A- CONTROL AIRCRAFT DURING DAY VFR SHOREBASED OPERATIONS

TASK			
1A42	19	CONTROL AIRCRAFT IN VARIOUS CONFIGURATIONS AT TOUCHDOWN.	1

DUTY B- CONTROL AIRCRAFT DURING NIGHT VFR SHOREBASED OPERATIONS

TASK			
1B11	19	CONTROL AIRCRAFT IN VARIOUS CONFIGURATIONS AT TOUCHDOWN.	1

MISSION SEGMENT NO. 11. ABNORMAL AND SPECIAL PROCEDURES
ROLE 1-CONTROLLER OF AIRCRAFT
DUTY A- CONTROL AIRCRAFT DURING DAY VFR SHOREBASED OPERATIONS

TASK			
1A15	19	CONTROL AIRCRAFT DURING CLEAN STALL/STALL RECOVERY.	1

MISSION SEGMENT NO. 16. CARRIER OPERATION
ROLE 4-COMMUNICATOR
DUTY C- COMMUNICATE USING AUDIO/VISUAL MEANS

TASK			
4C 5	19	COMMUNICATE WITH SHIPBOARD DECK PERSONNEL/TAXI DIRECTORS USING	1
4C 5	19	VISUAL SIGNALS. (HEAD, HAND, LIGHT, ETC.).	2

MISSION SEGMENT NO. 08. FINAL APPROACH, LANDING, MISSED APP
ROLE 1-CONTROLLER OF AIRCRAFT
DUTY A- CONTROL AIRCRAFT DURING DAY VFR SHOREBASED OPERATIONS

TASK			
1A46	16	CONTROL AIRCRAFT DURING LANDING ROLL-OUT (DRY RUNWAY).	1

DUTY B- CONTROL AIRCRAFT DURING NIGHT VFR SHOREBASED OPERATIONS

TASK			
1B15	16	CONTROL AIRCRAFT DURING LANDING ROLL-OUT.	1

MISSION SEGMENT NO. 13. CONTACT TASKS
ROLE 4-COMMUNICATOR
DUTY C- COMMUNICATE USING AUDIO/VISUAL MEANS

TASK			
4C 6	16	COMMUNICATE WITH OTHER AIRCRAFT USING VISUAL SIGNALS (HEAD,	1
4C 6	16	HAND, AIRCRAFT MOVEMENT, LIGHT).	2

MISSION SEGMENT NO. 08. FINAL APPROACH, LANDING, MISSED APP
ROLE 1-CONTROLLER OF AIRCRAFT
DUTY A- CONTROL AIRCRAFT DURING DAY VFR SHOREBASED OPERATIONS

TASK			
1A47	13	CONTROL AIRCRAFT DURING LANDING ROLL-OUT (WET/ICY RUNWAY).	1

MISSION SEGMENT NO. 11. ARRIVAL AND SPECIAL PROCEDURES
ROLE 1-CONTROLLER OF AIRCRAFT
DUTY A- CONTROL AIRCRAFT DURING DAY VFR SHOREBASED OPERATIONS

TASK			
1A19	13	CONTROL AIRCRAFT DURING SPIN RECOVERY.	1
1A32	13	CONTROL AIRCRAFT DURING HIGH ANGLE-OF-ATTACK AND BUFFET.	1

MISSION SEGMENT NO. 12. EMERGENCIES
ROLE 1-CONTROLLER OF AIRCRAFT
DUTY A- CONTROL AIRCRAFT DURING DAY VFR SHOREBASED OPERATIONS

TASK			
1A48	13	CONTROL AIRCRAFT DURING LANDING ROLL-OUT MINUS AN ENGINE	1
1A48	13	(WHERE APPLICABLE).	2

ISSION SEGMENT NO. 06. TACTICAL OPERATIONS
OLE 6-TACTICIAN
UTY A- CONTROL AIRCRAFT IN FORMATION FLIGHT

TASK			
6A17	11	MAINTAIN FLIGHT INTEGRITY AS LEAD.	1
6A18	11	DEMONSTRATE PLANNING ABILITY AND DECISIVENESS AS	1
6A18	11	FORMATION FLIGHT LEADER.	2
6A19	11	MAINTAIN LOOKOUT DOCTRINE IN A TACTICAL/THREAT ENVIRONMENT.	1

ISSION SEGMENT NO. 07. DESCENT, APPROACH
OLE 1-CONTROLLER OF AIRCRAFT
UTY A- CONTROL AIRCRAFT DURING DAY VFR SHOREBASED OPERATIONS

TASK			
1A33	11	CONTROL AIRCRAFT DURING BREAK.	1

ISSION SEGMENT NO. 12. EMERGENCIES
OLE 1-CONTROLLER OF AIRCRAFT
UTY A- CONTROL AIRCRAFT DURING DAY VFR SHOREBASED OPERATIONS

TASK			
1A 7	11	CONTROL AIRCRAFT DURING CLIMBOUT MINUS AN ENGINE	1
1A 7	11	(WHERE APPLICABLE).	2

ISSION SEGMENT NO. 13. CONTACT TASKS
OLE 1-CONTROLLER OF AIRCRAFT
UTY B- CONTROL AIRCRAFT DURING NIGHT VFR SHOREBASED OPERATIONS

TASK			
1B 5	11	CONTROL AIRCRAFT DURING NON-MANEUVERING FORMATION FLIGHT.	1
1B 5	11	(ATTITUDE CHANGES OF LESS THAN 30 DEGREE BANK AND 20 DEGREE	2
1B 5	11	PITCH).	3

ISSION SEGMENT NO. 16. CARRIER OPERATION
OLE 1-CONTROLLER OF AIRCRAFT
UTY D- CONTROL AIRCRAFT DURING SHIPBOARD OPERATIONS

TASK			
1D10	11	CONTROL AIRCRAFT IN RESPONSE TO FLIGHT DECK DIRECTORS.	1

ISSION SEGMENT NO. 13. CONTACT TASKS
OLE 1-CONTROLLER OF AIRCRAFT
UTY A- CONTROL AIRCRAFT DURING DAY VFR SHOREBASED OPERATIONS

TASK			
1A22	8	CONTROL AIRCRAFT DURING NON-MANEUVERING FORMATION FLIGHT	1
1A22	8	(ATTITUDE CHANGES OF LESS THAN 30 DEGREE BANK AND 20 DEGREE	2
1A22	8	PITCH).	3

ROLE 6-TACTICIAN
DUTY A- CONTROL AIRCRAFT IN FORMATION FLIGHT

TASK			
6A 2	8	PERFORM DAY CV RENDEZVOUS.	1
6A 3	8	PERFORM DAY RUNNING RENDEZVOUS.	1
6A 4	8	MAINTAIN PARADE POSITION.	1
6A 6	8	MAINTAIN CRUISE AND COLUMN POSITIONS.	1
6A 7	8	PERFORM LEAD CHANGE.	1
6A 9	8	PERFORM NIGHT SECTION FORMATION.	1
6A10	8	PERFORM NIGHT DIVISION FORMATION.	1

MISSION SEGMENT NO. 16. CARRIER OPERATION
ROLE 1-CONTROLLER OF AIRCRAFT
DUTY D- CONTROL AIRCRAFT DURING SHIPBOARD OPERATIONS

TASK			
1D 1	8	AWARE OF CVA/CVS MARSHAL AND PENETRATION PROCEDURES.	1

MISSION SEGMENT NO. 02. PRE-TAKEOFF
ROLE 1-CONTROLLER OF AIRCRAFT
DUTY A- CONTROL AIRCRAFT DURING DAY VFR SHOREBASED OPERATIONS

TASK			
1A51	0	CONTROL AIRCRAFT WHILE AIR TAXIING.	1

DUTY B- CONTROL AIRCRAFT DURING NIGHT VFR SHOREBASED OPERATIONS

TASK			
1B20	0	CONTROL AIRCRAFT WHILE AIR TAXIING.	1

ROLE 2-ENVIRONMENTAL ANALYSIS
DUTY C- COMPLY WITH THE PRINCIPLES OF SURVIVAL

TASK			
2C 8	0	AWARE OF EJECTION SEAT PROCEDURES (BODY POSITION,	1
2C 8	0	SEAT ENVELOPE, ETC.).	2

MISSION SEGMENT NO. 03. TAKEOFF
ROLE 1-CONTROLLER OF AIRCRAFT
DUTY A- CONTROL AIRCRAFT DURING DAY VFR SHOREBASED OPERATIONS

TASK			
[illegible]	0	CONTROL AIRCRAFT ON VERTICAL TAKE-OFF.	1
[illegible]	0	CONTROL AIRCRAFT DURING HIGH GROSS WEIGHT TAKE-OFF.	1

DUTY B- CONTROL AIRCRAFT DURING NIGHT VFR SHOREBASED OPERATIONS

TASK			
[illegible]	0	CONTROL AIRCRAFT ON VERTICAL TAKE-OFF.	1

ROLE 6-TACTICIAN
DUTY [illegible] AIR-TO-AIR WEAPONS

TASK			
[illegible]	[illegible]	CONTROL AIRCRAFT DURING HOVER IN RESPONSE TO VERBAL DIRECTIONS	1
[illegible]	[illegible]	[illegible] CREW CHIEF.	2
[illegible]	[illegible]	CONTROL AIRCRAFT DURING HOVER IN RESPONSE TO VISUAL	1
[illegible]	[illegible]	SIGNALS FROM USL.	2

MISSION SEGMENT NO. 04. CLIMB, DEPARTURE
ROLE 1-CONTROLLER OF AIRCRAFT
DUTY A- CONTROL AIRCRAFT DURING DAY VFR SHOREBASED OPERATIONS

TASK			
1A52	O	CONTROL AIRCRAFT DURING TRANSITION FROM A HOVER TO NORMAL CLIMB.	1

DUTY B- CONTROL AIRCRAFT DURING NIGHT VFR SHOREBASED OPERATIONS

TASK			
1B21	O	CONTROL AIRCRAFT IN TRANSITION FROM A HOVER TO NORMAL CLIMB.	1

MISSION SEGMENT NO. 06. TACTICAL OPERATIONS
ROLE 1-CONTROLLER OF AIRCRAFT
DUTY A- CONTROL AIRCRAFT DURING DAY VFR SHOREBASED OPERATIONS

TASK			
1A23	O	CONTROL AIRCRAFT DURING MANEUVERING FORMATION FLIGHT.	1
1A23	O	(ATTITUDE CHANGES OF MORE THAN 30 DEGREE BANK	2
1A23	O	AND 20 DEGREE PITCH).	3
1A25	O	CONTROL AIRCRAFT DURING VERTICAL RECOVERIES.	1
1A26	O	CONTROL AIRCRAFT WHEN MANEUVERING IN THE VERTICAL PLANE.	1
1A27	O	CONTROL AIRCRAFT WHEN MANEUVERING INVERTED.	1
1A28	O	CONTROL AIRCRAFT DURING HIGH "G" LOADING.	1
1A29	O	CONTROL AIRCRAFT DURING ZERO "G"/LOW ANGLE-OF-ATTACK MANEUVERS.	1
1A30	O	CONTROL AIRCRAFT DURING HIGH ENERGY FLIGHT.	1
1A31	O	CONTROL AIRCRAFT DURING LOW ENERGY FLIGHT.	1

DUTY B- CONTROL AIRCRAFT DURING NIGHT VFR SHOREBASED OPERATIONS

TASK			
1B 6	O	CONTROL AIRCRAFT DURING MANEUVERING FORMATION FLIGHT.	1
1B 6	O	(ATTITUDE CHANGES OF MORE THAN 30 DEGREE BANK AND 20 DEGREE	2
1B 6	O	PITCH).	3

ROLE 6-TACTICIAN
DUTY A- CONTROL AIRCRAFT IN FORMATION FLIGHT

TASK			
6A12	O	PERFORM NIGHT RUNNING RENDEZVOUS.	1
6A14	O	PERFORM SECTION LANDINGS.	1
6A15	O	PERFORM DAY AIR-TO-AIR REFUELING.	1
6A16	O	PERFORM NIGHT AIR-TO-AIR REFUELING.	1

DUTY B- CONDUCT AIR-TO-GROUND WEAPONS DELIVERY

TASK			
6B 8	O	FLY PRESCRIBED TARGET PATTERNS.	1
6B 9	O	PERFORM PROPER ROLL-IN TECHNIQUE.	1
6B10	O	EVALUATE ESTABLISHED DIVE ANGLE.	1
6B11	O	EVALUATE AIRSPEED ERROR.	1
6B12	O	APPLY CORRECTIONS DURING RUN.	1
6B13	O	DETERMINE RELEASE/FIRING POSITION.	1
6B14	O	PERFORM PROPER DIVE RECOVERY.	1
6B15	O	EVALUATE WIND CORRECTION FROM WEAPON IMPACT.	1
6B16	O	ANALYZE ERRORS OF PREVIOUS DELIVERY.	1
6B17	O	OPERATE ARMAMENT SYSTEM SWITCHES TO ENSURE PROPER WEAPON	1
6B17	O	RELEASE/FIRING.	2

6B18	0	PERFORM AIR-TO-GROUND WEAPONS DELIVERY DURING NIGHT OPERATIONS.	1
6B19	0	AWARE OF MINE LAYING/MINE COUNTERMEASURES PROCEDURES.	1
6B20	0	PERFORM SPECIAL WEAPONS DELIVERY (LOFT, POP-UP,	1
6B20	0	LAYDOWN TECHNIQUES, ETC.)	2
DUTY C- CONDUCT SURVEILLANCE/RECONNAISSANCE			
TASK			
6C 2	0	PERFORM LOW-LEVEL RECONNAISSANCE.	1
6C 3	0	PERFORM HI-LEVEL RECONNAISSANCE.	1
DUTY E- CONDUCT AIR COMBAT MANEUVERING (ACM)			
DUTY- E. CONDUCT ANTI-SUBMARINE WARFARE (ASW)			
TASK			
6E 1	0	MAINTAIN COMBAT SPREAD POSITION.	1
6E 2	0	PERFORM CALLED AND UNCALLED TURNS IN THE COMBAT	1
6E 2	0	SPREAD FORMATION.	2
6E 3	0	PERFORM HARD TURN, BREAK TURN, AND VERTICAL REVERSE MANEUVERS.	1
6E 4	0	PERFORM LOOSE DEUCE MANEUVERING.	1
6E 5	0	MAINTAIN TACTICAL WING POSITION THROUGHOUT AGGRESSIVE	1
6E 5	0	SECTION MANEUVERING.	2
6E 6	0	PERFORM HIGH/LOW YO-YO'S.	1
6E 6	0	CONTROL AIRCRAFT DURING LOW LEVEL INBOUND HEADING/OUTBOUND	1
6E 6	0	BEARING RELATIVE TO A SMOKELIGHT.	2
6E 7	0	PERFORM HORIZONTAL SCISSORS MANEUVER.	1
6E 8	0	PERFORM ROLLING SCISSORS MANEUVER.	1
6E 9	0	PERFORM HIGH AND LOW "G" ROLLS.	1
6E10	0	MANEUVER FLIGHT SO AS TO AVOID DEFENSIVE POSITION	1
6E10	0	(KEEP 6 O'CLOCK CLEAR).	2
6E11	0	ENGAGE SO AS TO OBTAIN AN OFFENSIVE POSITION.	1
6E12	0	MAINTAIN AN OFFENSIVE POSITION.	1
6E13	0	PROVIDE MUTUAL SUPPORT FOR WINGMAN.	1
6E14	0	MONITOR WINGMAN/BOGIE POSITIONS DURING AIR COMBAT MANEUVERING.	1
6E15	0	MONITOR AND TRANSMIT TACTICAL COMMENTARY DURING	1
6E15	0	AIR COMBAT MANEUVERING.	2
6E16	0	DETERMINE WHEN ENGAGEMENT HAS DEGENERATED INTO A DEFENSIVE	1
6E16	0	SITUATION AND EXECUTE PRUDENT ESCAPE MANEUVERS.	2
6E17	0	DETERMINE THE PROPER TACTIC TO BE USED AGAINST	1
6E17	0	DISSIMILAR AIRCRAFT.	2
6E18	0	MANEUVER DURING DISSIMILAR AIRCRAFT ENGAGEMENT	1
6E19	0	AWARE OF THE IMPORTANCE OF AGGRESSIVENESS WITHIN THE	1
6E19	0	TACTICAL ENVIRONMENT.	2
DUTY F- MANAGE AIR-TO-AIR WEAPONS			
TASK			
6F 1	0	AWARE OF VARIOUS TYPES OF TACTICAL AIR-TO-AIR WEAPONS AND	1
6F 1	0	THEIR EFFECTIVENESS.	2
6F 2	0	APPLY GUNSIGHT TRACKING PRINCIPLES.	1
6F 3	0	CONTROL AIRCRAFT DURING APPROACH TO A HOVER WITH EXTERNAL	1
6F 3	0	CARGO ATTACHED.	2
6F 3	0	AWARE OF AIR-TO-AIR CANNON/GUN ENVELOPES.	1
6F 4	0	AWARE OF AIR-TO-AIR MISSILE ENVELOPES	1
6F 4	0	(SIDEWINDER, SPARROW, ETC.).	2

MISSION SEGMENT NO. 07. DESCENT, APPROACH
ROLE 1-CONTROLLER OF AIRCRAFT
DUTY A- CONTROL AIRCRAFT DURING DAY VFR SHOREBASED OPERATIONS

TASK			
1A65	O	CONTROL AIRCRAFT DURING HIGH SPEED, HIGH RATE OF DESCENT	1
1A65	O	SPIRALING APPROACH.	2

DUTY B- CONTROL AIRCRAFT DURING NIGHT VFR SHOREBASED OPERATIONS

TASK			
1B 8	O	CONTROL AIRCRAFT DURING BREAK.	1

ROLE 3-NAVIGATOR
DUTY B- NAVIGATE USING RADIO AIDS (TACAN, ADF)

TASK			
3B31	O	PERFORM VOR PENETRATION.	1

ROLE 6-TACTICIAN
DUTY A- CONTROL AIRCRAFT IN FORMATION FLIGHT

TASK			
6A 8	O	MAINTAIN POSITION THROUGHOUT DAY SECTION PENETRATION AND	1
6A 8	O	CONFIGURATION CHANGE TO LANDING APPROACH.	2
6A13	O	MAINTAIN POSITION THROUGHOUT NIGHT SECTION PENETRATION AND	1
6A13	O	CONFIGURATION CHANGE TO LANDING APPROACH.	2

MISSION SEGMENT NO. 08. FINAL APPROACH, LANDING, MISSED APP
ROLE 1-CONTROLLER OF AIRCRAFT
DUTY A- CONTROL AIRCRAFT DURING DAY VFR SHOREBASED OPERATIONS

TASK			
1A53	O	CONTROL AIRCRAFT DURING APPROACH TO A HOVER.	1
1A54	O	CONTROL AIRCRAFT DURING VERTICAL LANDING.	1
1A55	O	CONTROL AIRCRAFT DURING RUNNING LANDINGS.	1
1A56	O	CONTROL AIRCRAFT DURING HIGH ANGLE OF DESCENT APPROACHES.	1
1A57	O	CONTROL AIRCRAFT DURING WAVE-OFF FROM HIGH ANGLE OF	1
1A57	O	DESCENT APPROACHES.	2
1A62	O	CONTROL AIRCRAFT DURING HIGH GROSS WEIGHT LANDING.	1
1A63	O	CONTROL AIRCRAFT DURING HIGH SPEED QUICK-STOP.	1
1A64	O	CONTROL AIRCRAFT DURING HIGH SPEED APPROACH TO A SPOT.	1

DUTY B- CONTROL AIRCRAFT DURING NIGHT VFR SHOREBASED OPERATIONS

TASK			
1B22	O	CONTROL AIRCRAFT DURING APPROACH TO A HOVER.	1
1B23	O	CONTROL AIRCRAFT DURING VERTICAL LANDING.	1

ROLE 6-TACTICIAN
DUTY A- CONTROL AIRCRAFT IN FORMATION FLIGHT

TASK			
6A12	O	PERFORM SECTION LANDINGS.	1

MISSION SEGMENT NO. 11. ABNORMAL AND SPECIAL PROCEDURES
ROLE 1-CONTROLLER OF AIRCRAFT
DUTY A- CONTROL AIRCRAFT DURING DAY VFR SHOREBASED OPERATIONS

TASK			
1A18	O	CONTROL AIRCRAFT DURING DEPARTED FLIGHT RECOVERY.	

MISSION SEGMENT NO. 12. EMERGENCIES
ROLE 1-CONTROLLER OF AIRCRAFT
DUTY A- CONTROL AIRCRAFT DURING DAY VFR SHOREBASED OPERATIONS

TASK			
1A36	O	CONTROL AIRCRAFT DURING WAVE-OFF MINUS AN ENGINE	1
1A36	O	(WHERE APPLICABLE).	2
1A59	O	CONTROL AIRCRAFT DURING RECOVERY FROM POWER SETTLING.	1
1A60	O	CONTROL AIRCRAFT DURING SIMULATED FUEL CONTROL MALFUNCTION.	1
1A66	O	CONTROL AIRCRAFT DURING ACTUAL OR SIMULATED EMERGENCY POWER	1
1A66	O	LOSS AT ALTITUDE.	2
1A67	O	CONTROL AIRCRAFT DURING PRACTICE AUTOROTATION ENTRY.	1
1A68	O	CONTROL AIRCRAFT DURING AUTORATIVE FLIGHT.	1
1A69	O	CONTROL AIRCRAFT DURING POWER RECOVERY FROM AUTOROTATION.	1
1A70	O	CONTROL AIRCRAFT DURING AUTOROTATION RUNNING LANDING.	1
1A71	O	CONTROL AIRCRAFT DURING AUTOROTATION FLARE LANDING.	1
1A72	O	CONTROL AIRCRAFT DURING SIMULATED EMERGENCY POWER LOSS	1
1A72	O	WHILE IN A HOVER.	2
1A73	O	CONTROL AIRCRAFT DURING POWER-OFF LANDING FROM A HOVER.	1
1A74	O	CONTROL AIRCRAFT DURING SIMULATED FLIGHT CONTROL/ SERVO	1
1A74	O	MALFUNCTION.	2
1A75	O	AWARE OF THE CONDITIONS WHICH INDUCE GROUND RESONANCE.	1
1A76	O	AWARE OF GROUND RESONANCE RECOVERY TECHNIQUES.	1
1A77	O	CONTROL AIRCRAFT DURING SIMULATED LOSS OF TAIL ROTOR CONTROL.	1

DUTY B- CONTROL AIRCRAFT DURING NIGHT VFR SHOREBASED OPERATIONS

TASK			
1B16	O	CONTROL AIRCRAFT DURING DITCHING/FORCED LANDING DRILLS.	1
1B24	O	CONTROL AIRCRAFT DURING AUTORATIVE FLIGHT.	1
1B25	O	CONTROL AIRCRAFT DURING POWER RECOVERY FROM AUTOROTATION.	1

MISSION SEGMENT NO. 13. CONTACT TASKS
ROLE 1-CONTROLLER OF AIRCRAFT
DUTY A- CONTROL AIRCRAFT DURING DAY VFR SHOREBASED OPERATIONS

TASK			
1A21	O	CONTROL AIRCRAFT DURING PRECISION ACROBATICS.	1
1A21	O	CONTROL AIRCRAFT DURING MANEUVERING FORMATION FLIGHT (ATTITUDE	1
1A21	O	CHANGES OF MORE THAN 30 DEGREE BANK AND 20 DEGREE PITCH.	2
1A48	O	CONTROL AIRCRAFT IN A HOVER OVER THE GROUND.	1
1A49	O	CONTROL AIRCRAFT DURING HOVERING TURNS.	1
1A50	O	CONTROL AIRCRAFT IN A HOVER IN CROSSWIND/DOWNWIND CONDITIONS.	1

DUTY B- CONTROL AIRCRAFT DURING NIGHT VFR SHOREBASED OPERATIONS
TASK

```
  1B18      0  CONTROL THE AIRCRAFT IN A HOVER OVER THE GROUND.                1
  1B19      0  CONTROL AIRCRAFT IN HOVERING TURNS.                             1
ROLE 3-NAVIGATOR
DUTY D- NAVIGATE USING DEAD RECKONING (DR) TECHNIQUES
  TASK
  3D 5      0  USE DRIFT SIGHT TO DETERMINE WIND.                             1
ROLE 6-TACTICIAN
DUTY A- CONTROL AIRCRAFT IN FORMATION FLIGHT
  TASK
  6A 1      0  PERFORM SECTION TAKE-OFF AND MAINTAIN POSITION THROUGHOUT       1
  6A 1      0  CONFIGURATION CHANGE.                                           2
  6A 5      0  PERFORM PARADE CROSS-UNDERS.                                    1
  6A 5      0  PERFORM PARADE CROSS-OVERS.                                     1


MISSION SEGMENT NO. 16,  CARRIER OPERATION
ROLE 1-CONTROLLER OF AIRCRAFT
DUTY D- CONTROL AIRCRAFT DURING SHIPBOARD OPERATIONS
  TASK
  1D 2      0  CONTROL AIRCRAFT DURING CCA.                                   1
  1D 3      0  CONTROL AIRCRAFT DURING LANDING APPROACH (ABEAM TO FINAL).     1
  1D 4      0  CONTROL AIRCRAFT ON GLIDE SLOPE DURING APPROACH.               1
  1D 5      0  CONTROL AIRSPEED/ANGLE OF ATTACK OF AIRCRAFT DURING APPROACH.  1
  1D 6      0  CONTROL POWER OF AIRCRAFT DURING APPROACH.                     1
  1D 7      0  CONTROL LINE-UP OF AIRCRAFT DURING APPROACH.                   1
  1D 8      0  CONTROL AIRCRAFT AT TOUCHDOWN.                                 1
  1D 9      0  CONTROL AIRCRAFT DURING TAXI OUT OF ARRESTING GEAR.            1
  1D11      0  CONTROL AIRCRAFT DURING TAXI ONTO CATAPULT.                    1
  1D11      0  CONTROL AIRCRAFT TO COMPENSATE FOR RELATIVE MOTION             1
  1D11      0  DURING APPROACH TO SHIP.                                       2
  1D12      0  CONTROL AIRCRAFT IN A HOVER OVER SHIPBOARD LANDING SPOT.       1
  1D12      0  CONTROL AIRCRAFT DURING ROTATION AFTER CATAPULT LAUNCH.        1
  1D13      0  CONTROL AIRCRAFT DURING VERTICAL SHIPBOARD LANDING.            1
  1D13      0  CONTROL AIRCRAFT DURING NIGHT CARRIER LANDINGS.                1
  1D14      0  CONTROL AIRCRAFT DURING VERTICAL SHIPBOARD TAKE-OFF.           1
  1D15      0  CONTROL AIRCRAFT DURING TRANSITION TO CLIMBOUT FROM A SHIP.    1
  1D16      0  CONTROL THE AIRCRAFT IN A HOVER OVER WATER DURING DAY VFR.     1
ROLE 4-COMMUNICATOR
DUTY C- COMMUNICATE USING AUDIO/VISUAL MEANS
  TASK
  4C 8      0  RESPOND TO LSO SIGNALS.                                        1
ROLE 6-TACTICIAN
DUTY A- CONTROL AIRCRAFT IN FORMATION FLIGHT
  TASK
  6A11      0  PERFORM NIGHT CV RENDEZVOUS.                                   1
ROLE 4-COMMUNICATOR
DUTY C- COMMUNICATE USING AUDIO/VISUAL MEANS
  TASK
  4C 8      0  RESPOND TO LSE SIGNALS.                                        1


**FORTRAN ** STOP
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APPENDIX G

COST ANALYSIS

This appendix presents a listing of the variables which were inputs to the TAEG developed cost model. This model served as the basis for the economic analysis performed in this study.

INPUT DATA

1. Graduates required per year

   Predicated on a pilot production rate of 1750.

2. Cost/Square Foot

   OM&N cost for maintenance of hangar space at $1.50 sq ft or $3.50 sq ft for classroom/briefing, etc.

3. Operation and Maintenance cost/year

   For aircraft costs, figures were derived from CNET N-4A, 18 Feb 1975 data.

   For existing simulators $12,300 derived from CNATRA TECEP Computer Runs. For 2F90 and 2F101 $96,206 derived from NTEC cost data.

   For new simulators 2 percent of estimated acquisition cost.

4. Annual acquisition cost per student position

   Zero for all runs--no additional equipment added during planning period.

5. Unique hours of IMD per year

   Assumed to be zero for all runs.

6. Number of years in planning period

   3 for Current and Quick Fix; 15 for all others.

7. Attrition rates

   Rates for Current, Quick Fix, LRPTS and Alternative 1 are derived from Department of Defense Military Manpower Training Report for FY 1976 dated March 1975.

   Rates for SPOT are predicted rates based on available synthetic selection data.

8. Length of training in weeks

Derived from current syllabus or projected from revised training.

9. Average hours spent in training medium

Length of training in weeks multiplied by 40 (hr/wk).

10. Weeks "school" operates per year

For aircraft, input data were derived from CNATRA data as follows:

$$\frac{\text{Aircraft Available hr/yr}}{40} = \text{Weeks school operates/yr}$$

For simulators:

$$\frac{\text{Daily Scheduled hrs (8 or 12)} \times 5 \times 50}{40} = \text{Weeks school operates/yr}$$

For all classroom/other, assumed to be 50 weeks/yr.

11. Percentage of time student positions are down

Derived from historical data and or predicted for new hardware.

12. Recycle rate

For all aircraft runs assumed to be 100 percent.

For all other runs assumed to be 12 percent based on CNATRA TECEP cost comparison runs.

13. Average recycle time in weeks

For aircraft runs data obtained from CNATRA Planning Factors dated 6 March 1975.

For all other runs assumed to be .12 weeks; based on CNATRA cost comparison runs.

14. Average student cost to/from school

Based on data received from CNATRA.

15. Average student travel as a part of course

Assumed to be zero.

16. Excess number of student positions

Assumed to be zero.

17. Instructor/Student Position Ratio

For aircraft.

$$\frac{\text{No. of Grads + Input}}{2} = \text{Average students}$$

$$\frac{\text{Average Studs. X Syllabus Hours X Overhead Factor}}{\text{Aircraft Hours per Year Available}} = A$$

$$\frac{\text{Average Studs. X Instructor Time Per Stud.}}{\text{Instructor Available Flt Hrs/year}} = B$$

B/A = Instructor student position ratio

For training devices instructor/student position ratio = 1

For classroom/other instructor/student position ratio = .05.

18. Square foot/instructor position

Acquired from CNATRA cost comparison runs.

19. Square foot/student position

a. 9616 for all aircraft runs. Acquired from CNATRA cost comparison runs.

b. Based on CNATRA data for all training equipment.

c. Assumed to be 22 for all classroom runs.

20. Update factor of instructional material

Assumed to be .2 for all runs.

21. Hourly cost of IMD

$96/hr for all aircraft and simulator hardware runs. $30/hr for all classroom and/or CFT.

22. Salary of one instructor

$19,100 all runs.

23. Supplies cost/student

For aircraft/simulator 43¢ per hour in media.

For others 5¢ per hour in media.

24. Life of equipment in years

15 except for T34B, T28 and TS2 and their associated training hardware which were estimated to be 3.

25. Value of IM at end of planning period

0 for all runs.

26. Student salary

$12,000 for all runs.

27. Discount rate

.10 for all runs.

28. Equipment implementation cost/student position

Estimated acquisition costs based on a variety of data from various sources.

29. Equipment cost independent of student position

Zero for all runs.

30. Facilities acquisition or refurbish cost

Based on $36.4 per sq ft x square foot requirements for new training hardware.

31. Percent of training medium time requiring unique hours of IMD

Estimates percentage of new instructional material development required due to revision of the present syllabus or a totally new syllabus development.

32. Manning and overhead factor

Derived from CNATRA Planning Factors dated 6 March 1975.

33. Manning and overhead wages and benefits

Estimated average based on costs furnished by BUPERS.

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