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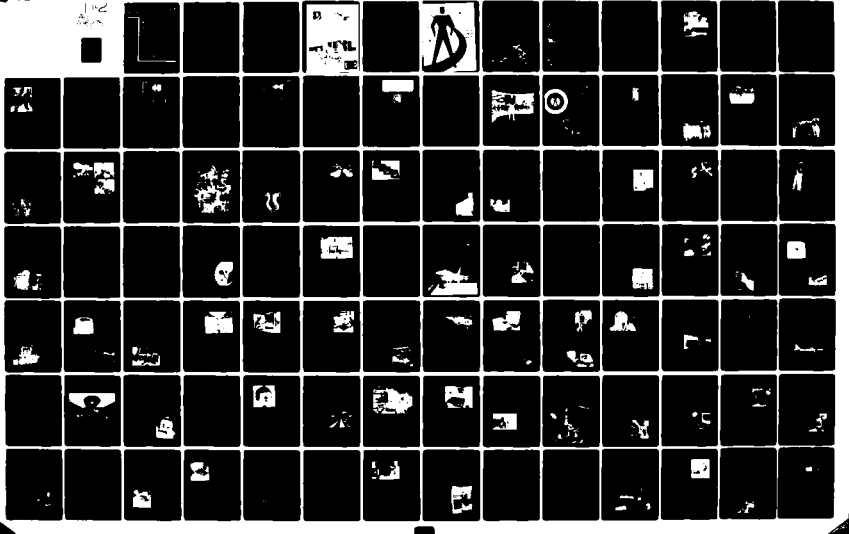

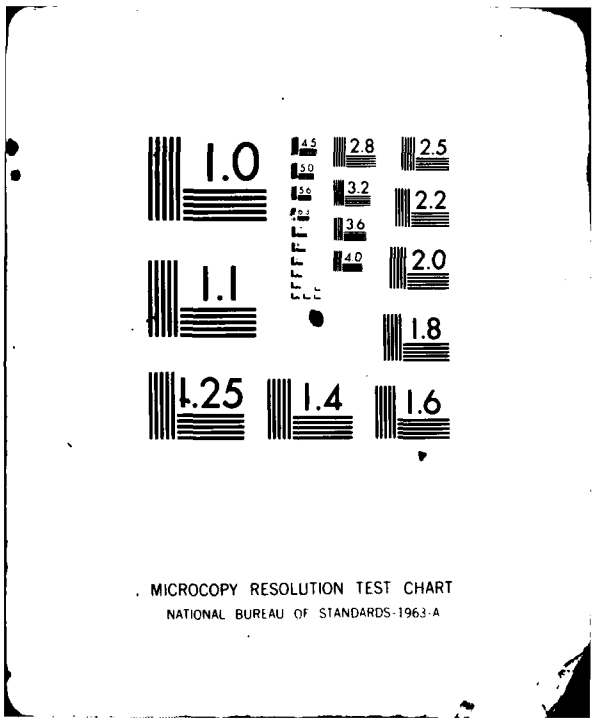
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AIR FORCE HUMAN RESOURCES LABORATORY

AIR FORCE HUMAN RESOURCES LABORATORY ANNUAL REPORT — FISCAL YEAR 1981

Edited by

Ruth M. Buescher

APPLICATIONS AND LIAISON OFFICE
Brooks Air Force Base, Texas 78235

June 1982

Final Technical Paper

AIR FORCE SYSTEMS COMMAND
BROOKS AIR FORCE BASE, TEXAS 78235

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

This paper presents the Air Force Human Resources Laboratory (AFHRL) mission, corporate philosophy, and descriptions of its research and development (R&D) thrusts. Fiscal Year 1981 technical achievements and on-going R&D are organized under each thrust area. It further outlines AFHRL organizational structure, the functions of its divisions and staff offices, and available technical resources. It lists publications and presentations by Laboratory personnel during Fiscal Year 1981.

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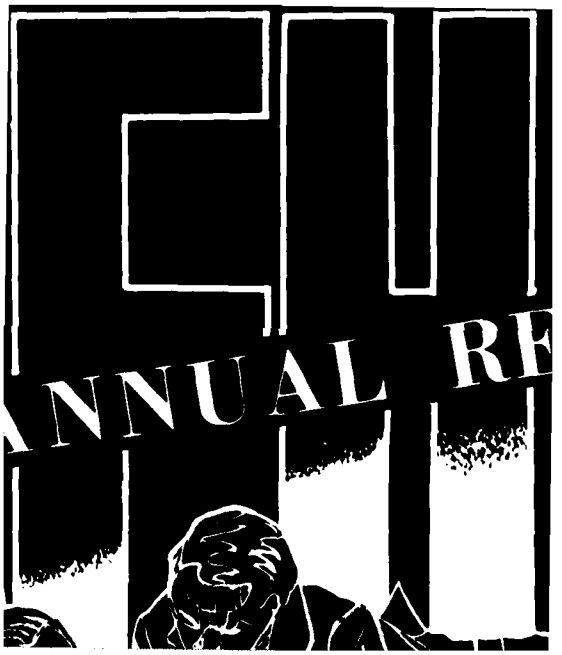

ANNUAL RE

AIR FORCE HUMAN RESOURCES LABORATORY

A Designated Organizational Element of the Air Force Systems Command

RONALD W. TERRY
Colonel, USAF
Commander

EARL A. ALLUISI
Chief Scientist

ACKNOWLEDGEMENTS

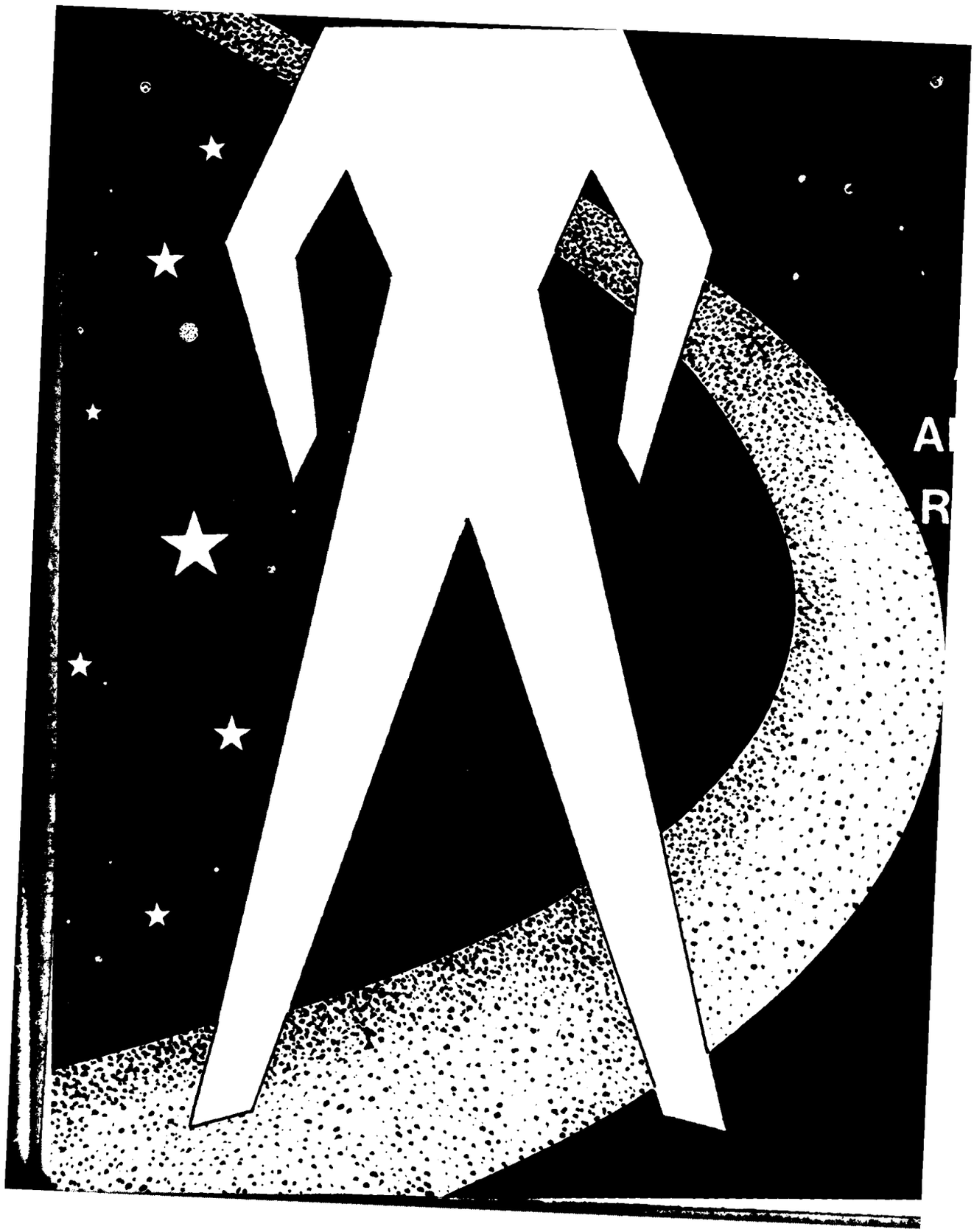
Prepared by the Applications and Liaison Office (AFHRL/AZ) on the basis of the research and development efforts of the AFHRL scientists and associated contractors, with the assistance of numerous individuals from the operating divisions and the headquarters staff. Special appreciation is due Dr. Ruth Buescher who organized and coordinated the report and Mr. Sharon H. Tice (USAF School of Aerospace Medicine, Medical Illustrations Section) who provided many of the graphics and illustrations.

NOTICES

CONTACTS: A directory of AFHRL headquarters staff personnel and division chiefs is provided on the inside back cover. Points of contact are also given for each technical achievement and for each ongoing research and development project.

NOTE: The findings in this report are not to be construed as an official Department of the Air Force position unless so designated by other authorized documents.

Department of the Air Force
AIR FORCE HUMAN RESOURCES LABORATORY (AFSC)
Brooks Air Force Base, Texas 78235



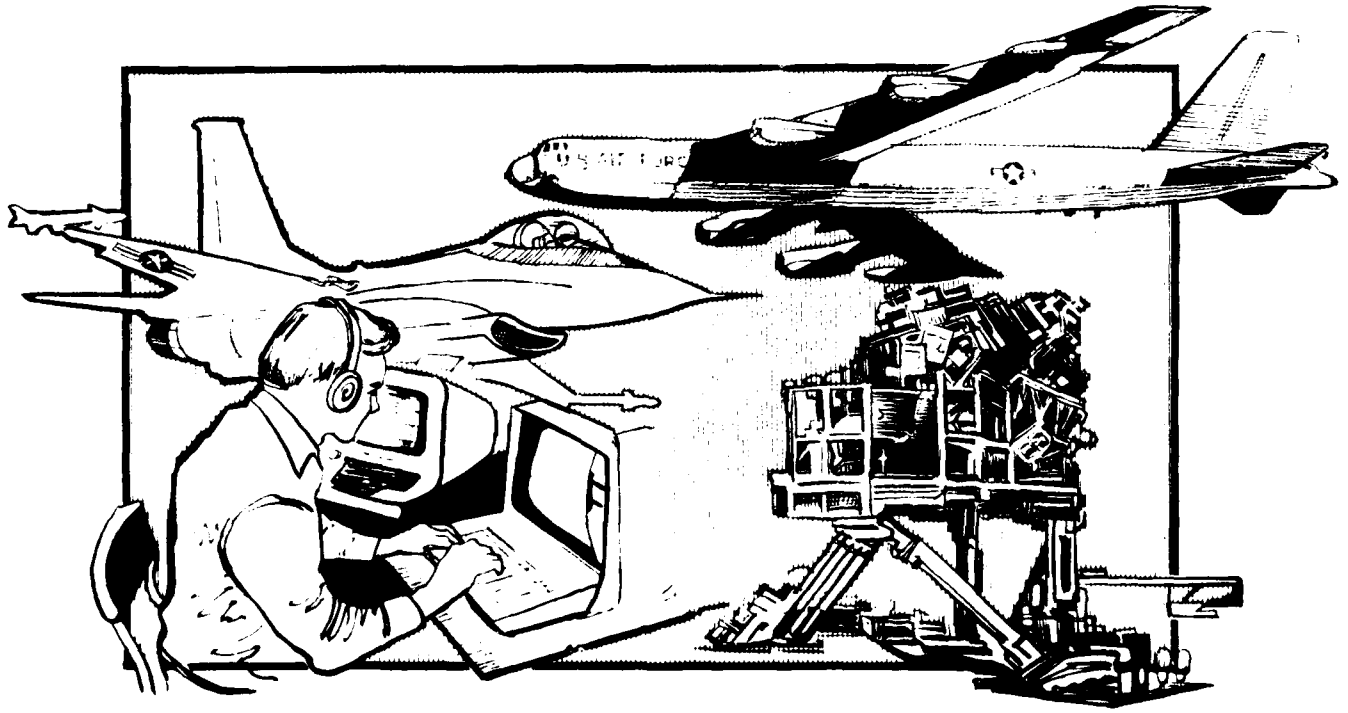
MISSION

The Air Force Human Resources Laboratory (AFHRL), with headquarters at Brooks AFB, Texas, is one of six laboratories reporting directly to Air Force Systems Command (AFSC). AFHRL plans and executes the USAF exploratory and advanced development programs in manpower and personnel, education and training, simulation and training devices, logistics and group aspects of human factors engineering. The Laboratory also develops demonstrations of advanced simulation and training delivery systems hardware and software technologies and provides technical consultation and support of analyses, studies, research and development planning and conceptual study efforts. Laboratory research also supports exploratory, advanced, and engineering development projects, equipment procurements, modifications, test and evaluation programs, and systems acquisition programs where the intended end product has human performance as an integral component.

The AFHRL mission is related to all functional areas of the Air Force since there is no area that escapes the requirement for trained and qualified personnel. The Laboratory executes its mission through its research and development (R&D) programs in training and personnel systems technology. These include manpower and personnel R&D programs in selection, classification, retention, force structures and force utilization; education and training R&D programs in technical training flying training, and crew, group, team, and unit training; simulation and training-device R&D programs to develop flight simulators and maintenance training simulators; and logistics and human factors R&D programs in weapon systems logistics and combat maintenance.

Of prime importance in the AFHRL mission is the development of timely information and analytical techniques for management and policy decision makers on personnel planning, selection, training, and weapon systems support. This information is especially related to changing conditions such as a drawdown or buildup in personnel, introduction of new weapon systems, and new or modified operational environments. Since the largest single item in the Department of Defense budget is the cost of personnel, and their training and administrative support, there is a greater possibility for cost savings from the human resources technology area than in all other technology areas combined—and such savings tend to be cumulative over the years, thereby producing disproportionately high returns from the modest investment in training and personnel systems technology R&D.

More importantly, since only people can formulate, implement, and modify the objectives, strategy, and tactics that ensure Air Force superiority over any adversary, human resources technology has the potential and awesome responsibility to contribute substantially to the operational success of all Air Force elements. Thus, advanced human resources technology applications can be a real force multiplier to the extent that it can produce the means for improved personnel acquisition and utilization, enhanced training, and enhanced weapon systems performance in combat.



AFHRL ANNUAL REPORT FY 81

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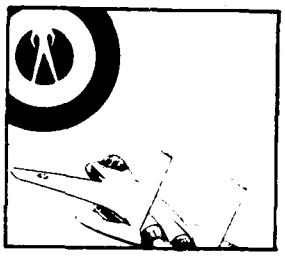


"Our effectiveness in the end is clearly a function of the effectiveness of our hardware and the quality of the people that operate and maintain it. . . . If we are to succeed in leveraging the technological advantages that we possess, we must devote more effort and resources to the personnel who will make that technology effective as a deterrent."

Walter LaBerge
Deputy Undersecretary of Defense,
Research and Engineering

MESSAGE FROM THE COMMANDER

Colonel Ronald W. Terry

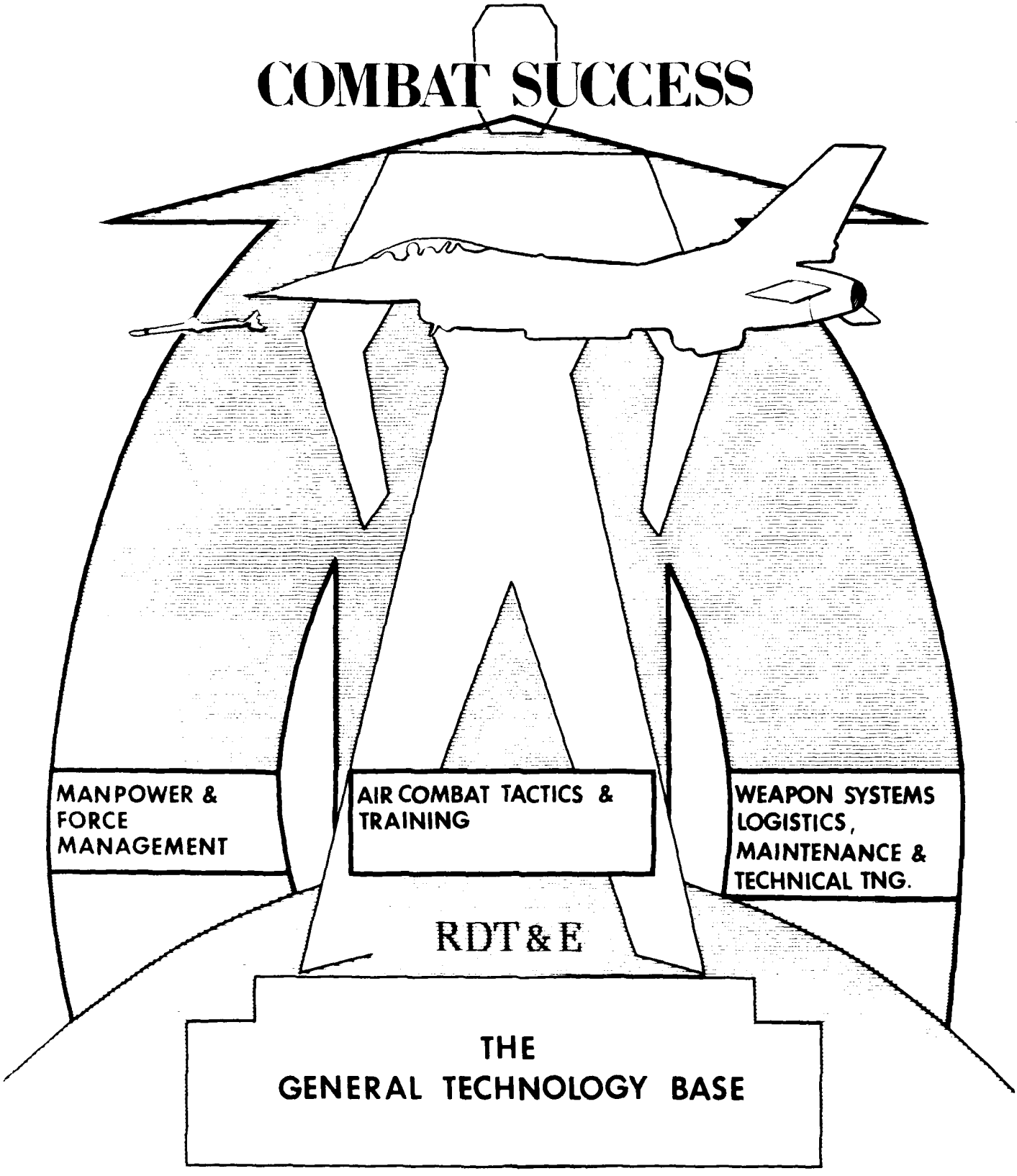
We continue to face a time of testing for our country. The rising tide of national concern over war readiness and military preparedness is of overwhelming importance to the survival of our country. Our goal is the maintenance and improvement of our ability to deter war through strength, and our ability to win should war prove necessary. All the goals, objectives and strategies are for naught if they do not focus on the central themes of readiness and combat success.

Readiness has three principal components: people, hardware, and the command and control structure. The components must be in perfect synergism to optimize the formula for combat success. In this regard, the Air Force Human Resources Laboratory's research and development (R&D) goals seek to enhance the people-hardware match through the development of alternate new technologies that provide options for our leaders in the arena of world affairs.

The decreasing applicant pool of service-eligible personnel makes the effective use and retention of in-service personnel critical during the 1980s. Our R&D must continue to be directed toward attracting and retaining quality people. The ability to forecast force strength is essential to defense planning, policy development, and budget formulations. Likewise, the Laboratory's R&D in the area of weapon systems logistics must provide a sound basis for making decisions involving the interaction of manpower and hardware in the design and acquisition of weapon systems. The Laboratory's R&D program in the area of training for air combat tactics, command and control, and the maintenance of our equipment must ensure U.S. air superiority through effective use of training devices, methods, processes, and the development of the criteria and the methodology for performance measurement.

In short, the Laboratory's R&D program must be responsive to the operational needs of the Air Force, must be dynamic, and must be constantly updated to reflect new directions dictated by emerging technologies and an ever-changing world situation.

RONALD W. TERRY, Colonel, USAF
Commander


COMBAT SUCCESS
MANPOWER & FORCE MANAGEMENT
AIR COMBAT TACTICS & TRAINING
WEAPON SYSTEMS LOGISTICS, MAINTENANCE & TECHNICAL TNG.
RDT&E
THE GENERAL TECHNOLOGY BASE

CORPORATE PHILOSOPHY

The direction of the AFHRL's Research and Development program is articulated by three major thrusts, each representing a unique and vital segment of Air Force human resource needs. This direction relates positively to the goals *toward* which the Laboratory is working rather than to the disciplines *from* which the Laboratory develops its technology. All three of the major thrusts (Manpower and Force Management; Air Combat Tactics and Training; Weapon Systems Logistics, Maintenance, and Technical Training) are aimed at *development of technology to increase* the ease and probability of combat success for our forces.

In order to achieve simpler management control and to increase productivity, the Laboratory has been reorganized into three major R&D divisions (one for each of the major thrusts), a Technical Services Division, and a small Headquarters staff. The number of work units has been reduced from 250 in FY 78 to 170 at present. The intent of this reduction is twofold: (a) to increase efforts in selected areas to achieve the critical mass necessary for timely development and implementation, and (b) to reduce the "overhead" time spent by task scientists in the administration of both in-house and contract efforts that tend to be constant regardless of size. To increase the efficiency with which we invest technology-base funds, not only in the Air Force but also in the Army and Navy as well, we began during 1979 to meet quarterly with the Commanders of the Army Research Institute for the Behavioral and Social Sciences (ARI) and the Navy Personnel Research and Development Center (NPRDC). We have integrated our programs as fully as feasible. To increase the technical quality of the work, and to seek further integration of the program across the Laboratory's Divisions, we have charged our Technical Advisory Board (consisting of the Technical Directors of the Divisions, and chaired by the Chief Scientist), to review in depth the technical aspects of the program twice annually. We are stressing the development of new initiatives within the Laboratory to stimulate innovative ways of achieving objectives for the Air Force.

Our technology base is common across all programs and crosses all functional areas of the Laboratory. Perhaps more than any other R&D activity, the work of the Air Force Human Resources Laboratory needs to be undertaken from the standpoint of both vertical and horizontal integration across all functional areas of the Air Force. Nowhere else is the probability so great that optimization of a micro part of one functional area will result in suboptimization of the total Air Force system. With the quite necessary predisposition of the Air Force toward innovations in the physical sciences and engineering leading to ever better and more capable hardware systems and weapons, R&D on Manpower, Personnel and Training has been historically unglamorous; R&D in these areas has been assigned lower priorities, and the work is neither well understood nor deemed to be of as much value as hardware R&D. At all levels the tendency is toward minimum investment, yet there is growing evidence that the issue of manpower availability and trainability may be one of the most, if not *the* most, limiting factor on the amount of Air *Force* truly available in the future.

CHIEF SCIENTIST'S REPORT

Dr. Earl A. Alluisi

AFHRL is developing technology for Air Force use (1) to *acquire* and manage a highly capable personnel force, (2) to train this force to use and effectively support their *weapon systems*, and (3) to improve airerew, ground crew, and total system combat performance. The Laboratory's R&D program is organized into three technical thrusts as follows:

(1) The *Manpower and Force Management* thrust aims to provide technology for effective acquisition, distribution, and management of the personnel force. This means making the best person-job matches possible—a difficult task considering the size of the Air Force (510,000 uniformed personnel in 1981), and the impacts of economic, social, and political factors on manpower availability.

(2) The *Air Combat Tactics and Training* thrust provides engineering technology for *flight simulators and* training technology for proper use of these simulators in acquiring and maintaining combat flying skills. The aim is to provide the means to train highly effective airerews capable of performing as well as combat veterans who have already successfully flown several combat missions.

(3) The *Weapon Systems Logistics, Maintenance, and Technical Training* thrust is developing technology for *technical and maintenance training*, and for weapon systems support. The technology permits integration of manpower, training, and logistics considerations into weapon systems design and acquisition to increase the combat supportability of fielded systems. The thrust also aims to provide advanced training technology using computer-based instructional systems as well as technology to improve the performance of maintenance and support units.

Each of the three thrusts is described in greater detail on the pages that follow. Each is managed principally by one of the Laboratory's three R&D divisions located near major Air Force users of the technology developed within the thrusts.

These collocations of R&D efforts with the users of the R&D products, and the resultant frequent contacts between R&D and user personnel, serve the practical goal of ensuring that the on-going R&D program is not only technically sound, but also adaptive, relevant, beneficial, and cost effective within the context of developing technology that can be used to increase the ease and probability of USAF combat success.

Technical Evaluations. There were many management reviews of the Laboratory during FY 81, as there are every year, and one major technical review aimed to assess the quality of the program and its technical soundness. This technical review is conducted through the AFHRL Technical Advisory Board (TAB), which

consists of the Technical Directors of the three R&D divisions, the Chief Scientist as chair, and a secretary. For each of the three thrusts, the TAB is assisted by a different Research Advisory Panel (RAP), each of which consists of three scientists of international repute in relevant substantive areas from outside the Department of Defense, and by External Reviewers (ERs) who are counterparts from the corresponding laboratories of the other Services. The initial round of TAB/RAP/ER technical reviews was based on a week-long meeting with division personnel, including especially the task scientists actually conducting or monitoring the work in the specific thrust. As a "first round," the reviews were judged successful, but a need for greater technical (as contrasted with management) detail was recommended for subsequent reviews in all three cases. More importantly, the benefits of the progress that had been made to integrate the program within each of the three thrusts were manifestly evident, and the ground work was laid for further integration among them.

Technical Status of the Manpower and Force Management Thrust. The development of Enlisted and Officer Force Acquisition and Distribution Systems continued as the major subthrust, with the development of Enlisted and Officer Force Management Systems emerging somewhat more strongly during FY 81. Both efforts are primarily responsive to Air Force personnel system operations in the current or peacetime environment, but both are now including plans and increased attention to issues of applicability to combat operations. As noted last year, this thrust, which includes as its goals the development of new technology for selection, classification, training, assignment, retraining, retention, and force management generally, is based on a mature technology that has had considerable refinement, but very little real expansion since World War II. With the support of the Air Force Office of Scientific Research, steps were taken during the year to establish data-collection facilities in basic areas such as interest measurement, information processing, cognitive skills, and learning. Rejuvenation and expansion of the technology now seems feasible, with the integration of coordinate technology advancements in other areas (such as computers and cognitive psychology); the first experiments will be conducted next year, in FY 82.

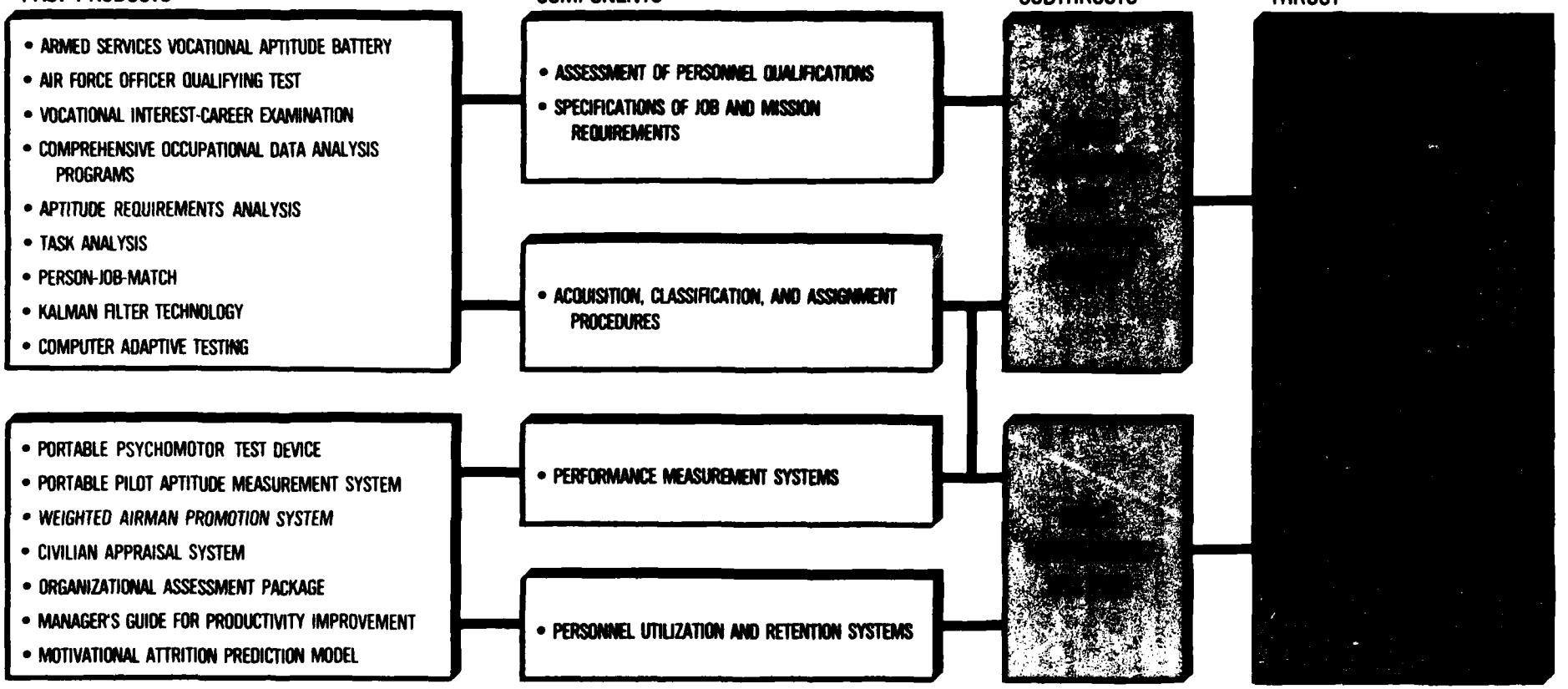
Technical Status of the Air Combat Tactics and Training Thrust. The Laboratory's engineering R&D on flight simulation continued in a single integrated subthrust on Engagement Simulation Technology. Prototype light-valve (LV) projectors were successfully demonstrated, and work continued on the development of what would represent the culmination of edge-based computer image generation (CIG). However, the technical soundness of the CIG and LV-projector development program continued to be detrimentally impacted by shifts in program directives made necessary by reductions in previously planned and approved funding profiles. Concurrent developments in more advanced, nonedge-based CIG, will be monitored closely, for it now appears possible that these still newer technologies will overtake and exceed the capabilities of edge-based CIG. A proposed new engineering subthrust to demonstrate the technological feasibility of a Combat Mission Trainer (CMT) emerged during the year as a cooperative effort with the Aerospace Medical Research Laboratory. The CMT proposal was evaluated as to risk by a special committee of the Air Force Scientific Advisory Board as FY 81 ended. The evaluation attested to the feasibility of the CMT concept with its application of fiber-optics, helmet-mounted display, advanced CIG, and microlinkage technologies to demonstrate a relatively low-cost, transportable device suitable for combat mission training at the Squadron level. The major "risks" identified had to do with the optimum utilization of such a device were it made available, and the motivational aspects of its regular use by aircrews. The behavioral R&D side of the thrust is represented primarily in the Air Combat Training Systems subthrust, which although restructured and strengthened during the year remains less technically sound than desired. Although the individual experiments proposed appear reasonable enough, the efforts remained insufficiently integrated and without clear objectives and schedules. The subthrust in Operational Unit Training Systems subthrust has been left in the category of "emerging," with just a few on-going efforts during the year.

Technical Status of the Weapon Systems Logistics, Maintenance, and Technical Training Thrust. This thrust has been completely restructured during FY 81. The initial planning was reviewed technically by the TAB, RAP, and ERs, as well as by the Laboratory's Corporate Planning Group, then revised and extended as recommended. The emerging Crew, Group, Team, and Unit (CGTU) Performance and Training Systems subthrust is now employing the command and control system as an environment (or "carrier signal") in which to begin, and both equipment and facility-connections were acquired to support the R&D plans. The Combat Logistics Technologies subthrust was evolved from sound experience in manpower and human-resource factors in design and weapon systems acquisition, and battle-damage repair studies. Similarly, the Technical and Maintenance Training Systems subthrust was developed out of prior R&D in maintenance aiding and performance enhancement, maintenance training simulation, and computer-based instructional systems in technical training. The needs in this thrust area remain clear—to provide a technology base for the delivery of skilled personnel and materiel to the operating Major Commands of the Air Force. This thrust continues to emphasize issues of applicability to combat operational support, but the program's early stage of development limits any technical assessment to its potential and promised quality, both of which are respectably high as based on past performances.

The direction is set—to develop and apply the technology base in order to increase the probability and ease of combat success.

MANPOWER AND FORCE MANAGEMENT THRUST

R & D DIRECTIONS



AFHRL THRUSTS

General Description

The Laboratory's R&D program is currently divided among three thrusts: (a) Manpower and Force Management, (b) Air Combat Tactics and Training, and (c) Weapon Systems Logistics, Maintenance, and Technical Training. Each thrust is managed through a Laboratory R&D Division: (a) the Manpower and Personnel Division (AFHRL/MO), (b) the Operations Training Division (AFHRL/OT), and (c) the Logistics and Technical Training Division (AFHRL/LR), respectively.

The subthrusts and components of the thrusts have been defined, with certain of them still in the "emerging" stage. The "architectures," "roadmaps," or "R&D agendas" that are employed to describe all three levels—thrust, subthrust, and component—are dynamic rather than static. They may be expected to change somewhat from year to year to show validly the identification of both near-term and long-term objectives, the planned transfer of technologies and products where appropriate, and the approach employed to develop the technologies and systems desired for enhancement of combat success.

General descriptions of the thrusts are given below and on subsequent pages. Diagrams portraying the respective thrusts are also provided. These diagrams are employed with highlighting in later sections to aid in identification of the parts of the R&D program being reported.

MANPOWER AND FORCE MANAGEMENT THRUST

The primary objective of this thrust is a Force Acquisition and Management Technology based on management tools, procedures, and associated technologies that foster more effective use of personnel resources by: (a) improving selection and assignment methodologies, (b) establishing appropriate job requirements for Air Force specialties, (c) structuring and maintaining a workforce with the required aptitudes, experience, interests, and motivation to meet operational commitments both in peacetime and wartime environments, and (d) establishing comprehensive skills management programs to improve personnel utilization and productivity. These technologies are applicable to the recruitment and selection of personnel motivated for Air Force service, the assignment of personnel to jobs compatible with their aptitudes, interests, and experiences, and the establishment of effective reenlistment/career assignment programs. This thrust consists of two on-going subthrusts: Force Acquisition and Distribution Systems, and Force Management Systems.

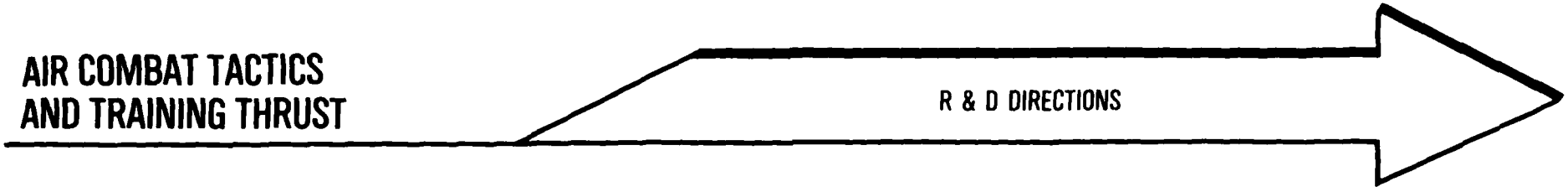
The Force Acquisition and Distribution Systems subthrust is to provide advanced computer-based personnel management tools for use in the acquisition, initial assignment, and distribution of uniformed Air Force personnel. These tools will permit increased precision in recruitment, selection, classification, and assignment of Air Force personnel. The development of computer-assisted Force Acquisition and Distribution Systems will provide the Air Force with a variety of alternatives to force-manning compatible with various manpower supply scenarios, and will help to ensure that the available pool of talent is optimally employed, with personnel resources allocated to maximize the return on personnel investments.

The Force Management Systems subthrust is to provide devices, models, procedures, and strategies to improve evaluation of job performance, career motivation, retention, job satisfaction, and both individual and unit productivity, and to establish effective career assignment programs.

The products of this thrust include technologies that (a) improve the efficiency and economy of personnel acquisition, (b) ensure optimum classification and assignment of first-term and career personnel, (c) provide an accurate evaluation of individuals best qualified for Air Force service, (d) facilitate movement between specialties to correct manning imbalances, and (e) provide prototype systems for assessing the performance of Air Force personnel, both uniformed and civilian.

The longer-term benefits obtainable with the technologies being developed include (a) improving the capability and accuracy of matching an individual's abilities with Air Force job requirements, (b) increasing the flexibility and validity of testing by including other aptitude and non-aptitude domains, as well as computer-based methods such as computer-adaptive testing, (c) reducing attrition, (d) identifying and forecasting potential critical problems of manpower supply in time to propose remedial-action alternatives, (e) improving job satisfaction, productivity, and retention, and (f) developing on-the-job performance criteria for validation of selection devices and training syllabi.

AIR COMBAT TACTICS AND TRAINING THRUST



PAST PRODUCTS	COMPONENTS	SUBTHRUSTS	THRUST
• AIRCREW PERFORMANCE MEASUREMENT SYSTEMS • GUIDELINES FOR TACTICAL SKILLS ACQUISITION AND MAINTENANCE • VISUAL AND FORCE CUEING SIMULATION REQUIREMENTS • COST EFFECTIVE TRAINING STRATEGIES	• STRATEGIC OFFENSE TRAINING SYSTEM • TACTICAL WARFARE TRAINING SYSTEM • MOBILITY TRAINING SYSTEM • FLYING TRAINING SPECIALIZED SUPPORT	AIR COMBAT TRAINING SYSTEMS	
• ADVANCED TACTICAL AIR COMBAT SIMULATION	• DATA BASE ACQUISITION TECHNOLOGY • NON-EDGE COMPUTER DISPLAY	OPERATIONAL UNIT TRAINING SYSTEMS	
		[redacted]	
• IMAGE GENERATION • VISUAL DISPLAYS • MOTION & FORCE SIMULATION • ADVANCED SIMULATION CONCEPTS	• ADVANCED SIMULATION CONCEPTS • SIMULATION REQUIREMENTS FOR AIRCREW TRAINING • FULL MISSION ADVANCED SIMULATOR FOR PILOT TRAINING	ENGAGEMENT SIMULATION TECHNOLOGY	

AIR COMBAT TACTICS AND TRAINING THRUST

The primary objective of this thrust is an Air Combat Tactics and Training Technology that identifies and demonstrates in cost-effectiveness terms alternative training strategies and training equipment capabilities for use in obtaining, maintaining, or improving the skills and combat effectiveness of USAF aircrew members. It addresses Air Force goals to provide trained aircrews who can effectively operate aerospace vehicles under both training and combat conditions. The thrust consists of four subthrusts: (a) Air Combat Training Systems, (b) Operational Unit Training Systems, (c) Combat Mission Trainer, and (d) Engagement Simulation Technology. The first and last subthrusts are ongoing, whereas the middle two are only now emerging R&D programs.

Most of the Laboratory's flying training R&D is accomplished as part of the Air Combat Training Systems subthrust, the objective of which is to provide a technology base for training high-level aircrew performance skills through use of simulated combat environments. It is best interpreted as an extension of past work using the Advanced Simulator for Pilot Training (ASPT). Earlier R&D explored the development of basic flying skills, such as transition, instruments, and air-to-surface ordnance delivery on conventional ranges. The current R&D extends to the development of training strategies and equipment requirements for use in ordnance delivery on tactical targets using wartime tactics in a realistically modelled combat arena. The rate and scope of this expansion depends in part on the availability of new engineering technology from the Engagement Simulation Technology and Combat Mission Trainer subthrusts.

The Operational Unit Training Systems subthrust is emerging and expected to be formally initiated in FY 82 or FY 83. Its objective is the integration of operationally applicable findings concerning aircrew training into on-going unit training programs to improve both efficiency in training and the effectiveness of operational capabilities. It will integrate the full range of training-delivery capabilities from microcomputer-based desk-top procedural trainers to full-field-of-view full-mission simulators such as the proposed Combat Mission Trainer.

The Combat Mission Trainer subthrust emerged during FY 81, as a cooperative effort with the Aerospace Medical Research Laboratory. The objective is to develop and demonstrate through the application of fiber-optics, helmet-mounted display, advanced computer image generation, and computer microlinkage technologies a relatively low-cost, transportable device suitable for air-to-air and air-to-surface combat mission training at the Squadron level.

The Engagement Simulation Technology subthrust is primarily engineering R&D oriented towards the development of algorithms, software, and hardware techniques that support the ASPT and the Laboratory's operations training R&D mission. Attention is focused on the development of mission simulator components and techniques that provide greater training capability. It includes development of advanced computer image generation technology, as well as projection and display technologies to provide full field-of-view visual scenes for use in simulators.

The development of new technology and the demonstration of technological advancements in flying training are aimed at producing well-trained and highly skilled aircrews. In the near term, the products of this thrust are providing the equipment and training technologies necessary to teach basic combat skills and tactics. In the longer term (FY 83 and beyond), this thrust will increasingly address the training of those combat skills required to be successful in specific combat areas and to function effectively as a member of a coordinated combat team. The benefits of R&D success in this thrust will be increased mission readiness for operational aircrews.

WEAPON SYSTEMS LOGISTICS, MAINTENANCE AND TECHNICAL TRAINING THRUST

R & D DIRECTIONS

PAST PRODUCTS	COMPONENTS	SUBTHRUSTS	THRUST
• FUNCTIONALLY INTEGRATED SYSTEMS TRAINER (GUNSHIP) • 3D GRAPHICS FOR WEAPON DIRECTOR TRAINING	• CREW, GROUP, TEAM, AND UNIT PERFORMANCE TECHNOLOGY • CREW, GROUP, TEAM, AND UNIT TRAINING SYSTEMS FOR COMMAND AND CONTROL	CREW, GROUP, TEAM, UNIT PERFORMANCE AND TRAINING SYSTEMS	
• COORDINATED LOGISTICS RESOURCE PLANNING • LIFE CYCLE COSTING • LOGISTICS COMPOSITE MODEL • REPAIR OF BATTLE DAMAGE • PROCEDURALIZED TROUBLESHOOTING AIDS • JOB GUIDE MANUALS	[redacted]	[redacted]	
• SPECIFICATIONS AND FIDELITY REQUIREMENTS FOR SIMULATORS • COMPUTER BASED TRAINING MANAGEMENT SYSTEMS • RESOURCE SCHEDULING SYSTEMS	• MAINTENANCE SIMULATION • INTEGRATED TRAINING SYSTEM • COMPUTER BASED INSTRUCTION TECHNOLOGY TRANSFER	TECHNICAL AND MAINTENANCE TRAINING SYSTEMS	

WEAPON SYSTEMS LOGISTICS, MAINTENANCE, AND TECHNICAL TRAINING THRUST

The primary objective of this thrust is a Weapon Systems Logistics, Maintenance, and Technical Training Technology to ensure effective and efficient support of Air Force operations. This support includes logistics, materiel, and human resources. Special attention is devoted to maintenance, and to the supportability of new weapon systems. Also included as an objective is the technology to ensure effective team performance in ground-based systems. The thrust consists of three interrelated subthrusts: (a) Crew, Group, Team, and Unit (CGTU) Performance and Training Systems, (b) Combat Logistics Technologies, and (c) Technical and Maintenance Training Systems.

The emerging CGTU Performance and Training Systems subthrust is aimed at improving the performance of non-flying crews, groups, teams, and units. Special attention is being given to teams involved in command and control systems because of the pressing current needs for improvements in those systems.

The on-going Combat Logistics Technologies subthrust pertains especially to the logistics aspects of Air Force weapon systems. It includes four components: one, to develop the technology for the integrated logistics system of new weapon systems; second, to provide the technology to ensure effective logistics support for combat maintenance; and the remaining two to provide means for improving the performance of maintenance.

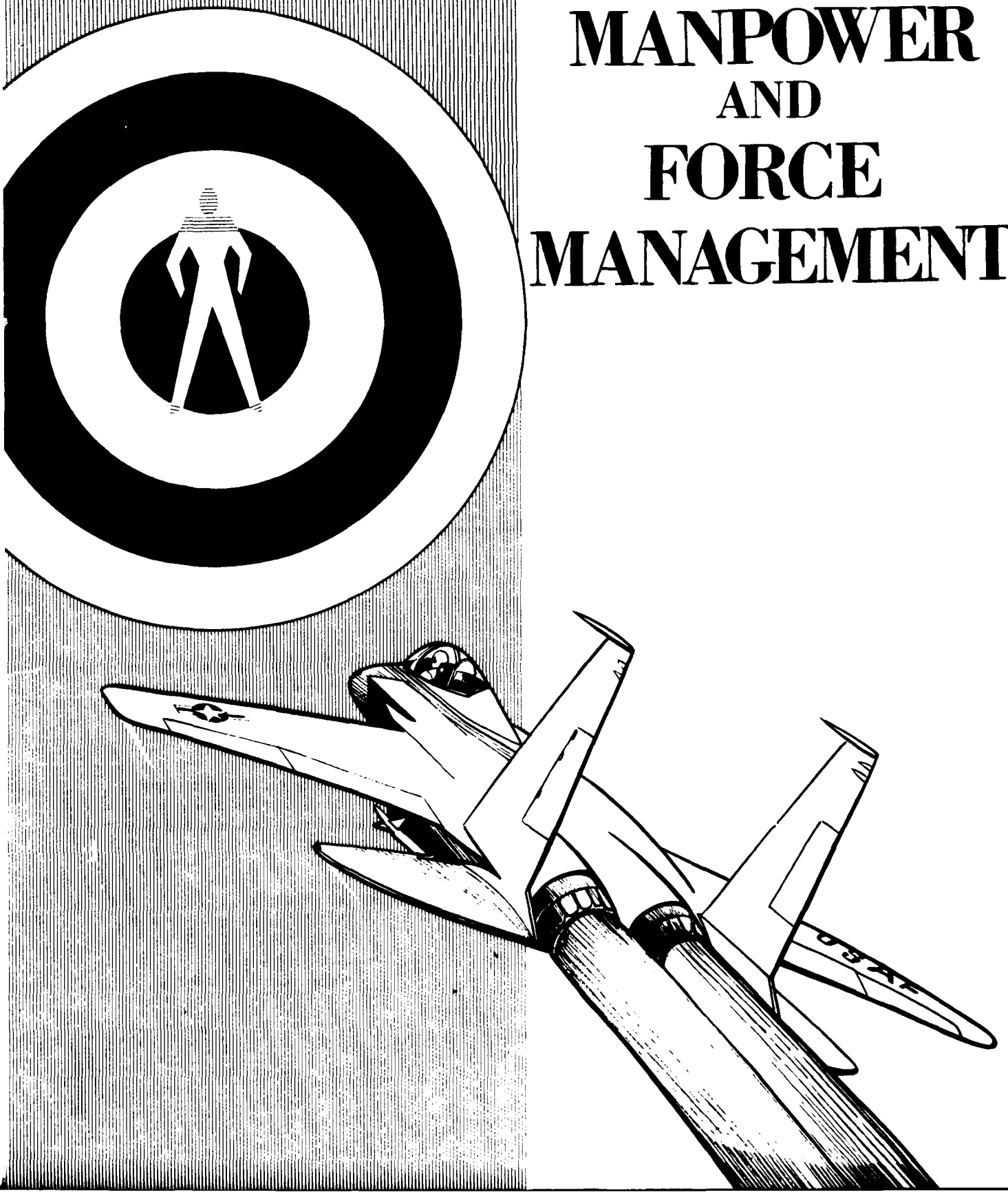
The Technical and Maintenance Training Systems subthrust pertains primarily to technical training, with special attention to the training of maintenance personnel. Its components include simulators for maintenance training, a system for on-the-job-training delivery and management, and more extensive transfer of the technology for computer-based instructional systems developed by the Air Force.

The R&D investment represented by this thrust promises unusually high payoff. The potential to reduce costs and increase weapon systems supportability is high because this area of technology is quite underdeveloped and initial big-step improvements can be made. The subthrusts, as well as most of their components, have been the subject of unusual high-level interest. Special scientific and operational study groups have stressed the need for increased R&D in this area.

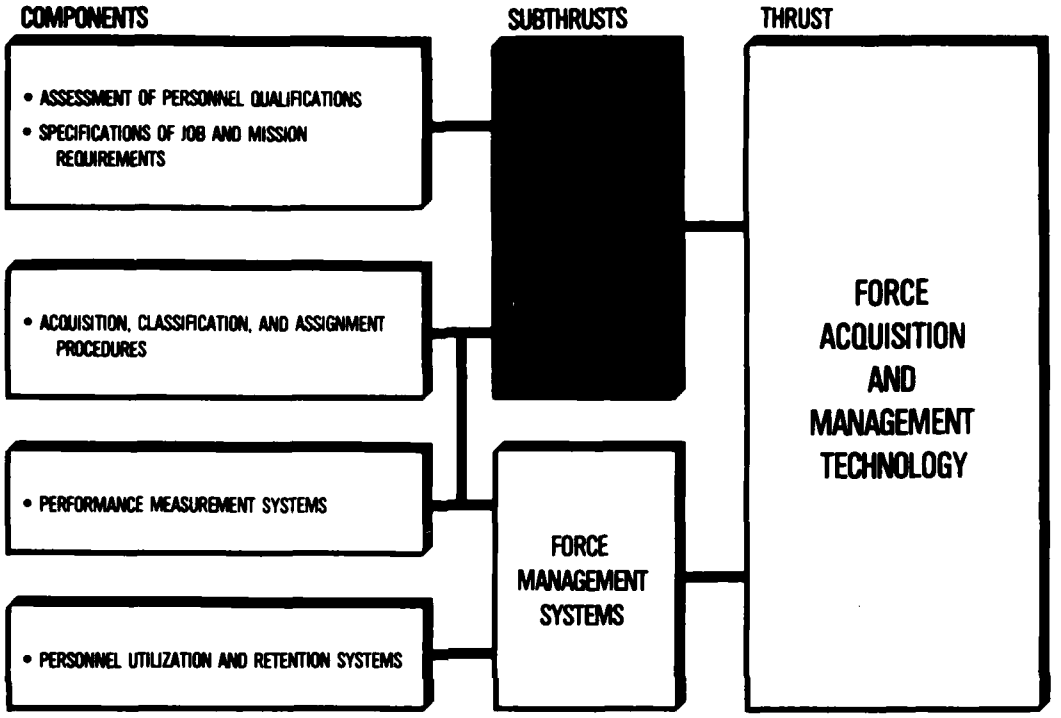
"Wars may be fought with weapons, but they are won by men. It is the spirit of the men who follow and the man who leads that gains the victory."

General George S. Patton, Jr.

MANPOWER AND FORCE MANAGEMENT



MANPOWER AND FORCE MANAGEMENT THRUST



FORCE ACQUISITION AND DISTRIBUTION SYSTEM TECHNICAL ACHIEVEMENTS

Title: Development and Calibration of Enlistment Screening Test Forms 81a and 81b

Description: The Enlistment Screening Test (EST) was originally designed as a short prescreening instrument for use by Air Force recruiting detachments. Recent events have made updating the EST necessary. The content of selection tests, such as the Armed Forces Qualification Test (AFQT) has changed, and other services are also using the EST. New EST forms 81a and 81b have been developed. These closely match the content of the current AFQT and contain items which better discriminate among applicants around AFQT cutoff scores of the various services. The EST tests have been calibrated in a field study on applicants.

Utilization: The new EST forms are now being used by recruiting detachments of all the Armed Services. Calibration data have been provided to recruiters to enable them to predict qualification status of service applicants.

Benefits: The EST is reducing administrative costs by identifying enlistment candidates who are likely to fail the operational selection tests, thus reducing travel expenditures.

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Title: Economic Cost of First-Term Enlisted Force

Description: The purpose of this research effort was to identify and compile a data base of cost and economic parameters relative to the first-term enlisted force. These costs are being used to answer economic and operational questions for Air Staff for use in determining optimal terms of enlistment in critical Air Force Specialty Codes (AFSCs). These costs include recruiting, training (both basic military training and technical training school), attriting, and all incidental costs of a first-termer (e.g., clothing, travel, and PCS). In addition, all costs were identified as either variable, average, or marginal. The final product is a handbook which assembles all available cost data for each entry-level AFSC in the Air Force in a consistent, easily understood format.

Utilization: Results of this research will be used by Air Staff and various Air Force agencies in developing the costs of various AFSCs and in improving the cost models used in determining optimal terms of enlistment standards. This effort will improve the information base for the decision-making process and thereby make the job of the decision maker easier and more reliable.

Benefits: The data base is already being used as the basis for a cost study of optimal terms of enlistment for each AFSC. It will enhance the capability to respond quickly to policy and budget issues and also provide researchers and analysts with a tool by which they can assess the economic implications of various policy options for the first-term enlisted force.

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Title: Development and Validation of Officer Selection and Classification Tests

Description: A new form of the Air Force Officer Qualifying Test (AFOQT-0) was implemented September 1981. As analyses of the forthcoming data bases are completed, modifications to the test structure may be required. These changes may take the form of test division into separate portions (general aptitudes and special aptitudes), change in length of subtests, and/or the substitution of some scales. A "quick score" device has been developed to assist recruiters in identifying provisionally qualified applicants at recruiting main stations.

Utilization: AFOQT-0 is used by the selection boards of Officer Training School (OTS) and the Air Force Reserve Officer Training Corps (AFROTC) in conjunction with other variables to select civilian and military applicants for these programs. The "quick score" method will provide instant feedback to applicants and should aid the recruitment of highly qualified personnel.

First-Term Enlisted Force

AFOQT Aids Officer Selection

Benefits: Better selection and classification of officer candidates will result in lower attrition and improvement in the quality of the officer force.

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Title: Evaluation of Aptitude Requirements for Air Force Enlisted Job Specialties

Description: In an all-volunteer recruiting environment, particularly with a decreasing manpower pool projected for the 1980's, it is critical to ensure that occupational aptitude requirements not be overstated and that high-level talent be allocated to the most difficult occupations. A methodology has been developed to evaluate aptitude requirements which results in measures of learning difficulty for each enlisted job specialty. Initially, learning difficulty is generated on a position-by-position basis and is derived through a task analysis of learning difficulty and the time spent performing tasks in the position under study. To characterize the entire occupation, learning difficulty is averaged across occupational positions. The methodology is sufficiently flexible to provide either the learning difficulty of an entire occupation or the learning difficulty of a subset of positions within the occupation, i.e., the learning difficulty of only entry level positions within the occupation. To date, the methodology has been applied to over 200 job specialties representing the mechanical, administrative, general, and electronics aptitude areas.

Utilization: Measures of occupational learning difficulty provide an empirical, job-centered frame of reference which can be systematically utilized in the evaluation of occupational aptitude requirements. The data issuing from this project have been delivered to an aptitude requirements working group consisting of representatives from the Air Force Manpower and Personnel Center, Air Force Technical Training, Air Force Recruiting Service, and Air Force Human Resources Laboratory. The purpose of the working group is to review the aptitude requirements for all enlisted job specialties with specific attention devoted to employment of occupational learning difficulty in defining job aptitude requirements. The data resulting from this effort have also been delivered directly to Air Force Recruiting Service where they have been implemented through the computerized job reservation system. Three areas of possible future potential application have been identified. First, the results of this research can be used for the purpose of redesigning or restructuring occupations in order to reduce the occupational learning load. Second, there is considerable potential for training applications. With additional research, it may be possible to design and or evaluate technical training courses on the basis of the learning difficulty of tasks as they are performed on the job and thereby increase the linkage between job performance and technical training. Third,

these data have potential applications in the area of job performance. Lists of occupational tasks ranked in terms of learning difficulty can guide decisions concerning the development of job performance aids.

Benefits: There are many significant areas where cost avoidance can be achieved as a result of this research. Contingency plans for talent shortages will be available as a by-product of this effort. These plans will enable the Air Force to plan for talent shortages in any specific specialty or across all specialties. Another product will be a more defensible position for aptitude requirements in the case of court actions. The present system, which excludes many individuals from entering Air Force jobs based on a cut-off aptitude score, has no objective data to support its use. This research will provide data on the learning load requirements for each occupation. Perhaps the single most important benefit resulting from this research is a more optimal person-job match. Ensuring that job aptitude requirements correspond to job learning load requirements can have positive effects on job attitudes, retention, and training.

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Title: Assessment of Physical Strength and Stamina Requirements in Air Force Specialties

Description: Each Air Force enlisted specialty is presumed to differ in the nature and extent of physical capabilities required for successful job performance. Moreover, in a variety of specialties, effective performance requires above average physical strength and stamina from incumbents. Despite these prevailing conditions, little systematic research has been done to support definitive assignment criteria to ensure that personnel capabilities meet or exceed on-the-job requirements. A comprehensive assessment of the physical occupational requirements in the more than 230 enlisted specialties is nearing completion. To date, approximately 24,000 supervisors have been surveyed for purposes of identifying, defining, and quantifying demanding tasks within specialties. Preliminary findings have shown that supervisory personnel can reliably identify and rate physically demanding tasks and thereby provide the empirical base for specialty-specific task demand profiles. These results will soon be documented in a series of technical reports.

Ongoing and future research activities include the formulation of regression models to establish the predictive accuracy of specific task parameters and to benchmark and compare demand characteristics across specialties. Moderator variables such as numbers of first

Physical Strength and Stamina Requirements Research

termers performing the tasks, time spent in task execution, and consequences of inadequate performance will be closely studied. AFHRL collaborated with the Air Force Aerospace Medical Research Laboratory (AFAMRL) at Wright-Patterson AFB, Ohio.

Utilization: Physical demand indices will ultimately be incorporated into the Air Force Person-Job-Match system as an additional factor to be considered for the optimal assignment of individuals to jobs. Further refinement of the algorithm with a physical demand factor is especially important in view of current accession trends; namely, declining numbers of qualified male enlistees and the concomitant increase in the proportion of females serving in the Air Force.

Benefits: Definitive physical job requirements can be expected to reduce recruiting costs by expanding the qualified applicant pool (particularly among females) and to curtail medical costs resulting from the assignment of persons to jobs where demands exceed physical capabilities. Specifications for entry into each enlisted career field will be sufficient to insure an optimum distribution of available talent.

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Air Force Career Specialties
Classified by Personnel
Research Methodologies

Title: The Effects of Item Calibration Sample Size and Item Pool Size on Adaptive Testing

Description: This unique achievement studied the effects of varying the item calibration sample size on varying size item pools. Through a series of simulations with varying subsample and item pool sizes, the resultant errors of ability estimates have been studied and delineated.

Utilization: This work helps specify the needed sample size for calibration of item pools for adaptive testing. It also provides information concerning the interaction of item pool size and calibration sample size on resultant ability estimates.

Benefits: Results of this project provide a much needed advance in the state-of-the-art in item pool construction. The study indicated the requirements for the number of items and subjects necessary to reap the benefits of adaptive testing.

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Title: Methods for Linking Item Parameters

Description: This massive effort investigated several methods for placing large blocks of test items on the same scale for purposes of adaptive testing item pool construction. Through a series of simulations, both common groups and common item linking paradigms were investigated.

Utilization: This work demonstrated that linear equating was possible and could be used for the construction of specially calibrated item pools required for computerized adaptive testing.

Benefits: Results of this project provide information on linking item parameters under a series of conditions ranging from small sample/long tests to large sample/short tests.

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Person-Job-Match System
Used for Enlisted
Classification

Title: Kalman Filter Prediction of Time Series Based on State-Space Models

Description: Time series analysis is a vital statistical tool in many areas of personnel research where regression analysis is not appropriate. State-space forecasting and Kalman filtering can be used to analyze many time-dynamic personnel problems. Through contract, the Air Force Human Resources Laboratory has developed these techniques and the software necessary for their application and is using these methods to analyze and predict the input variables for the Person-Job-Match (PJM) system used for enlisted classification. In addition, Kalman filter models for predicting enlisted retention have been developed. The forecasting system is documented in AFHRL-TR-79-83, Recursive Forecasting System for Person-Job-Match.

Utilization: These analysis methods improve prediction in the retention areas which have historically been difficult to predict. In addition, this forecasting research for the PJM system has provided statistical measures to enhance automated job classification of enlisted recruits.

Benefits: Kalman filtering and related methods improve the Air Force estimation capability for time-dynamic problems. Certain estimation problems, such as the forecasting of retention rates, require a method that can update its estimates as conditions change over time. This capability is present in Kalman filter/state-space forecasting methodologies and their use will improve the prediction requirements of the PJM algorithms.

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Title: Research Applications of the Comprehensive Occupational Data Analysis Programs

Description: The Comprehensive Occupational Data Analysis Programs (CODAP) is an occupational data analysis software package which inputs and performs calculations on massive quantities of raw data from job surveys. It was developed in response to the need for an efficient and effective method of identifying and classifying jobs in a rapidly changing Air Force. The basic input to this system is information provided by large numbers of job incumbents in the occupational areas being studied. Because the data are selected at the worker-task level, the CODAP system provides a base of information that may be utilized in many ways to address a variety of predefined and sometimes unanticipated management questions. The technical support during the past year has been aimed at (a) continued enhancement of a methodology for restructuring and summarizing these data for higher-level management in increasingly diverse functional areas, (b) upgrading of the utility and running efficiency of several major CODAP programs to meet the needs of the Air Force Occupational Measurement Center at Randolph AFB, (c) significant improvements in program documentation, and (d) development of several major analytic programs. A major extension of the CODAP system is planned for the coming year. It will involve the development of a package of profile analysis programs for analyzing and clustering anticipated types of data not amenable to standard CODAP analysis.

Utilization: In addition to its ongoing operational uses in updating and evaluating the Air Force officer and enlisted classification structures and in developing and validating the content of training programs, CODAP is now being employed to develop a scientifically sound basis for realigning entry-level aptitude requirements across Air Force career fields and to address questions about the requirements of jobs, all of which will be integrated into the initial personnel selection process and eventually into the Person-Job-Match model. Currently it is also being integrated into the Air Force Specialty Knowledge Test development program as the most effective means of assuring the job-relatedness of test content. The HQ USAF-directed experiment with position-oriented on-the-job training called SPOT (Standardized Position-Oriented Training) is totally dependent on the CODAP data base and software, including recent enhancements to the CODAP system specifically designed for use in the SPOT program. The development of methods for collecting and analyzing the task analysis data which resulted in "The Task Analysis Handbook" will depend heavily on CODAP data and analytic techniques for its implementation in Instructional Systems Development. Although developed by the Air Force, all branches of the United States Department of Defense, as well as the British, Canadian, and Australian Forces, have incorporated CODAP into their operational programs. In the public sector, many state and county governments are using CODAP to validate their traditional testing and selection procedures in accord with Equal Employment Opportunity guidelines, to develop job and performance evaluation procedures, and to improve job classification and training criteria. Educational institutions are using CODAP to modify their vocational education curricula. During the past year, the Air Force CODAP software has been sent to the Army and to the Marine Corps to help them update their CODAP systems. Also, the Los Angeles California School District and the Institute of Nuclear Power Operation were provided with the CODAP software package. The transfer of CODAP technology within and outside the Air Force will be intensified with the completion of a series of three CODAP applications manuals—an executive summary designed for management personnel, an inventory developers manual, and an occupational analysts manual.

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CODAP Embraces All Air Force Specialties

Force Acquisition and Distribution System

Title: Enlisted Assignment/Reassignment System

Description: This work unit supports the enlisted geographical assignments function of the Air Force personnel system. There is an opportunity to examine this assignments function at its most basic level. The work unit's objective is to design two alternative systems for assigning airmen to locations. The first system will be a computer-based procedure for producing for each airman a list of possible assignments which are pre-optimized to increase Air Force effectiveness. In addition, the system could produce for requirement managers a list of airmen for each assignment. The system will use policy modeling (e.g., policy specifying) to develop algorithms for modeling the individual payoffs of assigning airmen to locations. The general development sequence will be (a) customer involvement (problem identification), (b) policy algorithm development through a working group, (c) policy testing, and (d) modifications as necessary. The resulting system will combine important person and location variables, combine them into predicted payoffs using the new algorithms, optimize the payoffs using optimality indicators, and produce ordered lists (airmen and locations) based on these optimality indicators. The second system is designed to assign airmen using a goal programming approach. To support these two systems, four separate research projects will be necessary: a generalized modeling of the constrained ordered list process, batch optimization software and goal programming development, and software to simulate and demonstrate the resulting system.

Utilization: These two alternative systems should contribute to better assignments of airmen by the Air Force personnel system. The policy modeling process will result in a formal quantification of personnel manager policies related to location of assignment and should, therefore, improve individual retention, job satisfaction, and performance and will optimize Air Force assignments to accomplish the defense mission.

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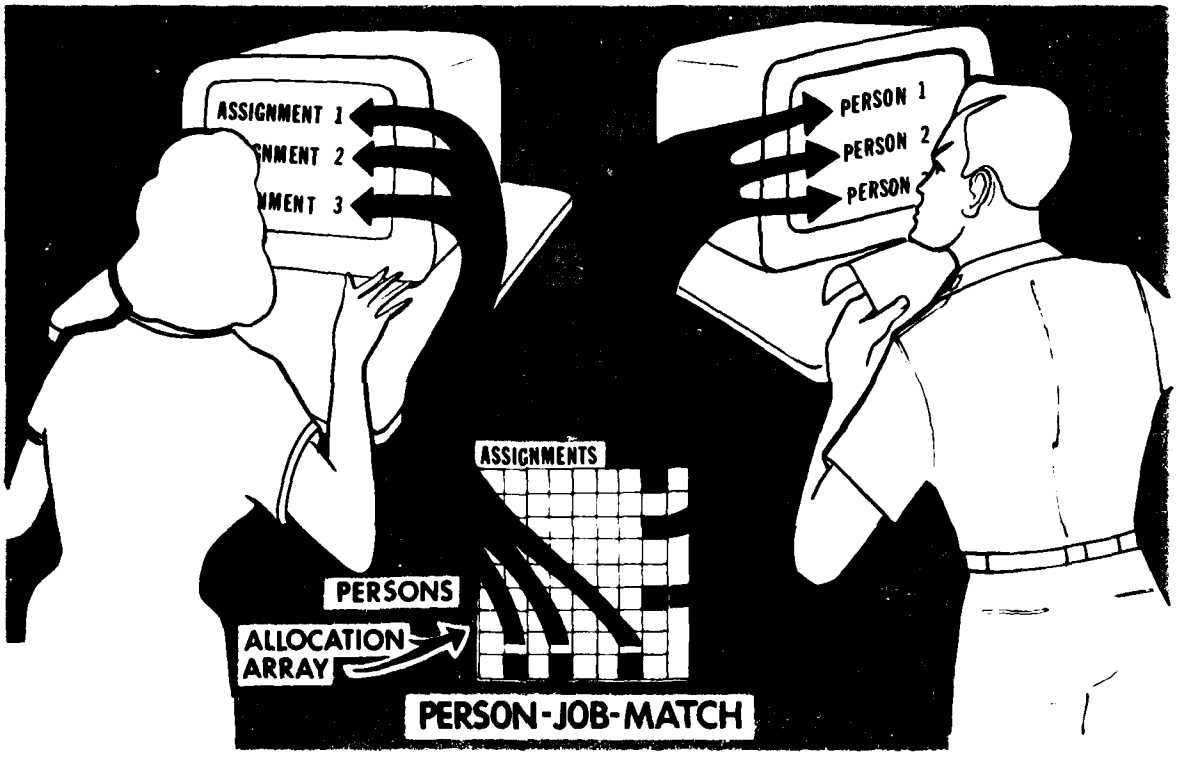

Airmen Entering the Air Force
at Lackland Air Force Base

Title: Estimation of Air Force Enlisted Manpower Supply

Description: A data file is to be developed for analyzing the impact of changes in civilian and military parameters (wages, unemployment, force levels, bonuses, etc.) on the distribution of enlisted personnel by specialty, experience, and aptitude. The data file being developed will also permit the identification of the civilian and military labor markets which compete most directly with the Air Force at both the accession and retention levels. Quantitative relationships will be derived between the parameters and the accession and retention of enlisted personnel. An analysis will be made to determine the most appropriate level for studying the Air Force competition and to analyze its past and future impact on Air Force accessions and retentions. During the developmental work, results of subtasks such as supply elasticities will be used in developing budget submissions as well as in evaluating various policy alternatives. Eventually the methodology and associated models will be incorporated into a dynamic model for policy analysis. The data base required for this effort has been expanded at the request of AF/MPXA to include an additional eighty variables. This addition will greatly enhance the investigative potential of the longitudinal file being developed and supply to MPXA the requested data at a minimum cost. Theoretical work on the supply-demand relationship in both recruiting and retention and the interaction of both has been completed. The data file being developed include information on all airmen between 1956 and 1980.

Utilization: This file will provide a data base for simultaneous estimation of accession and retention behavior. The file will be used to provide insight to who comes in, who stays in, the effects of economic variables, information on minorities, and other analyses. Beginning in FY 83, an extensive and detailed analysis will be made of accessions and retentions within and across Air Force specialties.

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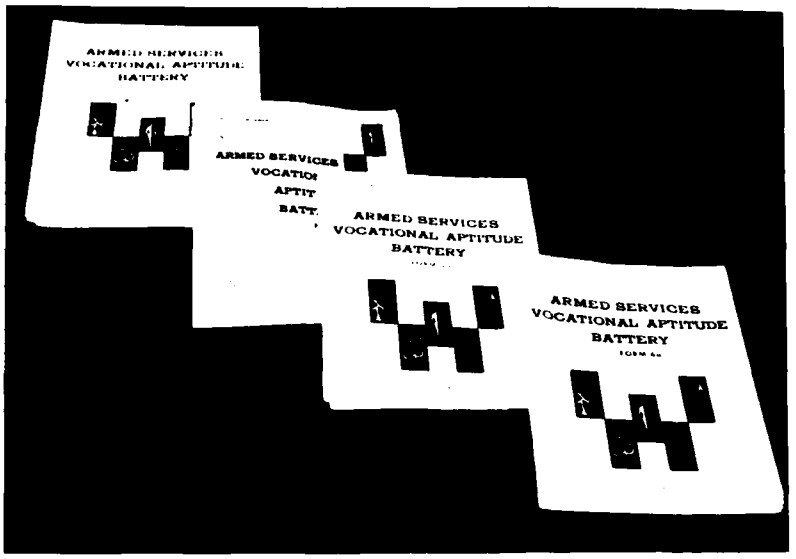

Title: Research on the Basic Dimensions of Learning Ability

Description: New techniques in the measurement of individual abilities will be explored, as well as a comprehensive study made of the specific areas of learning ability. New and unique procedures to broaden testing capabilities will be investigated. Questions to be answered include the following: (a) How quickly can an individual acquire the skills and knowledges necessary for adequate performance in various Air Force occupations? (b) How well would those skills and knowledges be retained during periods of non-use? (c) How quickly could decayed skills and knowledges be reacquired? (d) Finally, what ultimate level of skill is likely to be obtained? To answer these questions, research will focus on individual learning slopes, learning rates, the role of short/long term memory, skill decay and reacquisition, response latencies, and the efficiency of various learning modalities. A comprehensive investigation will also be accomplished of the wide individual differences in information processing skills and whether these skills are modifiable in the training situation. Individual performance levels for information processing skills and multi-task performance under varying conditions of information processing loads will be studied.

Utilization: Basic research in personnel measurement is needed to rejuvenate a mature technology and to advance the state of the art. The utility of the test measures developed and studied will be assessed and used to establish a test base of possible alternative aptitude measures for use in the development of operational tests for both enlisted and officer personnel.

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Title: Development of Follow-On Forms of the Armed Services Vocational Aptitude Battery (ASVAB)

Description: In calendar year 1983, additional forms of the ASVAB are scheduled for operational implementation. Item writing has been accomplished with contractor support and experimental forms have been constructed and are currently being administered to several thousand recruits of the various armed services. A contract has been let to provide support for the final calibration of the scores to the normative scale.

Utilization: ASVAB is revised periodically to maintain integrity of the battery and to incorporate improvements. It is used by all of the Armed Services to select and classify enlisted personnel.

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Title: Reading-Related Problems in the Air Force

Description: The Air Force has not had a direct measure of the reading ability of Air Force personnel. Two parallel forms of a lower level reading test have been developed. Percentile and reading level norms were generated through joint administration of several reading tests. The test is being validated against training performance using conditional distribution and correlation/regression methods. Refinement of test norms will be accomplished through testing of service applicants with a wide range of ability and education.

Utilization: This research supports the function related to selection and classification of Air Force personnel. These studies are designed to provide cost-effective reading tests and standards targeted at personnel of both acceptable and marginal verbal ability. Results will provide instruments and normative tables for use in remedial training programs and for improved personnel classification. These measures will replace more expensive and less effective commercial tests now in use.

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Title: Perceptual-Motor Ability Measurement

Description: Previous research has demonstrated the utility of measures of perceptual-motor abilities for the selection of personnel for pilot and navigator training and for technical training. The interest in these measures has been revived, following the discontinuance of apparatus testing in the 1950s, as computer-based testing techniques and the use of highly reliable solid-state components have become more widespread. These developments have eliminated most of the difficulties inherent in earlier electro-mechanical testing equipment. Testing devices utilizing solid-state electronics have been developed which administer two tests for psychomotor coordination. These devices have been used to collect data from a large sample of individuals slated for pilot training. These individuals will now be tracked through training and the relationships between the test scores and training performance determined. Additionally, devices have been developed to assess the rate of acquisition and terminal level of performance of skills very similar to those required in flying training through the use of a low-cost simulator linked to a microprocessor. During the course of a three hour syllabus of instruction which covers topics ranging from basic instrument interpretation and use of the flight controls to the accomplishment of climbing and descending turns and other flight maneuvers, an individual's performance is recorded and compared against optimal performance to produce summary performance scores. Individuals tested using this device are also being tracked through flight training. Finally, efforts are continuing to implement and evaluate a large, comprehensive battery of perceptual-motor and cognitive performance tasks that may prove useful for pilot, navigator, and enlisted specialties selection. Measures derived from this battery which show promise when assessed in a laboratory setting will later be incorporated into field-transportable testing devices for possible use in an operational setting.

Utilization: Perceptual-motor tests may be used by recruiting and assignment agencies and by Air Training Command for the selection and classification of both enlisted personnel and officers. The use of tests of perceptual-motor abilities will result in the reduction of attrition from training and a corresponding reduction in training cost.

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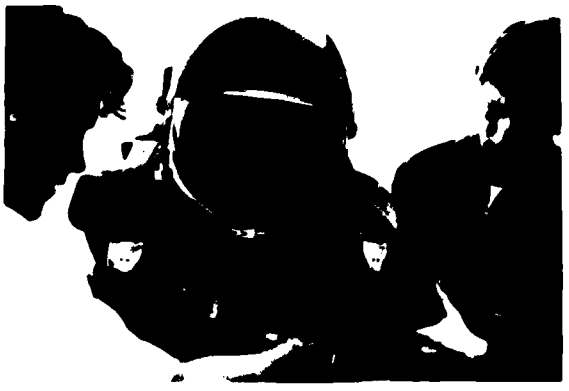
Perceptual-Motor Ability Measurement Apparatus

Force Acquisition and Distribution System

Title: Voice Spectral Analysis as a Measure of Stress in Air Combat

Description: Available methods of assessing operator stress (experienced as subjective feelings such as pressure, tension, and strain) have certain disadvantages which mediate against their use in many high stress situations. In particular, available methods have very limited applicability for assessing stress in airborne aircrew operations where no interference in task performance is tolerable, and post hoc measures provide a poor assessment of stress-task relationships. Recent literature suggests that the analysis of the spectral qualities of an operator's voice output can provide an unobtrusive, real-time indicator of the operator's stress level. The objectives of this research are to investigate the relationship between stress and voice output of aircraft operators and to develop a system of stress quantification, which can be used either in historical (via recorded sample) or real-time modes and is based on voice output analysis. The data base used in this study will be composed of audio-recordings from actual combat operations, aircraft accidents, and aircraft incidents. A computer Voice Spectral Analysis System has been developed and tested. Preliminary analyses are underway on the capability of this system to reliably and validly differentiate periods of high and low stress among aircrews.

Utilization: A valid, unobtrusive measure of operator stress would provide a means of assessing an individual's stress management capabilities which are critical in a variety of military operations. Additionally, a stress measure would serve as a useful criterion for stress training and stress reduction studies.



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Title: Advanced Research on Adaptive Testing Systems

Description: Traditionally, in the Air Force and elsewhere, uniform standardized aptitude and abilities tests have been given to applicants for employment. Among other characteristics, these tests must be fair and accurate. They must be valid for predicting some useful criterion such as performance in technical training school or performance on the job. When the same test is administered to every applicant, accuracy of measurement is limited to a restricted range about the mean. Without making a test exceedingly long, uniform accuracy across the measurement scale cannot be achieved. Computerized Adaptive Testing is a name given to a series of techniques for presenting an appropriate subset of items from a very large item pool, thus avoiding the presentation of inappropriate items. The Air Force Human Resources Laboratory is a recognized and respected leader in the field. A goal-oriented series of efforts is underway to develop both prototype and operational item pools, as well as to advance the state of knowledge in the theoretical basis of adaptive testing. Among these studies are pioneering efforts in linking of item statistics and analytic derivation of standard errors of advanced item parameters.

Utilization: Adaptive testing is usually based on Latent Trait Theory, and serious gaps exist in the body of theoretical knowledge. These efforts are directed at completing the knowledge as it applies to the Laboratory's responsibility to the Joint Services Computer Adaptive Testing Interservice Coordinating Committee. This research is necessary to achieve the necessary tasking under this commitment. Adaptive testing will eventually be used in developing and norming Air Force operational aptitude tests and by the Air Force Recruiting Service and the Army Military Enlistment Processing Command.

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Title: Task-Oriented Measurement Technologies

Description: Research is being conducted across a broad number of areas to address important technology-related problems. The purpose of this research is to identify and develop methodologies for clustering or otherwise determining underlying dimensionalities of occupational tasks, identify and develop optimal rating scales for measuring technical jobs, develop procedures for analyzing complex rating patterns involving multiple interrelated policies, and develop models for predicting job requirements based on available data.

Utilization: Advances in task-oriented measurement may impact instructional systems design, occupational measurement techniques, classification structure, and assignment procedures. Advances could result in more accurate training and assignment decisions, resulting in a more effective force.

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Title: Validation of Officer Training School and Air Force Reserve Officer Training Corps Selection System

Description: Both the Officer Training School (OTS) and the Air Force Reserve Officer Training Corps (AFROTC) use central selection boards to select applicants and to fill program quotas. The selection boards differ somewhat in approach, but the goals are identical; i.e., to select the best qualified personnel from among the applicants. The primary difference in the selection processes is the use of the Weighted Professional Officer Selection System by AFROTC which was developed through policy capturing. In this system, 11 weighted variables are used to develop a Quality Index Score. Selection in the OTS process does not involve empirically weighted variables. The two selection processes will be compared and each system will be validated against officer performance at several career points after commissioning and as student officers prior to commissioning.

Utilization: The results will be used to refine and improve the selection of OTS candidates or AFROTC cadets for the professional officer course and subsequent commissioning. This improvement in selection processes will relate directly to active duty performance and will ensure quality officers in the future. Attrition in both OTS and AFROTC, as well as in subsequent technical and flying training schools, will be reduced.

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Title: Development of the Officer Pipeline Management System and Person-Job-Match Technology

Description: Since September 1980, a coordinated effort has been made to develop a selection and classification model for Officer Training School (OTS). The first significant accomplishment was completion of the OTS selection equation in June 1981. This milestone's completion included internal validity checks to ascertain the equation's efficacy of modeling the expressed policy, as well as reliability measures against actual and simulated OTS selection boards. A series of senior management level briefings were conducted in July 1981. These briefings were designed to provide information about the selection policy which was modeled, how it was modeled, to obtain approval to begin implementation, operational test, and evaluation and external validity activities.

Utilization: Since these briefings, activities have focused on examining the operational requirements of the new system's implementation and planning field tests of a new rating scale and application forms.

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Force Acquisition and Distribution System

Title: Enhancement of Officer Survey Technology

Description: The technology developed for Air Force enlisted specialties, Occupational Survey/Comprehensive Occupational Data Analysis Programs (OS/CODAP) has produced sizable benefits for the Air Force over the years. Empirically derived job indices have guided decision makers in such areas as classification and occupational structure, training requirements, and personnel assignments. Comparable occupational survey technology for officer specialties is still in the formative stages, however. The need exists to improve the measurement technology for officer jobs so that problems in career development, classification, and training, for example, can be broached from a firm empirical knowledge base. Research is presently underway to extend the OS/CODAP technology for enlisted specialties to officer specialties and to develop new measurement techniques where the enlisted technology cannot be directly transferred. Specifically, the objectives are as follows: (a) develop and test job descriptive scales as alternatives to relative time spent, (b) establish the utility of existing task factor scales, (c) develop and test alternate task factor scales where needed, (d) identify appropriate samples for collecting task factor data, and (e) develop CODAP products to display officer data for specific users.

Preliminary analyses of needs assessment data that have been elicited to derive a rank-ordered set of needs for officer occupational data have yielded the following results: (a) raters assessed all officer occupational data needs as important to the total Air Force mission; (b) they demonstrated high levels of agreement in their ratings and rankings; and (c) they identified the primary applications of officer occupational data to be in the areas of determining training relevance, validating job prerequisites, and assessing officer attitudes regarding such factors as utilization of talent and training, job interest, and sense of accomplishment.

Utilization: Officer occupational surveys will ultimately be developed using validated task factors and job properties singly or in combination. The developed technology will provide the means for establishing an empirical data base for use by Air Force decision makers regarding utilization of officer personnel. Enhanced officer occupational survey methods can be expected to benefit the Air Force in terms of a more effective classification system, more clearly defined educational requirements, and a cost savings in training.

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Student Demonstrating the Pilot Aptitude Measurement System (PAMS)

Title: Selection for Rated Training (Pilot and Navigator)

Description: For many years, the Air Force Officer Qualifying Test (AFOQT), Pilot Composite, has been the primary selection variable for entry of pilot and navigator candidates into undergraduate flying training pilot and navigator programs. A program is underway to determine the feasibility of using newly devised tests of perceptual motor skills, information processing abilities, and flight skill learning rates to improve pilot selection. One segment of research in this area calls for administration of tests on this new equipment to large samples of pilot qualified students from Air Force Academy, Reserve Officers Training Corps, and Officer Training School commissioning sources. Another large segment involves

an extensive evaluation of the Air Force Flight Screening Program. In recent years, the Undergraduate Navigator Training (UNT) program has experienced an unusually high attrition rate. The Navigator-Technical composite for the AFOQT was considerably revised in an effort to ameliorate the problem, but additional research is needed. An experimental Basic Navigator Battery has been developed and administered to 16 UNT classes. The scores from the Navigator Battery and the AFOQT will be compared with performance in Navigator Training and in advanced courses, and with on-the-job performance after one year in an operational role. Additionally, research is underway to determine the optimum way to select student pilots for either the fighter/attack/reconnaissance or tanker/transport/bomber basic phase of training within Specialized Undergraduate Pilot Training.

Utilization: The new selection systems will be used by Air Training Command. The selection procedures developed should be useful to Air Training Command in improved selection decisions for pilots and navigators. Attrition from any training school is always very expensive, and this is particularly true for those schools training rated officers. Improvement of the pilot and navigator selection systems should reduce attrition from the Pilot Training and Navigator Training Programs and assist in the identification of superior pilots and navigators in an operational squadron.

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Officer Education Research

Title: Determining Officer Education Requirements

Description: This research effort is designed to develop a method of measuring educational attainment of officers and the educational requirements of officer specialties. Measuring education attainment is achieved through an officer education profile. The profile transforms college transcript data into a standard format consisting of 48 course headings representing management, computer science, social/behavioral science, engineering, physical science, and humanities courses. This format, in turn, became the foundation for two kinds of surveys for administration to job incumbents from 12 different officer specialties. The first survey form presents 50 transcripts coded in the profile format. Each is to be rated on its suitability to the incumbent's job. Data analysis will consist of regression equations using the profile data to predict suitability ratings. The second survey form lists the 48 course titles with their definitions. Incumbents receiving this survey are to indicate the number of courses within each course title that are necessary for successful job performance. Data analysis will consist of developing a synthetic transcript for each specialty which represents the ideal education requirements.

Utilization: The findings of the research will be applied by the Air Force Manpower and Personnel Center to revise the Educational Requirements for Air Force Officer Specialties. Revisions will be documented in the Officer Classification Regulation, AFR 36-1, and represented mathematically for use in the future Officer Person-Job-Match (PJM) system.

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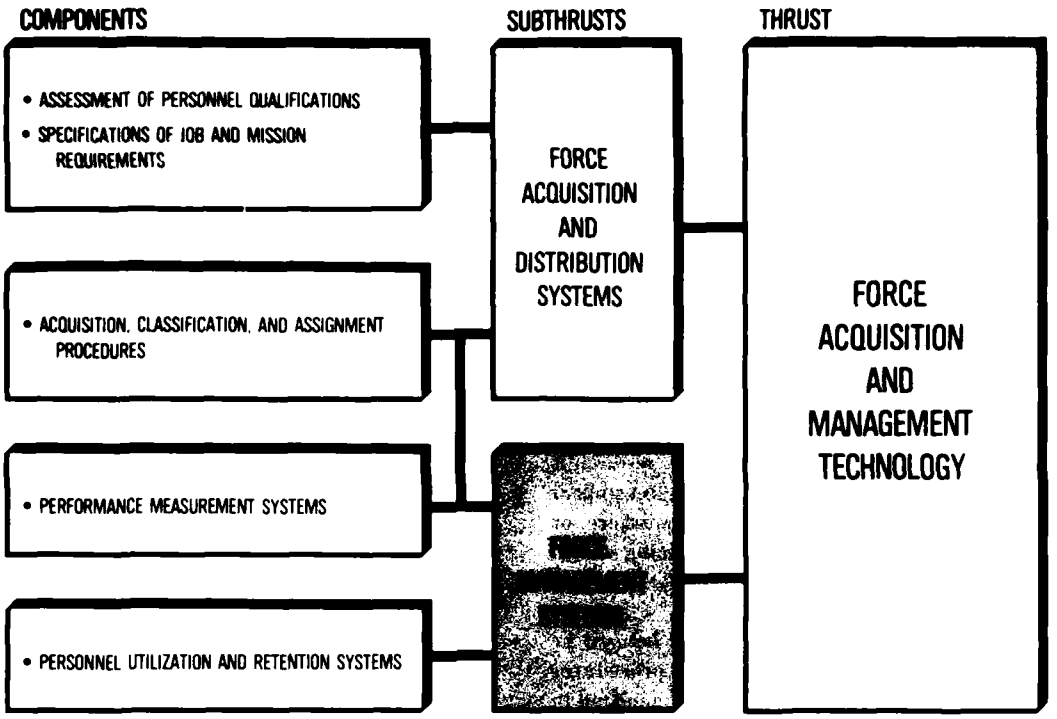

FORCE MANAGEMENT SYSTEM — TECHNICAL ACHIEVEMENTS

Title: Productivity Measurement and Enhancement

Description: A recent research project has focused on productivity measurement and productivity enhancement. The purposes of research in the first area were (a) to review current and past efforts to define/measure productivity, (b) to classify those measures with respect to practicality, cost-effectiveness, and relevance to the Air Force, (c) to systematize the major classes of factors which have been shown to impact on productivity, (d) to develop a conceptual framework, based on empirical data, that can serve as a guide to future research and evaluation efforts, and (e) to develop a method for generating efficiency and effectiveness measures for the Air Force work center environment. A field test of the method is presently being conducted to assess its generalizability across the functional areas of weather, aircraft maintenance, and administration at several Air Force installations. In a related effort to develop productivity enhancement techniques, feedback and goal setting techniques were evaluated as motivational treatments in data preparation and data processing sections of a major US corporation. Baseline data were obtained on format effectiveness and error rates on two different shifts. Supervisors were then trained to ensure that subordinates could set specific and quantifiable goals for improving productivity. Treatments were then initiated which involved feedback and goal-setting manipulations. The results included reductions in error rates and increases in format effectiveness. The results were substantially better in the feedback plus the goal-setting condition than in the feedback-only condition. Also, a change from impersonal, comparative feedback to personal, comparative feedback gave greater productivity. Four technical reports have been published documenting these two activities. Results and findings from the field-test for the productivity measurement study are anticipated to be available in the coming fiscal year.

Utilization: Development and assessment of the method for generating productivity criteria across Air Force work units provide researchers and managers with a useful tool for designing and evaluating changes in organizational factors related to productivity. Additionally, the identification of and communication with various agencies involved with productivity research have

fostered a positive interaction among those agencies. Technologies for implementing feedback and goal-setting techniques will provide first-line management with a capability for enhancing productivity and job satisfaction that otherwise would not be available.

Benefits: Results from the productivity criterion generation study will be used to plan and conduct a comprehensive study of Air Force productivity, to increase the generalizability of results from studies on productivity, to improve management of Air Force resources, and to increase the readiness and effectiveness of Air Force personnel. The motivational techniques used in the second study can be applied to a variety of Air Force work environments without the additional costs that monetary incentive programs typically require.

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Title: Retraining and Transferability of Skills

Description: Current research includes identification of the types of retraining actions which are operating smoothly and those which are generating adjustment problems. Retrained airmen and their supervisors have been surveyed to evaluate the job performance, satisfaction, and attitudes of retrainees. Preliminary analyses of the survey data have been completed, and interim results indicated that retrained airmen had typically made a smooth and successful transition between military occupations. Further analyses will evaluate retraining success for various categories of retrainees. Another ongoing effort has the objective of assessing the skill upgrading, career progression, and reenlistment rates of retrainees through comparisons with Air Force averages. A final pair of studies focuses on the performance of retrainees in technical training. The first study compares the academic performance and attrition levels of retrainees to those new recruits with equivalent aptitudes. The effects on retrainees' performance of years of military service, career or non-career status, and type of background experience prior to changing specialties is also being evaluated. Results of the second study of technical school performance will address the viability of the current policy which permits 10 points of the job aptitude requirement to be waived for retrainees.

Utilization: Managers of the Airman Retraining Program are sponsoring and utilizing the current research which provides an empirical basis for evaluating policy decisions.

Benefits: Improved retrainee selection and assignment procedures can be expected to stimulate participation in the program, favorably impact reenlistment rates, and increase productivity and satisfaction of airmen in second specialties. Assignments which optimize skills transfer will result in dollar savings through lowered attrition rates as well as reductions in training time required for retrained personnel to achieve proficiency in their new occupations.

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Force Management System

Title: Productivity in Security Police Squadrons

Description: The purpose of this research was to develop a methodology for measuring changes in the productivity of security police squadrons when these changes result from squadron reorganization. Productivity measures included both subjective criteria, such as supervisory ratings, and objective criteria developed in conjunction with job experts from the security police career field. Individual and organizational measures were collected from bases matched for similarity in all respects except squadron organization. Criterion data were collected before and after the reorganization. Policy capturing/specifying techniques were employed to identify the significant characteristics of effective security police squadrons.

Utilization: The effects of organizational changes implemented at the local level are often difficult to quantify. Techniques developed under this work unit provide a comprehensive and systematic approach to tracking and documenting positive and negative changes. The results of this research are being used in decisions regarding the organizational structure of security police squadrons in Europe. Additionally, the technologies developed are applicable for use in security police squadrons throughout the Air Force, as well as in other functional areas.

Benefits: Although developed for use in security police squadrons, the methodology could be used in a variety of operational settings. Its application will permit Air Force managers to make controlled before and after or between unit comparisons to assess the impact on productivity of any organizational, procedural, or other type of change.

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Security Police
Controlling Base Entry

Title: Development of an Air Force Occupational Research Data Bank

Description: Efforts to establish an Air Force Occupational Research Data Bank have resulted in the development of an on-line rapid access retrieval system for different kinds of occupational data. This retrieval system includes summary-descriptive variables about Air Force occupations, occupational survey data for the enlisted occupations, and a research report index system by occupations. The retrieval system provides the capacity to reference research materials through a cross-catalogued key word search and select, display, and print by specialty and subgroup variables related to occupational descriptors, prerequisites, and enlisted personnel characteristics. It also allows the user to extract various Comprehensive Occupational Data Analysis Programs reports. At present, these prototype systems within the Occupational Research Data Base are operational. Work has been directed towards the inclusion of medical, legal, and safety data. In addition, longitudinal analysis and cross occupation analysis capabilities will be built into the system.

Utilization: The Occupational Research Data Bank has been designed to support the research thrusts of the Air Force Human Resources Laboratory. The large volume of occupational data contained in the retrieval system provides a centralized location for researchers to obtain quick-response answers for personnel-related questions. At present, such questions may take weeks to answer. Cross-comparisons of specialties with respect to their characteristics are feasible and should lead to more effective selection of occupations for special studies. Personnel data from calendar years 1978 and 1979 are presently available. Medical, safety, and legal data from calendar year 1980 are also available.

Benefits: The Occupational Research Data Bank provides rapid access to a centralized source of occupational data. Limited studies with short suspense dates could be accomplished without the need to extract data from longitudinal studies and trend analysis can be performed on a real-time basis to provide a dynamic representation of occupational data.

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Title: Methods for Determining Safety Training Priorities for Job Tasks

Description: Functional Managers in every Air Force enlisted specialty are concerned about job safety. Some jobs are more hazardous than others, but each specialty strives to reduce on-the-job accidents. This research examined the feasibility of rank ordering job tasks in terms of hazard, possibility of accident occurrence, and/or other pertinent factors that could assist training designers in determining needs for safety training.

Three Air Force specialties were studied: (a) Aircraft Armament (Air Force Specialty Code (AFSC) 462X0), (b) Fire Protection (AFSC 571X0), and (c) Fuels (AFSC 631X0). Task and job factor data were collected for each specialty. Subject matter experts also matched accident data with the tasks being performed when the accidents occurred. From these data, four methods for rank-ordering hazardous tasks were developed. Previous accidents were matched to the tasks in the first method. The second method displayed rank-ordered hazardous tasks based on hazard potential ratings. Using the third method, a regression equation was developed and hazardous tasks were rank ordered based on predicted scores from the regression. A final method, a cost-benefit analysis, allowed for the estimation of how much money might be saved if certain tasks were trained.

Utilization: These methods would be most beneficial in those Air Force specialties in which accidents are the most frequent and costly. Trainers could choose which methods would produce the most pertinent information for the specialty under study. Once the potential accident tasks were identified, specialized training could be developed for those tasks and incorporated into the training program.

Benefits: Identification of potentially hazardous tasks would result in improved job safety training. The training would lead to avoidance of injuries and of the loss of equipment, time, and materials due to on-the-job accidents.

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Force Management System

Title: Development of Mission Impact GEBOS Model

Description: The purpose of this effort was to extend the Generalized Explanatory Base Operating Support Model (GEBOS-M) to include mission changes as an input parameter. GEBOS was designed as an explanatory model capable of estimating the impact of workload changes on Base Operating Support (BOS) and Real Property Maintenance Activities (RPMA) functional manpower, or alternatively, the impact of manpower changes in terms of workload execution capability. The current research and model building effort identified the key relationships between mission manpower/capabilities, and the primary BOS and RPMA manpower and workload indicators. These relationships permitted the development and testing of a programmable mission/support manpower planning model. Given specific mission changes, the GEBOS-M model can accurately estimate changes to primary workload indicators and BOS and RPMA manpower by functional category. The methods of analysis and results of this effort are documented in AFHRL-TP-81-30.

Utilization: The Air Force Directorate of Manpower and Organization (AF/MPM), the primary user of this research product, has loaded the GEBOS-M software on their computer and has completed initial testing. GEBOS-M is now being considered for integration into the AF/MPM programming system to aid their manpower programmers in responding to force structure changes during development of the Program Objective Memorandum, the Budget Estimate Submission, and the President's Budget.

Benefits: The Mission Impact GEBOS Model provides Air Force manpower managers with greatly improved capabilities to program and justify base level support manpower. The model can compute base operating support and real property maintenance activities manpower requirements directly from programmed changes in the mission elements of the force structure, reducing current reliance upon command average manpower factors for support manpower computations.

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Title: Performance Appraisal Systems for USAF Civilian Personnel

Description: The development of a comprehensive management system for encouraging excellence in job performance of Air Force civilian employees has been completed. The system has four major components: (a) Senior Executive Appraisal System (SEAS), (b) General Manager Appraisal System (GMAS), (c) Job Performance Appraisal System (JPAS), and (d) Promotion Potential Appraisal System (PPAS). Under SEAS, bonuses were distributed to senior executives based on job performance evaluations. SEAS was implemented 1 October 1979. A similar system for evaluating general managers (GMAS, GS-13 through GS-15) and distributing merit pay among these managers was developed and became operational 1 October 1980 with first merit pay awards made 1 October 1981. Similar to SEAS and GMAS, JPAS uses a supervisor/worker developed work plan which identifies the major elements of the job which are to be rated, shows the criticality and relative importance of the elements, and states the performance standards for each element. The promotion potential appraisal system (PPAS) was completed and will be implemented 1 February 1982 to rank order all GM, GS, and Federal Wage Scale promotion eligibles. Experts in each vocational area defined behavioral dimensions necessary for performance in their area, and policy capturing exercises produced mathematical algorithms for use in the ranking process. Although the requirement for the job performance and promotion efforts predate the Civil Service Reform Act of 1978 by two years, the evolved systems are in accord with the requirements of that act.

Utilization: The first bonuses were paid out to members of the Senior Executive Service under the Senior Executive Appraisal System (SEAS). Approximately 165 (GS-16 and above) employees were in competition for bonuses based on the performance ratings and Performance Review Board recommendations. The GMAS was implemented on 1 October 1980 for approximately 11,000 General Schedule employees identified as supervisors and managers in grades GS-13 through GS-15. The first appraisals under GMAS were completed on 30 June 1981 with the first merit pay increases under the system to be awarded during the first full pay period in October 1981. Approximately 120,000 General Schedule and Federal Wage System employees in all grades were trained in the concepts and practical application of developing work plans for the JPAS which became effective 1 October 1981. At that time, all

employees must have written work plans composed of job performance elements and standards. The JPAS appraisals are scheduled for 1 February 1982 with continuing increments of appraisals for employees based upon the employee's anniversary date of last within-grade increase or promotion.

Benefits: With full implementation of SEAS, GMAS, and JPAS, the Air Force has met the legal requirements of the Civil Service Reform Act of 1978 as it pertains to the development and implementation of new performance appraisal systems. These three systems are objective management systems designed to foster and reward excellence in performance and to identify substandard performance at any grade or level within the Air Force federal civilian employee area. The PPAS provides the Air Force with a completely visible civilian promotion system which was developed to meet the EEO and Uniform Guidelines for Employee Selection and thus minimize the threat of litigation.

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FORCE MANAGEMENT SYSTEM — ON-GOING R&D

Title: Utilization of Women in the Air Force

Description: During the past decade, the number of women in the Air Force has increased from approximately 12,000 to more than 60,000. To provide Air Force management with information relevant to the optimal utilization of women in nontraditional military roles, a study of the Aircraft Maintenance Career Field is being accomplished with the objective to evaluate the on-the-job utilization patterns of males and females and to identify gender differences in task assignment, in job changes over time, and in job expectations, experiences, and attitudes. The analysis of the job expectations, experiences, and attitude data indicate that some significant differences do exist between males and females in their reasons for entering the Air Force and the Aircraft Maintenance career field, in their previous mechanical experience and their plans for civilian work. Differences were also indicated in the area of expectations as to the amount of strength required on the job, initial supervisor confidence, and desire to leave the Air Force. However, differences were not found to be gender specific in other areas of expectations, experiences, and attitudes. Overall, satisfaction with the Air Force and their jobs, current supervisory confidence, job difficulties and job changes were not found to have discriminative gender significance. Preliminary results of this study have been briefed and further analyses are in progress.

Female Airmen in Non-Traditional Military Role

Utilization: Information generated from these studies has been used in making management decisions regarding the utilization of women in the Air Force. Decisions made utilizing this research have allowed an expansion of the role of women in the Air Force resulting in an increase in selection ratios for certain career fields and the optimal utilization of the personnel resources available to the Air Force.

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Title: Performance Relevant Situational Constraints

Description: This research is part of a comprehensive AFHRL program to identify factors which influence productivity in the Air Force. The purpose of this research is to identify situational constraints in operational Air Force work environments which are perceived by job incumbents to inhibit their productivity, and to develop, refine, and validate a questionnaire instrument which can be used to identify such factors in diverse settings. The study involves four phases in which different samples of first-term enlisted personnel will be selected for survey administration. During the first administration, a questionnaire eliciting open-ended responses will be administered, and the responses will be content analyzed. On the basis of this analysis, a number of dimensions which impede productivity will be identified, and this knowledge will serve as a basis for development of items to be included in a more structured and psychometrically sound questionnaire. This questionnaire will be administered to a second more comprehensive sample of first-term enlisted personnel. Responses to this questionnaire will be factor analyzed, and the instrument will be refined. Also, the extent to which situational constraints are present in a variety of Air Force jobs will be identified. During the third phase, focus will be on a more limited set of incumbents in each of six Air Force Specialty Codes (AFSCs), and the instrument will be validated against a variety of performance and satisfaction criteria. In the fourth phase, using a sample of incumbents in a single AFSC, the differential impact of similar work environments on incumbents differing on aptitude and other attributes will be examined, particularly with reference to attrition/retention.

Utilization: Identification of situational constraints to productivity, as well as development, validation, and refinement of a questionnaire to measure such constraints, will provide Air Force researchers and managers with important information, and a tool to deal with productivity problems. Knowledge of factors which impede productivity will provide managers in a variety of operational work settings with the information they need to make organizational and workgroup-specific changes to enhance productivity.

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Title: Personnel Factors Related to Attrition and Retention

Description: The purpose of this research is to support the Air Force function of sustaining personnel resources. This effort will exploit opportunities to favorably affect force quality by accomplishing the following objectives: (a) identifying personnel and occupational factors related to attrition and retention in the enlisted force, (b) developing reliable and valid measurement techniques for collecting such information, and (c) designing practical and efficient methodologies for incorporating research into current selection, classification, and assignment programs.

The approach to the study involves a conceptual analysis of the personnel retention problem focusing on determination of key factors. First, a taxonomy of attrition and retention criteria is being developed to present an orderly and compact arrangement of measures for use in personnel research. Files are being developed for use in a number of analyses in this research program. These studies will include a tracking of historical trends in attrition and retention, longitudinal studies of cohort groups from time of entry to time of loss, cohort analysis of loss rates for possible period, experience and specific cohort effects, investigation of occupational differences in continuation rates over time, and finally, analysis of alternative attrition/retention prediction systems and the evaluation of their impact on personnel acquisition.

Utilization: Identification of personnel factors related to attrition and retention will allow better forecasting of force strength and attenuation of factors negatively impacting personnel turnover.

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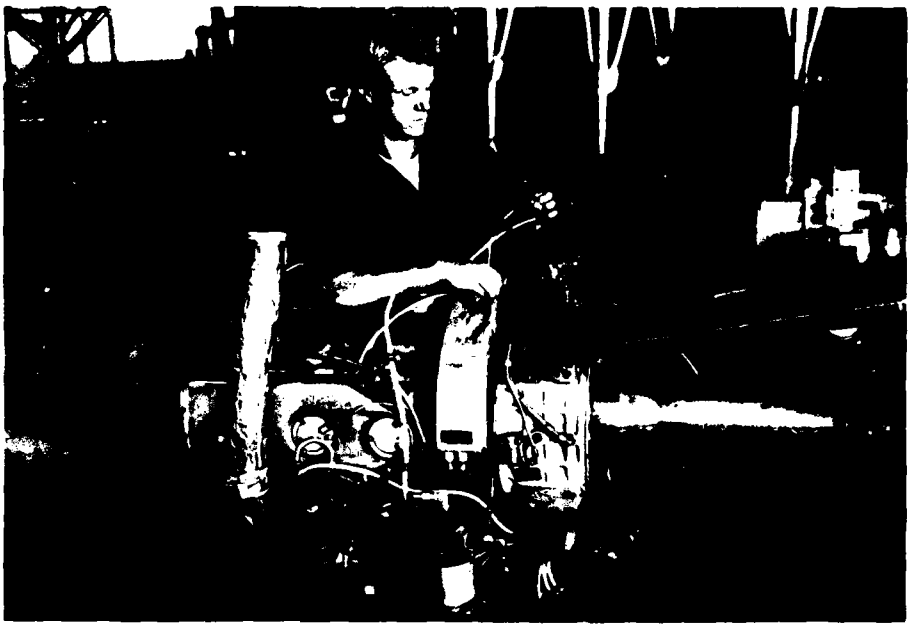
Performance in Mechanical Specialties



Title: Evaluation of Individual Performance in Mechanical Specialties

Description: With a limited labor supply, the optimal utilization of all Air Force personnel becomes increasingly important. The ability to objectively and accurately assess an individual's level of performance on the job is critical to many areas of human resource management. Specifically, in order to evaluate the validity and efficiency of systems for personnel selection, assignment, training and utilization, effective measures of on-the-job performance are necessary. The mechanical career area is a vital part of the Air Force including such diverse specialties as telephone equipment installation, aircraft maintenance, masonry, and carpentry. Since all these jobs require a high degree of mechanical competence, entrance requirements to mechanical specialties include a minimum level of mechanical aptitude as measured by the Armed Services Vocational Aptitude Battery (ASVAB). To ensure that these key mechanical positions are staffed with the best people, continual refinements are made to the personnel system. A methodology to objectively assess individual on-the-job performance within these specialties could provide empirical feedback to optimize the refinements and provide a means for assessing the impact of policy, equipment, and training changes. A method to provide objective feedback on actual job performance in the mechanical career areas would thus help improve the capability of the Air Force in operating its highly mechanized force. In order to meet these needs, an effort is underway to develop an integrated performance assessment methodology applicable to all mechanical career fields. The methodology will consist of a general

framework of instruments and techniques, and a set of clear-cut decision rules which can be applied to the content of each job. The prototype system, if successful, would be applicable to a full range of functional specialties.

Utilization: The performance assessment system developed by this effort will be used to assess individual performance levels in order to evaluate the validity and efficiency of systems for personnel selection, assignment, training, and utilization.

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Title: Development of Prototype, Computer-Based Training Decisions System

Description: The objective of this effort is to develop a user-oriented, interactive, computer-based system for training resource allocation and training assignment decisions at the worker-task or task cluster level. The effort will involve the exploratory development of four subsystems: (a) a task characteristics/task clustering subsystem to address the what and where of training, (b) a field utilization subsystem to address the consequences of training decisions in terms of personnel assignment strategies and mission accomplishment, (c) a resource/cost/capacity subsystem to assess the resource and capacity constraints and cost tradeoffs of training decisions, and (d) an integration subsystem to interface the other subsystems into a user-oriented, interactive, computer-based, training decisions system.

Utilization: This effort will produce a training decisions system that will provide readily available, validated information to Air Staff and user commands, especially Air Training Command, on costs and consequences of training decision alternatives under different constraints, costs, and personnel utilization patterns. The following benefits are anticipated from the implementation of such a system: (a) enhanced mission readiness through optimizing the mesh of technical training resources and overall operational demands, (b) increased training efficiency through optimizing the sequence and settings in which training occurs, (c) improved personnel utilization through development of methods for analyzing functional job patterns in relation to optimized training sequences, (d) increased cost effectiveness of training through the formulation of training decisions based on explicit cost and resource consequences, and (e) reduction of excessive operational training commitments through more accurate estimation and analysis of unit capacity to train while meeting ongoing mission demands. This effort will be supportive of, but will not duplicate, a parallel effort by the Logistics and Technical Training Division of AFHRL to develop specifications for an integrated training system for Air Force on-the-job training.

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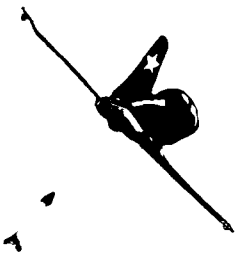
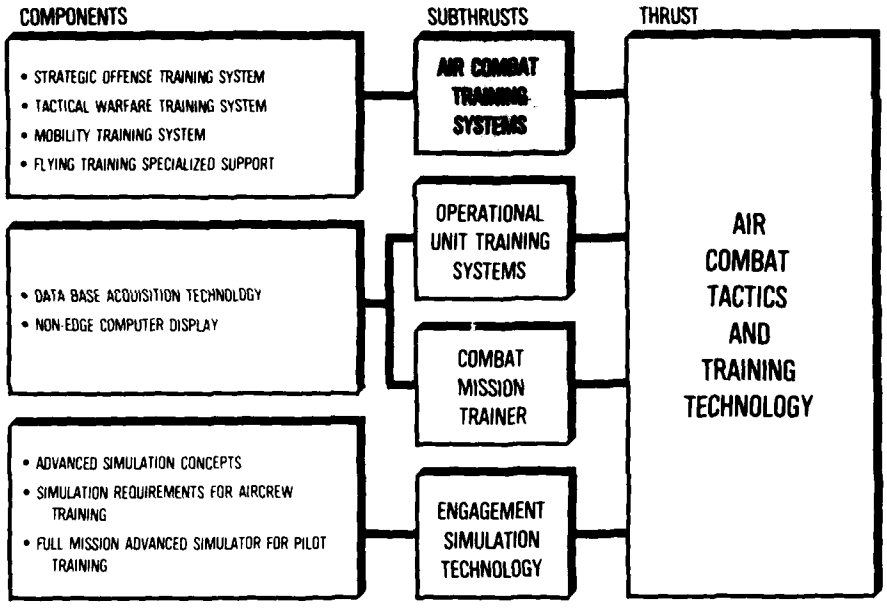
AIR COMBAT TACTICS AND TRAINING



AIR COMBAT TACTICS AND TRAINING THRUST



AIR COMBAT TRAINING — TECHNICAL ACHIEVEMENTS

Title: Desk Top Trainer Demonstration

Description: Computer-based instruction was not popular with the Major Commands (MAJCOMs) due to its operator requirements and maintenance costs. In order to open this area for research and development, a demonstration of a microcomputer-based instructional system was undertaken to answer these criticisms. In April 1981, in conjunction with the Image II conference, the Desk Top Trainer was demonstrated to members of the conference. The system consisted of off-the-shelf computer components in the hobby computer category and required no operator other than the trainee.

Utilization: Representatives of the Air Training Command (ATC) and the Tactical Air Command (TAC) agreed that the system design and implementation answered both criticisms (maintainability and operability). The projected utilization has potential impact on all pilot training but is most applicable at the squadron and flight levels.

Benefits: A low cost alternative to more traditional training methodologies, the Desk Top Trainer offers a more flexible training system. Content and control can be maintained at any level from MAJCOM down to the flight level without reducing the responsiveness of the system to the user. The low cost of the system allows a redundancy not possible with larger hosted systems.

Touch-Sensitive Graphic Displays Allow Pilot to Physically Make Selections on Desk Top Trainer

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Title: Operational Test and Evaluation Handbook for Aircrew Training Devices

Description: The Air Force plans extensive simulator procurements in order to maintain operational readiness and reduce training costs. These simulators will be employed across the entire flight training spectrum, beginning with Undergraduate Pilot Training, continuing through Combat Crew Training, and culminating in the maintenance of proficiency in aircrew skills. The critical requirement is that these simulators provide a training medium that enhances aircrew quality while using fewer resources than would be consumed by the aircraft. Since significant Department of Defense investments depend on the capabilities of these simulators, their training effectiveness must be thoroughly and accurately evaluated. Although the Air Force plans to conduct a series of tests and evaluations on these devices, the methodologies and techniques by which these are to be accomplished has not been determined. What can be stated with certainty is that a multidisciplinary approach will be required. At a minimum, thorough tests and evaluations will include considerations of training capabilities and transfer, media utilization, human engineering, device reliability and maintainability, and life-cycle costs. Knowledge from the fields of psychology, education, engineering, and economics must be combined to provide a cohesive approach. Consequently, a handbook has been prepared that will do the following:

1. Determine appropriate methodologies that can be utilized as standards for assessing simulator training effectiveness. The major elements of this effort include (a) application of alternate definitions of training effectiveness suitable for various systems, (b) selection of measures and techniques that validly and reliably evaluate levels of individual task performance for both student and instructor/operator personnel (items considered include appropriate statistical analyses, sample sizes, sample representativeness, and training criteria selection), (c) investigation of student/instructor/operator/training manager attitudes and their impact on simulator acceptance, utilization, and confidence in the training program, (d) investigation of the relationship between system availability and reliability and the capability to maintain the intended training program.

2. Determine appropriate techniques to evaluate system control features such as the instructor/operator console; adaptive training provisions; system operability and special system training capabilities such as freeze, reset, automated playback, and prerecorded demonstrations.

3. Determine the appropriate composition of the Operational Test and Evaluation team in terms of disciplinary skills and experience.

4. Determine the resources necessary to conduct Operational Tests and Evaluations in terms of personnel, hardware, and software.

Utilization: The research results (a) provide Air Force leadership with direction in making sound decisions in allocating huge expenditures on aircrew simulators, and (b) provide the operational Air Force units proper methodology in the planning and conduct of aircrew simulator test and evaluation programs for a variety of systems.

Benefits: The published handbook provides a standardized guide for Operational Tests and Evaluations. Planning and required test procedures are outlined in terms usable by operational command personnel. Application of these procedures will result in increased efficiency and reliability in operational test and evaluation of training equipment. The benefits will be cost savings in the conduct of the test and improved reliability and validity in the test findings.

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Title: F-16 Aircraft Turbulence Study

Description: A study has been completed to determine whether incorporating various levels of turbulence in the visual scene instruments and g-seat of the Advanced Simulator for Pilot Training (ASPT) F-16 cockpit can improve simulator performance in a subsequent moderate turbulence condition. Aircraft motion due to turbulence is not predictable by the pilot. When it occurs, the pilot must react in order to control the aircraft. In this study, motion due to turbulence was simulated by instrument and visual scene jitter and by the inflation and deflation of g-seat bladders. Platform motion was not used. The 18 pilots participating in this study were from the Tactical Air Command and all had experience in fighter aircraft and were transitioning to the F-16 aircraft. Nine of these pilots were trained in the ASPT/F-16 configuration on three tasks at three different levels of turbulence. The tasks were instrument landing system, 30-degree dive bomb, and strafe. These pilots were the experimental group. The other nine pilots received ASPT/F-16 training on the same three tasks but with no turbulence. These pilots were the control group. Pilots in the experimental group experienced task/turbulence conditions in a specially-balanced arrangement that exposed each pilot to all the conditions in a unique order.

Utilization: It was expected that this study would show that prior training with turbulence would enable pilots to perform better in subsequent turbulent conditions than would pilots who had not received prior training. Analysis of results shows that this expectation was not realized. As a matter of fact, the control group outperformed the experimental group on the criterion trials. Apparently, the training with turbulence was disruptive rather than beneficial. A tentative conclusion to be drawn is that, since the subjects were all experienced fighter pilots, they already had learned how to react to turbulence. Turbulence experienced by the experimental group did not improve skills which were already developed. Turbulence may have distracted the experimental group from the task of learning how to fly the F-16, resulting in reduced criterion performance compared to the control group.

Benefits: This research can influence the utilization of the syllabus for the F-16 Full Mission Simulator.

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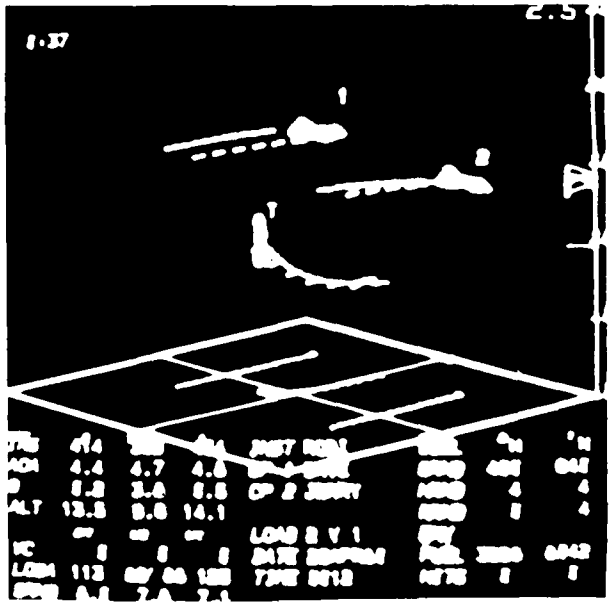
Title: Air Combat Maneuvering Performance Measurement System Development and Training Effectiveness Evaluation

Description: An air combat maneuvering performance measurement was developed to quantify tactically meaningful offensive and defensive maneuvering performance. The system is compatible with the Simulator for Air-to-Air Combat and Air Combat Maneuvering Range/Instrumentation. Transfer-of-training studies are projected when the system becomes fully operational.



Computer Generated Replay of Combat Encounter

Psychologist Debriefing A-10 Pilot Following ASPT Sortie

Utilization: The quantification of individual/unit combat readiness in the air-to-air task/Tactical Air Command training and operational units will provide for better measures of pilot and unit readiness.

Benefits: The benefits of improved air combat maneuvering performance measurement systems are (a) increased reliability in assuring desired training levels are achieved, (b) improved capability to optimize training efficiency and effectiveness in ground or airborne devices, and (c) enhanced capability to redirect training resources either to improve the product output or to reduce costs.

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Title: Force Cue Requirements for Air-to-Surface Weapons Delivery Simulation

Description: The objective of this research was to evaluate the effects of four different simulator force cueing configurations upon the learning of weapons delivery maneuvers in the Advanced Simulator for Pilot Training (ASPT), and subsequent transfer of this learning to performance in the A-10 aircraft. Student pilots were initially trained in the ASPT and subsequently evaluated on 10 air-to-surface sorties in the A-10. Each student received training under one of four simulator configurations: (a) platform motion on; g-seat and g-suit off; (b) g-seat and g-suit on; platform motion off; (c) *g-suit only* (*g-suit on; g-seat off*; platform motion off); and (d) visual only (platform motion off; g-seat and g-suit off). In addition, a group of students was unable to practice weapons delivery in the ASPT, thus providing a *partial control group*. Automated performance measures of weapons delivery scores were recorded in the ASPT; gunnery range scores were obtained from squadron weapons officers. Unfortunately, changes in training operations during the course of the experiment prevented the making of several crucial comparisons, and so the conclusions that could be drawn from the data were limited. The key findings of the study were (a) strong evidence that performance improved from sortie one to sortie two in the simulator, but no evidence for this improvement to be of different magnitude for different groups, (b) no evidence that different simulator configurations affected weapons delivery accuracy in the simulator, (c) no evidence that ASPT simulator weapons delivery pretraining resulted in an *overall* improvement in range scores over a group which had other ASPT training, but no weapons delivery practice in the ASPT (because of task and system changes during the experiment, the "best" simulator groups could not be compared with the control group), (d) little average improvement in accuracy on the range between sorties four and six in the dive bomb events (the training value of these dive-bomb sorties relative to other

potential uses of them needs to be examined more closely), and (e) pilots tend to produce lower aircraft g-forces in the ASPT when using the g-suit system.

Utilization: This research has produced data that will have direct impact on the definition of A-10 simulator requirements.

Benefits: Indefinite at this time.

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Title: Visual Channel Theory and Flight Simulator Imagery

Description: A continuing problem in the identification of optimum simulator display and image generation techniques has been the lack of accepted methodology for the scientific assessment of dynamic stimuli. Existing metrics and standards to date have been developed principally for the evaluation of static scenes. One approach to the study of dynamic visual stimulus requirements for simulators is channel theory. Channel theory seeks to identify what features of complex, moving stimuli the observer's visual system is tuned to during the performance of visually guided tasks. The basis of this approach is the hypothesis that the visual system analyzes the outside environment into a limited number of abstract categories called channels. Channels that have been experimentally identified to date include wavelength spatial frequency and movement in depth or position. If it can be established what channels are relevant to the performance of given flying tasks, then the task of simulator imagery reduces to one of driving the relevant channels. The present research was designed to determine if there is any relationship between channel sensitivity and flight performance on the Advanced Simulator for Pilot Training. Two studies were conducted. Visual pretests included spatial frequency, changing size, changing position, and flow pattern rate discrimination. Simulator tasks included landing in poor visibility, formation flight, and low-level bomb delivery. Substantial correlations were obtained between specific visual channel sensitivity and flight simulator performance, thus indicating this approach has merit.

Utilization: This basic research has potential for ultimately permitting the description of dynamic visual display requirements quantitatively in terms of minimum spatial and temporal frequency bandwidths.

Benefits: Specification of visual display requirements in terms familiar to electrical engineering and physics personnel resulted from this research.

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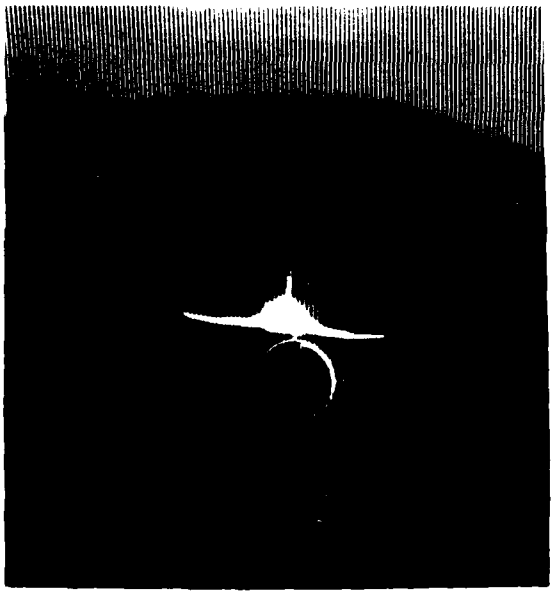
Visual Channel Theory Research



View Seen by Pilot During Target Acquisition in SAAC

Title: Visual Acquisition of Air Combat Maneuvering Targets in the Simulator for Air-to-Air Combat

Description: This effort evaluated the limitations in the Simulator for Air-to-Air Combat visual systems that inhibit air combat maneuvering training. It documented the capabilities and provided assessment of system limitations.

Utilization: Improved target imagery for simulator air combat maneuvering training will be realized from this research.

Benefits: Improved target imagery in the Air Combat Maneuvering trainer will result in increased capability to provide detection and engagement training at ranges approaching those in real-world air combat maneuvering. The result should be increased training effectiveness.

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Title: Simulator for Air-to-Air Combat Visual Dysfunction Study

Description: The psychophysiological aftereffects of flying the Simulator for Air-to-Air Combat (SAAC) were evaluated, and the physical or mental dysfunctions brought on by such training were determined.

Utilization: It was found that several instructional strategies and media caused varying degrees of psychophysiological disturbances, such as room spinning around after lying down at night, and flashback appearances of checkerboard-like squares before the eyes with sudden awakening at night. The results of the study were used to improve instructional methods, to brief students on visual impact of the SAAC, and to continue efforts to describe the cause.

Benefits: Such dysfunctions, if occurring in actual flight, are of major safety importance. Documentation of these data could affect policy both in the SAAC and in other visual simulators. This should help to ameliorate aftereffects that include mental and perceptual disorientation and should improve SAAC training.

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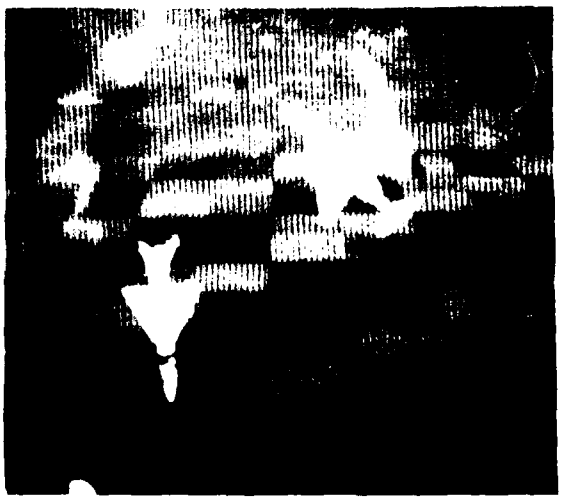

Checkerboard-Like Squares Which Occurred as Flashbacks to Pilots Going Through SAAC Training

Title: Air Combat Maneuvering Diagnostic Methodology Performance Measurement

Description: An iterative analysis of data collected on air combat maneuvers flown in the Simulator for Air-to-Air Combat (SAAC) is being made. The emphasis in this analysis is on the Tactical Air Space (TACSPACE) measurement structure concept, in order to determine the utility of that concept in providing real-time presentation performance data. These findings will be combined with results obtained from the Good Stick Index (GSI). The GSI is a measure of the training Tactical Air Command and Aerospace Defense Command pilots receive during air combat maneuvering (ACM) training programs at the Vought Corporation Simulation Facility.

Utilization: This effort should impact the basic technology concerning performance measurement applications in an ACM simulation environment. The results may also lead to use of improved ACM measures both on the simulator and the ACM range/instrumentation. The development of a functional specification for a performance measurement system, which can be implemented on the SAAC, will also describe for the SAAC programming staff the functional requirements for software to implement the developed performance measurement methodology, with the information presented to the Instructor Pilot in the recommended formats. It should be possible later to apply this index to range performance in actual aircraft.

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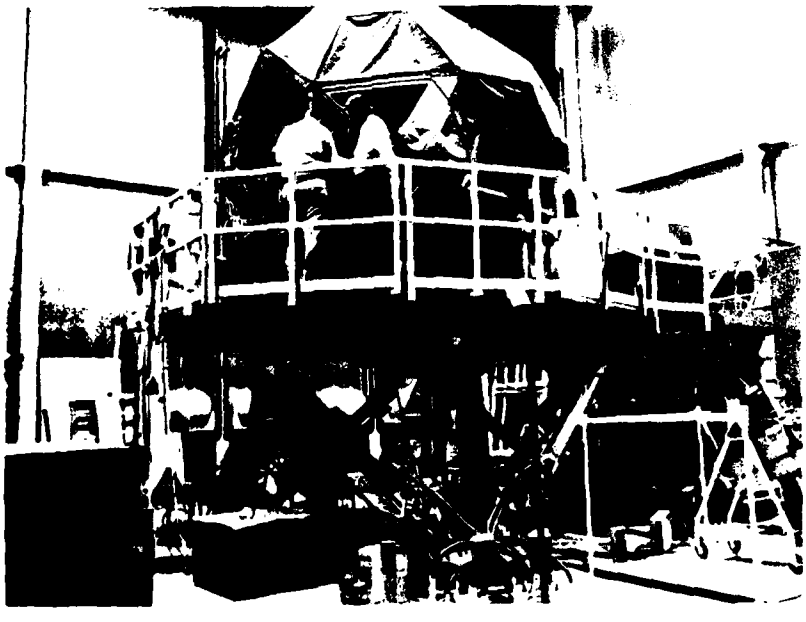
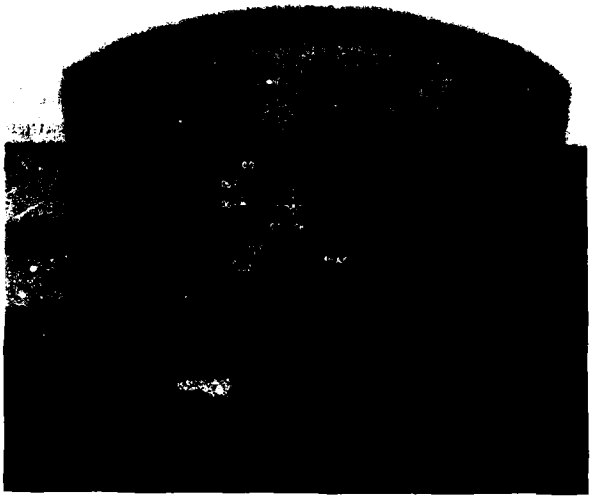
Title: Visual Cueing Requirements for Simulated Low-Level Flight

Description: The lack of adequate visual scene detail is often considered to be a limiting factor in the use of computer-generated imagery for simulated terrain flight. In actual low-level flight, far more visual detail is available to the pilots than currently can be simulated with a computer image generation system. This effort seeks to determine which aspects of the visual world at what level of detail can be effectively simulated into a computer image display to support low-level flight. A series of experiments will be conducted using specialized visual environments designed to identify critical cue types and densities for various types of low-level flight tasks. Recently completed research in this area has demonstrated the role of vertical development for level flight and surface patterns for contour following using



Simulator for Air-to-Air Combat (SAAC)



Visual Scene in Simulated
Low-Level Flight

the computer-generated imagery display capabilities on the Advanced Simulator for Pilot Training (ASPT). The range of flight tasks and the types of visual cues will be expanded in a series of parametric experiments. In addition to the use of the ASPT, the digital image generation system of the FB-111 aircraft system will be used to study increased detail capacity and alternative cue sources.

Utilization: The results of these studies will impact the design of visual scenes developed to support training needs in various types of low-level flight. The data could also be used by simulator system designers to set minimum specifications for visual displays. The results will provide data regarding the role of various types of visual cues for perception of depth, motion, and surface orientation. By combining all of this information, effective simulation capabilities can be produced for simulation training of low-level flight tasks.

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Title: Scenario Requirements for Simulated Tactical Ground Attack Training

Description: The objective of this research is to define, develop, and evaluate those aspects of the F-16 tactical ground attack mission that can be effectively simulated in the Advanced Simulator for Pilot Training. The technical approach is to develop alternative scenarios in which critical training factors and mission elements can be manipulated in a systematic fashion. Experienced tactical fighter/attack pilots will be used as subjects in a series of experiments using alternative scenario configurations. Initial research will concentrate on the part-task scenarios of visual target area penetration, attack, and egress. Those aspects of mission planning, weapon system operation, and tactics selection under the pilot's control will be studied to identify the skills which can be enhanced by simulator training in high threat scenarios.

Utilization: The results of this research should impact simulator design and procurement decisions for future fighter/attack aircraft simulators. The results should also impact the development and evaluation of tactics by providing a test bed for empirical testing as an adjunct to theoretical model manipulations and special exercises.

Simulated Tactical Ground
Attack Visual Scene

Effective simulator scenarios should provide a mechanism for enhancing pilot skills for those aspects of tactical missions which are normally only experienced in actual combat. A dramatic increase in mission readiness is possible. Additionally, the effect of enhanced pilot skill can be evaluated relative to existing models of force effectiveness.

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Title: Microcomputer-Based Special Function Training

Description: An effort is underway to examine the capabilities and effectiveness of training aircrew tasks and parts of aircrew on trainers consisting of programmable color graphics displays driven by microprocessors. Various hardware and software innovations are under study to determine transfer of training, control strategies, and task utilization scenario optimization for computer-aided and computer-managed instructional technologies.

Utilization: This work will define (a) the control strategies that instructor pilots use most efficiently in controlling a simulator through observation of a cathode ray tube (CRT), (b) the transfer ratio of the F-16 Stores Control Panel Simulation to the Advanced Simulator for Pilot Training F-16 configuration and, (c) threat assessment strategies for fighter pilots at the exercise ranges at Nellis AFB. Major Commands (MAJCOMs) can use the results indirectly in the evaluation of microcomputer-based training systems and can use the software developed as a direct input to their training system.

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Title: B-52/KC-135 Weapon System Trainer Operational Test and Evaluation

Description: A B-52 Weapon System Trainer (WST) is expected to be provided to each operational B-52G/H bomb wing for skill maintenance training. In addition, one bomb wing will receive a G model WST, an H model WST, and a KC-135 WST to support the Combat Crew Training School programs. This is the largest simulator procurement in the free world. AFHRL is providing the expertise for evaluating training effectiveness. This has involved consultation on curriculum integration, the

Pilot Operates Training System Driven by Microprocessors

B-52 Being Refueled by a KC-135

development of a test plan, and the specification of a data base that was then developed by AFHRL. The first phase will be to assess WST effectiveness for skill acquisition by monitoring the impact of the WST program on instructor evaluations of student performance, training event accomplishment, and check ride results. The test plan has provisions for program modifications based on these test results. The second phase will be to evaluate skill maintenance potential in an operational environment. Finally, the nature of skill acquisition and reacquisition will be investigated using the performance measurement capabilities of the WST.

Utilization: This research is designed to maximize the training potential of the WST and to evaluate its impact on skill maintenance and skill acquisition. This simulator should ultimately be a major part of the overall training program at the Strategic Air Command.

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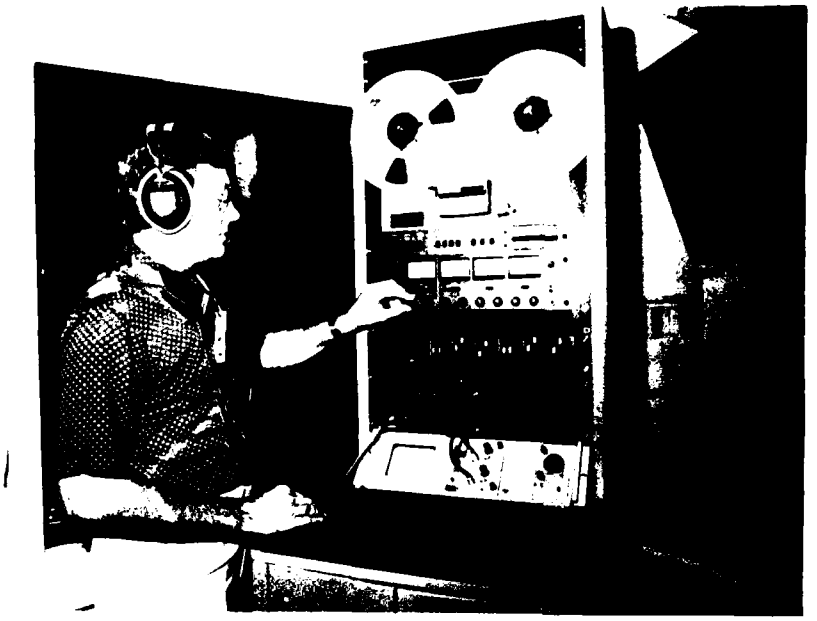
Title: Assessment of Workload and Prediction of Performance by Combined Psychophysiological and Behavioral Techniques

Description: Physiological measures of pilot attention and workload are to be developed. These measures will ultimately be used in conjunction with behavioral measures of pilot attention and task difficulty in order to optimally structure flight simulation training programs and equipment. One initial objective has been to establish laboratory procedures for handling the large quantities of data involved in psychophysiological research and ensure that all components of the computer laboratory were functioning properly. The variables of heart rate, skin conductance, respiration rate, pulse transit time, cortical evoked potentials, and eye movement have not been investigated simultaneously in previous research. A second major objective of this study is to investigate the interrelationships of these variables with each other and with performance on behavioral information processing tasks. A simplified laboratory flight simulation provides the behavioral task which is being used to study the various physiological variables. Heart rate, skin



Measuring Devices and Monitoring Equipment Which Provide Pyscho-Physiological Assessments During Pilot Performance

conductance, respiration rate, and pulse transit time are being studied as indicators of autonomic arousal. The cortical evoked potentials are related to attentional state and the complexity of stimuli emulation environment.

Utilization: The measure of arousal (heart rate, skin conductance, respiration rate, and pulse transit time) reflect, in a gross sense, the degree of subject involvement in the task. Also, both the early and late components of the cortical evoked response vary with task difficulty and performance. Assessment of human performance has become more difficult as the complexity of man-machine systems has increased. The point has been reached where behavioral research must step beyond the limits imposed by quantifying behavior in terms of motor responses only. Psychophysiological assessment of the internal state of the operator shows promise of providing the tools to take this step. By combining behavioral and psychophysiological assessments, a more comprehensive profile of human performance should emerge. This should permit a greater understanding of the conditions under which performance deteriorates and should point to training techniques and training equipment configurations that will maximize pilot performance.

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Title: Tactics Training Research

Description: Three significant developments occurred in the area of tactics training research. The first involved the design for a microcomputer-based system for training attack mission planning skills. The design, called TACLAB, was partially implemented on a TRS-80 machine. TACLAB focuses on the planning of interdiction strike tactics under conditions of visual penetration and target attack. The system uses actual RED FLAG scenarios as problems. Aircrews' plans are input via a flexible menu presentation which contains a list of the critical elements of the attack plan as determined in consultation with ground attack instructors at the Fighter Weapons School at Nellis AFB. In addition, the menu contains performance measurement routines for assessing the aircrews' knowledge of the operations environment. Instructional feedback is provided using information about the advantages and disadvantages of possible values of each element. This information is based on actual performances against targets at RED FLAG. Feedback is automatically generated in the form of stored, nonprescriptive comments which the aircrew may use as resources to improve the plan. In its present form, TACLAB has limited graphics capability and therefore cannot display information visually about threat coverages. A projected map is currently its only display of geographical information. Commercially available hardware and software are being procured to significantly expand the TACLAB concept of operations in the graphics area. The immediate use of this system is to prepare

aircrews for RED FLAG exercises by sharpening their knowledge of the operational environment and their proposed attack plans. However, since the system will collect data on the tactics planning process as well as providing practice and instructional feedback to the aircrews, it will also be of value in answering important part-task research questions. The second area of significant development during FY81 has been the modeling of an actual electronics warfare range at Nellis AFB for operational use in the Advanced Simulator for Pilot Training. The range provides for the display and operation of the major air defense threats associated with forward elements in the region of the Forward Edge of the Battle Area. The range was specifically created in order to support an A-10 transfer-of-training study planned for FY82. Aside from its intended use for the planned transfer study, the development work in itself has been significant in that it has provided a high degree of operator/experimenter control over all relevant aspects of the tactical ground attack environment. As such, it provides a realistic, highly controlled environment in which the acquisition of selected tactical skills can be systematically investigated. A third area of research has involved an initial involvement with the TAC BRAWLER model for air combat. TAC BRAWLER, a value-driven, decision-logic math model of air combat, was used during FY81 to evaluate the effects of visual system resolution, target contrast, and field of view on the topography of one versus one and two versus one air combat engagements. The results thus far will have direct impact on specifications for simulators to be used for air combat training. The computer modeling effort has been extremely productive from the standpoint of efficiently addressing the implied impacts of alternate engineering design decisions on the capability of a flight simulator to support certain types of task performance. The results of TAC BRAWLER will also have significant impact on the design of the visual system for the AFHRL Combat Mission Trainer. New efforts involving the use of TAC BRAWLER are in the planning stages. These efforts will involve specific manipulation of BRAWLER's "behavioral" and "decision process" variables in order to determine the sensitivity of air combat to pilot variation in these areas. Also being considered is the feasibility of integrating some form of TAC BRAWLER with the measurement and feedback logic of the Air Combat Maneuvering Instrumentation range facilities. The intent would be to provide for more diagnostic feedback than is currently available. TAC BRAWLER is being considered too as a possible basis for a "conceptual" trainer for air combat tactics training and development.

Utilization: Work over the past year has accomplished several important things. First, the configuration of the

TACLAB

Advanced Simulator for Pilot Training visual environment after an actual tactical range complex has provided the capability for conducting controlled transfer-of-training studies under realistic simulated threat conditions. These developments have also given the necessary degree of experimental control over the conditions affecting the acquisition of tactical aircrew skills. Second, the use of computer modeling has allowed research to move well into the area of air-to-air combat even before an actual on-site simulator capability became available to do so. Continued use of computer modeling promises to afford a more efficient way to conduct much of the research into those areas where traditional forms of experimental control are difficult and where resources to support experimental studies are often prohibitive. Spin-offs involving the application of the TAC BRAWLER model to the area of aircrew performance measurement also appear likely. Perhaps most important over the past year has been the work initiated in the area of part-task or special function trainers. Products such as TACLAB promise to provide extremely cost effective approaches to training those critical tactical skills which are essentially cognitive in nature.

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Title: Instructor/Operator Station Design

Description: An effort was initiated to systematically develop and validate Instructor/Operator Station (IOS) design criteria for Air Force flight simulators. These design criteria will be presented in an IOS Design Guide and will provide best estimates of IOS standards for prime users and will provide design recommendations based on available information. As new data become available through site visits or formal reports, the Guide will be expanded to include this information. Initial emphasis will be given to a summary of all available human factors information which bears on the design of IOSs in general. With this baseline, subsequent efforts will address the unique IOS requirements for fighter/attack simulation systems followed by a similar analysis for multi-crew strategic bomber simulators.

A study was initiated to investigate alternative control devices for use in conjunction with IOS interactive cathode ray tube (CRT) displays. The controls are (a) touch panel, (b) light-pen, and (c) numeric keyboard. These controls will be compared in relation to three CRT display designs. The CRT displays involve (a) weapons loading, (b) aircraft repositioning or a navigation map, and (c) entering alphanumeric data to change aircraft/airfield parameters and coodinates. Displays have been programmed and the controls are operational; data collection will commence in December 1981.

While the results of the joint Air Force/Navy freeze study provided little information about the advisability of errorless approaches to training, the results did provide guidance on the use of the freeze feature during the acquisition of continuous control tasks such as the approach to landing. The freeze feature is simply the stopping of the simulator scene at any desired frozen image. Basically, the freeze was viewed as "aversive" and as contributing significantly to the difficulty of performing the task. While at a gross level of analysis, the use of freeze had no measurable effect upon performance; at the level of pilot control responses the use of the freeze resulted in performances that clearly were less smooth than those of a no-freeze control group. The study too was significant in its use of a probe technique as an alternative to the more traditional transfer-of-training paradigm.

Utilization: Work in the analysis of IOS design requirements will impact the design of future IOSs. The results of these studies are of immediate interest and value to the Deputy for Simulator Procurement. Studies such as that on the instructional use of the freeze feature will benefit users of simulators, e.g., the Air Training Command and the Tactical Air Command, in making optimum use of instructional support features currently found on existing simulators.

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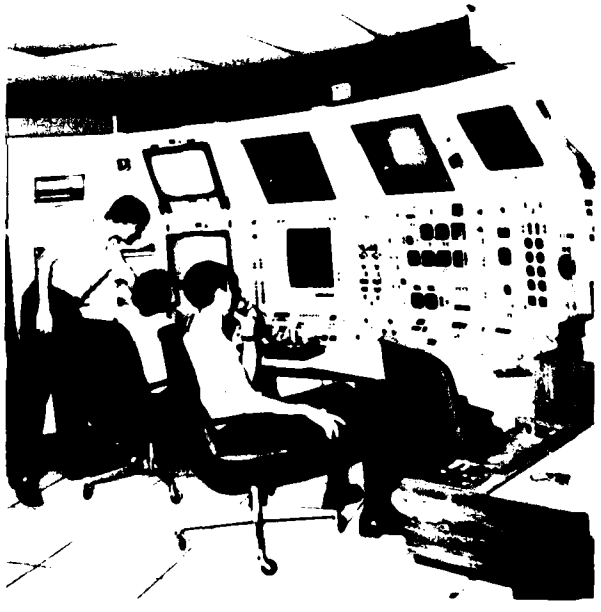
Title: Air Force Skills Maintenance and Reacquisition Training Research Program (Project SMART)

Description: Project SMART (Skills Maintenance and Reacquisition Training) has been designed to develop and validate comprehensive, quantitative, objective procedures which will permit the Air Force to manage an individualized flying training program to provide acceptable aircrew mission readiness at minimum cost. This objective will be achieved through the orderly accomplishment of our research phases: Phase I—preliminary evaluation of Project SMART methodology; Phase II—identification and definition of critical flying skills and the development and test of objective procedures for measuring them; Phase III—measurement of the retention of mission readiness skills as a function of duration of periods of no flying; and Phase IV—evaluation of the effectiveness of alternative programs designed to maintain and foster rapid reacquisition of these critical skills. Project SMART was



Air Force Pilot Trainer
Instructor Operator Station

Air Crew Mission Readiness

initiated in 1978 in response to an Air Force Directorate of Operations, Plans, and Readiness research requirement and with participation by the Strategic Air Command and the Tactical Air Command. Since then, the Tactical Air Command program has completed Phase I and Phase II research. This work has focused on air-to-surface weapon delivery and air-to-air combat tasks and skills. Research is in progress to develop a comprehensive set of measures and critical flying skills that can be made in flight, in simulator, and using other ground-based skill measurement procedures. The F-4, F-15, and A-10 aircraft systems are being studied in the development of these measures. The Strategic Air Command research program Phase I has focused on the B-52 low altitude bomb run employing the major weapon delivery modes. Analysis of radar navigation weapon delivery accuracy has been completed, as well as a study describing the performance of the Electronic Warfare Officer. Measures of aircraft commander and copilot performance are being developed through analysis of the approach and landing and in-flight refueling tasks. Skill measurement efforts with the B-52 crewmen have employed existing in-flight and simulator training performance data. Coordination of the Tactical Air Command Phase III efforts and Strategic Air Command Phase II efforts have been delayed. In mid-year, the principal investigator for this program departed. In addition, other manpower resources employed on this effort were lost or diverted to higher priority short-term efforts. At the present time, the total SMART plan is under review by the new principal investigator and the research staff.

Utilization: Skill measurement procedures developed by Project SMART will be used by Air Force training managers to assess the effectiveness of current and upcoming training methods and equipment and to guide in the fine-tuning of future training programs to maximize the gain in Air Force combat capability per unit of training resources used.

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Title: Energy Management Decision Making

Description: Pilots' ability to make vehicle control decisions will be investigated. The decision process of interest involves timing of turns, acceleration, etc. as opposed to fine control inputs such as stick and throttle inputs. The experimental task is a Flight Decision-Making Assessment Task (FDAT). In FDAT, given the situation of an airplane frozen in altitude, the subject is required to handle a vehicle through a series of discrete moves. Like an airplane, the FDAT vehicle is susceptible to speed/acceleration loss due to parasite drag and induced drag. This timing, of course, changes, and unloaded acceleration is critical to good task performance.

The research performed to date has related FDAT performance to weapons delivery performance in the Advanced Simulator for Pilot Training (ASPT). For two groups of F-16 T-course students, FDAT performance was related to performance in a "turkey shoot" in ASPT. Simulator and FDAT were compared using a speaker and rank-order correlation coefficient. The average

Researcher Correlating Flight Decision-Making Assessment Task (FDAT) Data

correlation for the two groups was .85, showing a strong relationship between control decision performance as measured by FDAT and simulator weapons delivery performance.

Utilization: The results of this effort will be used for identifying pilot skills and abilities and for development of non-real-time training aids.

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Title: Automated Performance Measurement System C-5 Aircraft

Description: Development of a prototype, automated performance measurement system for an operational flight training simulator continued. The system for the C-5A aircraft is to be shipped to Altus AFB in November 1981, and beginning in February 1982, a 2-year evaluation of the system will be initiated. Following completion of the simulator measurement system, a companion airborne measurement system will be developed and integrated with the simulator system. The combined system will allow for the comparison of aircrew performances measured both in the simulator and in the aircraft, comparisons which should greatly facilitate answering critical transfer-of-training questions concerning aircrew training device effectiveness.

Utilization: The C-5 Performance Measurement System will provide the Military Airlift Command with the means for quantitatively assessing the training effectiveness of C-5A aircrew training. As a prototype, the system will aid in the functional specification of measurement systems for future aircraft. The system should be of special interest to the Air Training Command in identifying measurement requirements for tanker/transport/bomber training.

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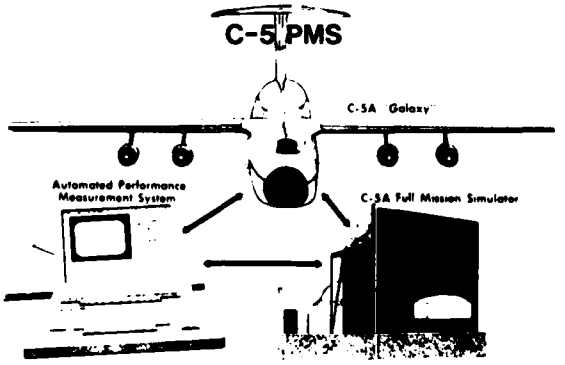

Title: Pilot Eye Movement Patterns and Scanning Algorithms

Description: The utility of eye movement metrics for flight simulator applications will be explored. The effectiveness of such indices for the evaluation of display/imagery effects will be quantitatively documented. In addition, the use of eye movement measurement technology to train scan patterns leading to enhanced visual search performance will be experimentally assessed.

Utilization: The results of this study are expected to improve visual performance in air combat maneuver environments.

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Gulf and Western Eye Movement Monitor

Title: Pilot Memory Structure

Description: A multi-dimensional scaling approach is being applied to investigate pilots' mental organization of flight-related information. Experiential factors have been found to have a significant effect on the way pilots organize flight-related information in memory. The pilots having the most experience have a more efficient and economical organizational schema than do less experienced pilots. Particular flying experience also has an effect on mental structure.

Utilization: The results of this research will be employed in developing methodologies for assessing pilots' knowledge and understanding of particular flying tasks. It will also impact the structure and evaluation of training programs and has human factors implications for device design.

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Pilot Memory Structure Research

Air Combat Training

Pilot in Combat Engagement Training

Title: Pilot Performance and Stress

Description: Biochemical measures of pilot stress were taken in conjunction with Undergraduate Pilot Training and A-10 aircraft surface attack training. The results established (a) that there is a consistent relationship between instructor pilot techniques and student pilot stress, (b) that stress incident to A-10 surface attack simulator training is not significantly different from stress observed in the aircraft, (c) that the establishment of competence in both simulator and aircraft tasks is associated with measurable changes in biochemical substrates, and (d) that experienced pilots exhibit a pronounced stress response when exposed to high threat/high workload tactical simulator scenarios.

Biochemical measures of stress and attention were taken following in-flight emergencies and precautionaries in T-37 and T-38 aircraft. Biochemical data are being analyzed using high pressure gas chromatography. Also, a second line of research is examining variation in biochemical response over the course of Undergraduate Pilot Training. Research was formally co-monitored with USAF School of Aerospace Medicine.

Utilization: These results provide validation of the effectiveness of advanced simulation training for eliciting realistic stress levels.

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Title: Phase I FOT&E of the A-10 Operational Flight Trainer

Description: A follow-on for operational test and evaluation (FOT&E) is underway to provide an independent assessment of the operational effectiveness of the A-10 Operational Flight Trainer (OFT) for training pilots to perform operational A-10 aircraft tasks. The effort is being conducted in cooperation with the Air Force Test and Evaluation Center and the Tactical Air Command.

Utilization: The effort will help determine the utility of the A-10 OFT in training operational A-10 tasks.

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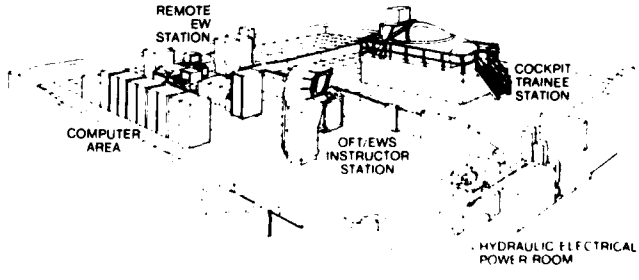

Title: A-10 Combat Scenario Development and Evaluation: Low Altitude Simulation Training

Description: This effort was designed to examine the feasibility of providing supplemental Basic Attack Maneuvers and Low Level Navigation training using the Advanced Simulator for Pilot Training A-10 aircraft configuration. Specifically, the research will assess the effect such training has on student airborne performances. Data collection for this effort has been completed and analysis of these data is near completion.

Utilization: The effort will help determine the utility of full mission simulators in training low altitude tasks. The result will be directly applicable to A-10 training syllabus development.

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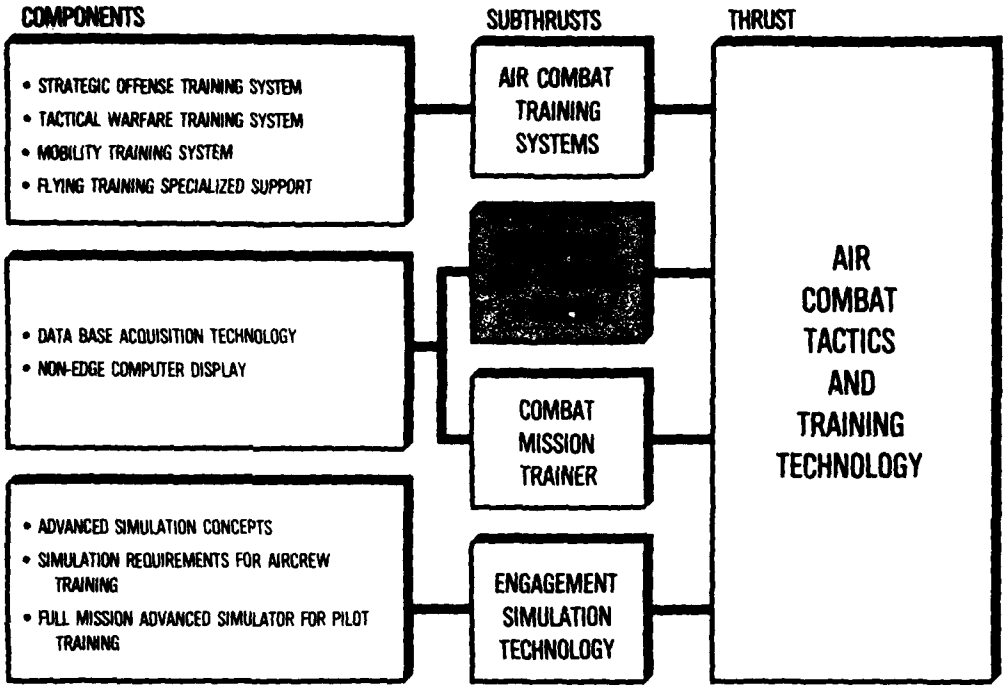
Low Altitude Cues Developed to Assist Pilots in Determining Orientation During Low-Level Flight



OPERATIONAL UNIT TRAINING — ON-GOING R&D

Title: Measurement of Inflight Electronic Warfare Officer Performance

Description: Current methods for scoring Electronic Countermeasures (ECM) activity during B-52 sorties at Strategic Training Ranges (STRs) do not provide meaningful measures for feedback and training management. A prototype system which performs radio frequency spectrum analyses, the Threat Reaction Analysis and Interpretation System (TRAINS), was evaluated for its capability to provide more effective measures of electronic warfare (EW) officer performance. This test, GIANT SCORE II, revealed that measures such as reaction time and jamming accuracy were reliably related to situation variables, e.g., complexity of the threat environment, and to operator variables, e.g., EW experience level. This suggests that such measures could be used profitably with production systems of the TRAINS type to provide feedback to the EW and to training managers.

Utilization: The measures and data from GIANT SCORE II have already been employed in the design of a portion of the ECM scoring for the 1981 SAC Bombing/Navigation Competition (GIANT VOICE). The measures have also been included in the specifications for production models of a TRAINS type system.

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Title: F-16 Back-up Control Airstart Training Research

Description: An evaluation of the proficiency of experienced F-16 pilots in back-up control (BUC) airstart of the F-16/F-100 engine was conducted to determine whether modification of the airstart system would be required. The Advanced Simulator for Pilot Training (ASPT) in the F-16 configuration was used to determine the level of pilot airstart proficiency as well as the feasibility of increased training as an alternative to airstart system modifications. The results of the study indicated initially high levels of pilot failure in successfully executing the BUC airstart. Analysis revealed

that pilot errors in initial throttle setting and rate of throttle movement were the major contributing factors. Rapid acquisition of BUC airstart proficiency was found for all pilots during the testing sessions.

Utilization: The results of the study indicate that modification to the F-16/F-100 BUC airstart system is not necessary if adequate training in the BUC airstart procedure, specifically throttle management, is provided to F-16 aircrews.

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Title: Linear Systems Analysis of B-52 Weapon Delivery Accuracy

Description: A linear system model was developed to describe B-52 weapon delivery accuracy. Several techniques are operationally interrelated in such a way that differences in accuracy can be attributed to the effects of specific component behaviors. System identification techniques were used to determine mathematical models for these processes. Synchronous bomb scores, missile scores, and scores from an alternate bombing procedure were included in the original model. Scores reflecting complex weapon delivery procedures were successfully modeled by convolving the error distributions of the component tasks. Models of component inaccuracy were then used to suggest changes in procedures by assuming that the component densities reflected the nature of the underlying processes.

Utilization: This analytical approach should be generalizable to isolating and studying component processes in other complex behaviors. A recent application was the isolation of response, stimulus detection, and attention-switching components for a simple reaction time task.

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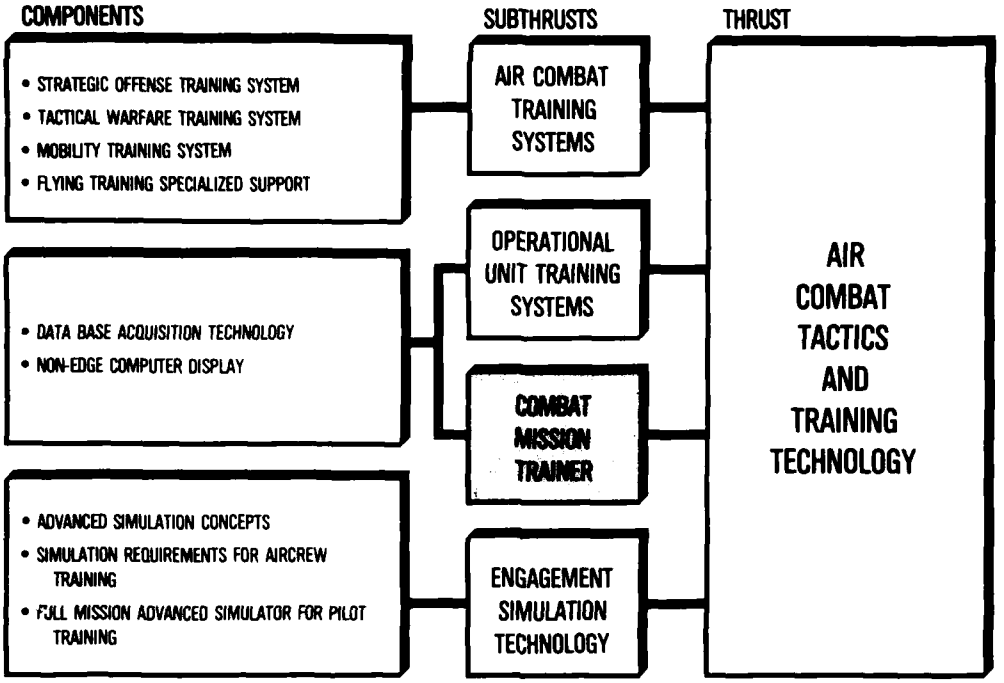
B-52 G with Six AGM-109 Air-Launched Cruise Missiles



COMBAT MISSION TRAINER — ON-GOING R&D

Title: Combat Mission Trainer

Description: A Combat Mission Trainer (CMT) is being developed to provide training for combat essential tasks at minimum cost. It is to be both affordable and transportable so as to allow deployment at the squadron level. Initial emphasis has been placed on the development of a Fiber Optic Helmet Mounted Display (FOHMD) for use in the CMT. This includes development of alternate mechanical and optical helmet sensor with improved dynamic accuracy. Interim supporting systems (i.e., cockpit, Instructor Operator Station (IOS), computational, and linkage systems) are being designed in-house this year. FY 83 development will provide the major cost and size reductions necessary to support the program objectives of low cost and transportability. The image generator for the initial FOHMD technology demonstration will be provided by two Singer FB-111 Digital Image Generators (DIGs) presently on loan to AFHRL from TAC. The complete fulfillment of the program objectives will require the eventual incorporation of new visual technologies from Project 2363, Advanced Visual Technology System; Project 2364, Advanced Visual/Sensor Simulation (AVSS-non-edge CIG); eye tracking systems; and emerging video disk technology. This system offers a major cost reduction over a conventional mosaic CRT or dome based simulator. Visual simulation performance goals relative to ASPT or present state of the art systems include a 1000% improvement in final display brightness, a 300% improvement in resolution, and a 200% improvement in displayed edge equivalency.

Utilization: The affordability and transportability of a CMT will provide an opportunity to train combat mission skills at the unit level. Past research has shown a rapid loss of the finely tuned skills needed for full combat effectiveness. By offering an opportunity for frequent simulated practice of realistic combat tasks, individual combat skills can be maintained at "razors edge" proficiency. This will serve as a significant force multiplier through increased enemy kills and enhanced survivability.

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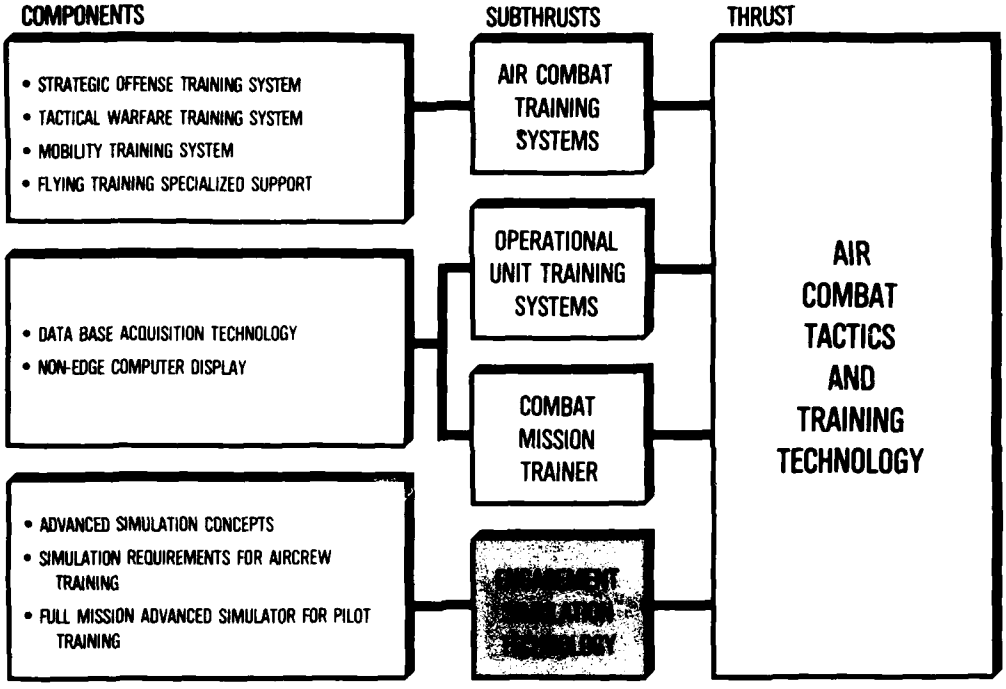
Combat Mission Trainer

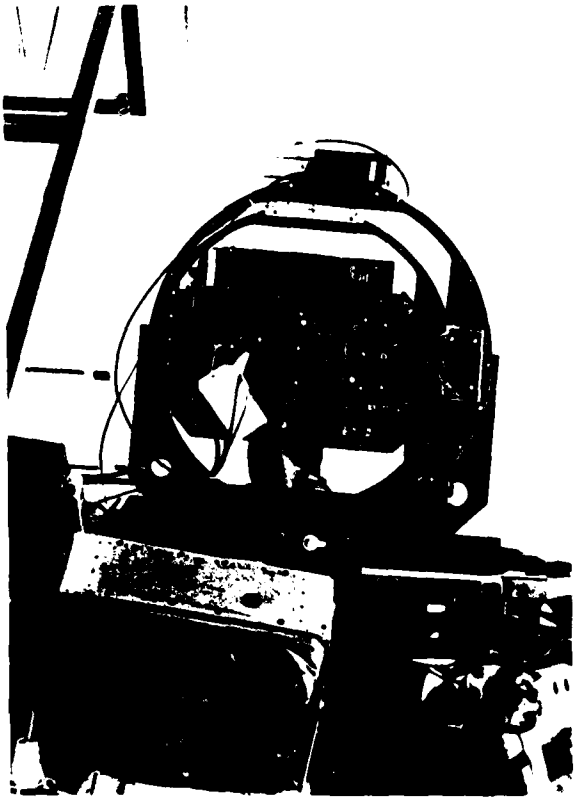


Title: Advanced Simulator for Pilot Training (ASPT) Alternate Display

Description: The cathode ray tubes (CRTs) used for the Advanced Simulator for Pilot Training (ASPT) are rapidly approaching their projected life span. Sixteen replacement CRTs will be required within the next 24 months, necessitating a combined refurbishment and new CRT production rate which exceeds past performance of the CRT vendor. An attempt to alleviate this situation has been investigated by replacing one of the present CRT assemblies with a 1000-line light valve projector, lens, and rear screen assembly.

Utilization: One channel of the ASPT display was replaced with a light valve projector in order to assess its performance, maintainability, and reliability. The light valve projector has proven successful and provides the ASPT display system with an alternate source that should be more readily available and reliable on a competitive basis. This projector also provides additional reliability and maintenance data for similar projects.

Benefits: The 1000-line light valve has proven itself to be a very reliable alternate source to the CRTs currently in use; however, it has one major drawback. While the maintainability and reliability of the light valve have been assessed as being superior to that of present CRTs, there is a diminished level of brightness and resolution in



A Light Valve

the current state-of-the-art light valve. Thus, CRTs will remain the better choice of the two display systems until the brightness and resolution deficiencies of the light valve can be overcome.

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Title: A-10 Aircraft Simulation

Description: One cockpit of the Advanced Simulator for Pilot Training (ASPT) has been converted from a T-37 to an A-10 aircraft configuration. This modification includes a realistic A-10 cockpit configuration underneath the seven-channel ASPT visual system. The A-10 hardware and software were developed using a modular design that allows changes to simulate new aircraft capabilities to be incorporated quickly. The current system allows air-to-ground weapon delivery of bombs and the cannon. Also the normal flight control system and the manual reversion flight control system are simulated.

Utilization: The A-10 cockpit was used by the Tactical Air Command (TAC) for all A-10 training until the A-10 simulators were delivered. TAC plans to continue using the ASPT A-10 for air-to-surface weapon delivery training. An A-10 combat transfer-of-training study is also planned using the A-10 cockpit and an ASPT high threat environment.

Benefits: This configuration of the ASPT provided an A-10 simulation for 3 years, while TAC was awaiting delivery of their A-10 simulators. This system was utilized by TAC and the Air Force Systems Command for training and research. Also this simulation demonstrated the use of the modular design for flight simulators.

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Title: Implementation of a Helmet-Mounted Sensor/ Helmet-Mounted Display on the Advanced Simulator for Pilot Training

Description: An effort has been completed to integrate state-of-the-art equipment with Advanced Simulator for Pilot Training (ASPT) as a follow-on to the engineering feasibility demonstration of the helmet-mounted sensing and display equipment borrowed from the Aerospace Medical Research Laboratory. The new helmet-mounted sensor (HMS) utilizes an electromagnetic field detector rather than an infrared detector and provides X, Y, Z (roll, pitch, yaw) data. This information is supplied to a greater degree of accuracy for a wider range of helmet motion, compared to the previous equipment. The HMS/ helmet-mounted display (HMD) has been implemented in both ASPT cockpits. The HMD consists of a small cathode ray tube mounted on the side of the pilot's helmet, projecting a display on a combining glass in front of the pilot's eye. This system presents either a high resolution range (less than 1 to 3 arc minutes) monocular (right or left eye) central vision area (10 to 10 degree field-of-view (FOV)) display, or two units may be combined to provide binocular coverage in conjunction with the ASPT full FOV display. The HMD collimated image is at the same focal distance as the background ASPT wraparound display and is optically combined with the background which is observable with both eyes. The system also allows unconstrained pilot movement within the cockpit and will provide a correct image perspective with occlusion by the pilot's aircraft.

Utilization: Installation of the HMS equipment provides the capability to utilize the ASPT in pilot workload, head-in cockpit, head versus aircraft attitude, and visual FOV studies. The addition of HMDs in both ASPT cockpits will vastly expand the research potential to include key issues in visual flight simulation. Studies may be conducted to determine resolution, scene detail, and FOV requirements for various flying tasks. HMDs may be evaluated for their training potential in air combat maneuvering, air combat tactics, stand-off weapons systems, and associated tactics. Evaluation may also be performed on fly-by-sensor system displays, Maverick missile helmet displays, and helmet display of aircraft data. With the F-16 and A-10 cockpits, studies could also be performed to develop F-16 and A-10 tactics-training scenarios.

Benefits: The findings from studies using this equipment should be very useful in designing specifications for future flight simulators. This research will, therefore, result in considerable dollar savings.

Helmet Mounted Sensor/Helmet Mounted Display

reduced training time, enhanced operational readiness, and increased capabilities and training effectiveness.

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Title: Visual Scene — Area of Interest

Description: The computer image generation (CIG) system for the Advanced Simulator for Pilot Training (ASPT) is limited in the number of edges, and hence detail, it can display at one time. In order to provide more visual detail in the pilot's area of attention, Phase I of the Area of Interest (AOI) project concentrated the edges into a selectable variable-sized rectangular area from 1 by 1 degree to the full display. Only selected features, such as the horizon, appear outside the AOI. In Phase I, the objects were deleted or reinstated as entire objects flashing into or out of the visual display. Phase II AOI project truncates features as they intersect the AOI boundary and permits the addition of peripheral cues in addition to the horizon outside the AOI. This provides a much smoother and, therefore, less distracting transition at the AOI boundary.

Utilization: Phase II of the AOI project will significantly enhance pilot performance in tactical combat simulation applications by providing, with minimum distraction, the necessary visual detail otherwise available only from much larger and more expensive CIG systems.

Benefits: Use of the AOI Phase II feature has demonstrated an alternate, inexpensive method of displaying a high resolution scene in a selectable variable-sized rectangular area. This method of display has a large impact on the Combat Mission Trainer. The feature is essential for the continuing development of an inexpensive, portable visual display system.

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Title: Advanced Simulator for Pilot Training: Multiple Moving Models Update

Description: The Advanced Simulator for Pilot Training (ASPT) was delivered with the capability of displaying a single moving model in the visual environment. This was adequate for formation flight and other tasks requiring a single moving model. With the change in laboratory thrusts to investigate air combat tactics and training, additional moving models in the visual environment were required to provide moving targets (tanks, trucks, aircraft) and threat simulations (surface-to-air missiles). To satisfy this requirement it was necessary to acquire additional computational power to perform the frame one

computations on the ASPT visual system. The two Systems Engineering Laboratory (SEL) 86 computers which were supplied with ASPT to perform the frame one computations were replaced by four SEL 32/75 computers and an array processor. This, together with an extensive modification to the special purpose visual image generation computer, allows simultaneous display of up to seven moving models.

Utilization: This update to the ASPT visual system has undergone acceptance testing by the Air Force, and has been successfully integrated with the ASPT flight simulation system.

Benefits: The increased capabilities provided by the multiple moving models enable research into air-to-ground combat tactics using moving targets, forward air controller aircraft, and surface-to-air missiles simultaneously in the visual environment. For air-to-air combat tactics, the system will be able to provide multiple enemy aircraft. These capabilities, together with the A-10 and F-16 cockpits on ASPT, greatly enhance the research potential of the ASPT simulator system.

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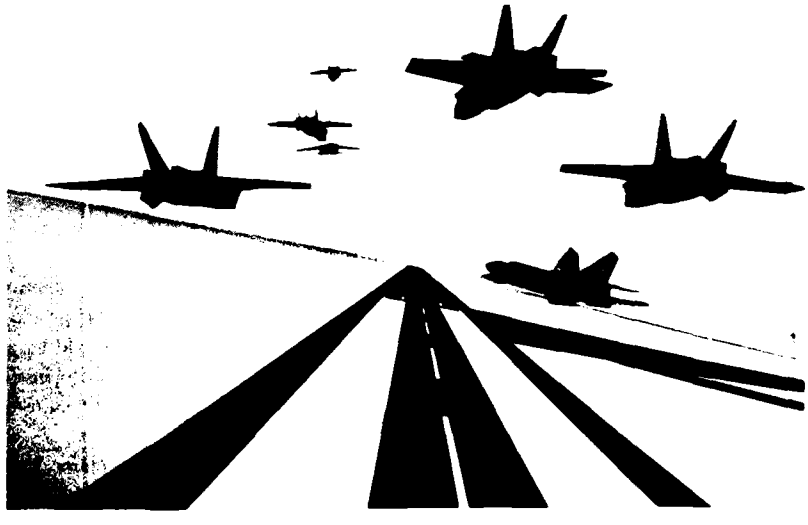
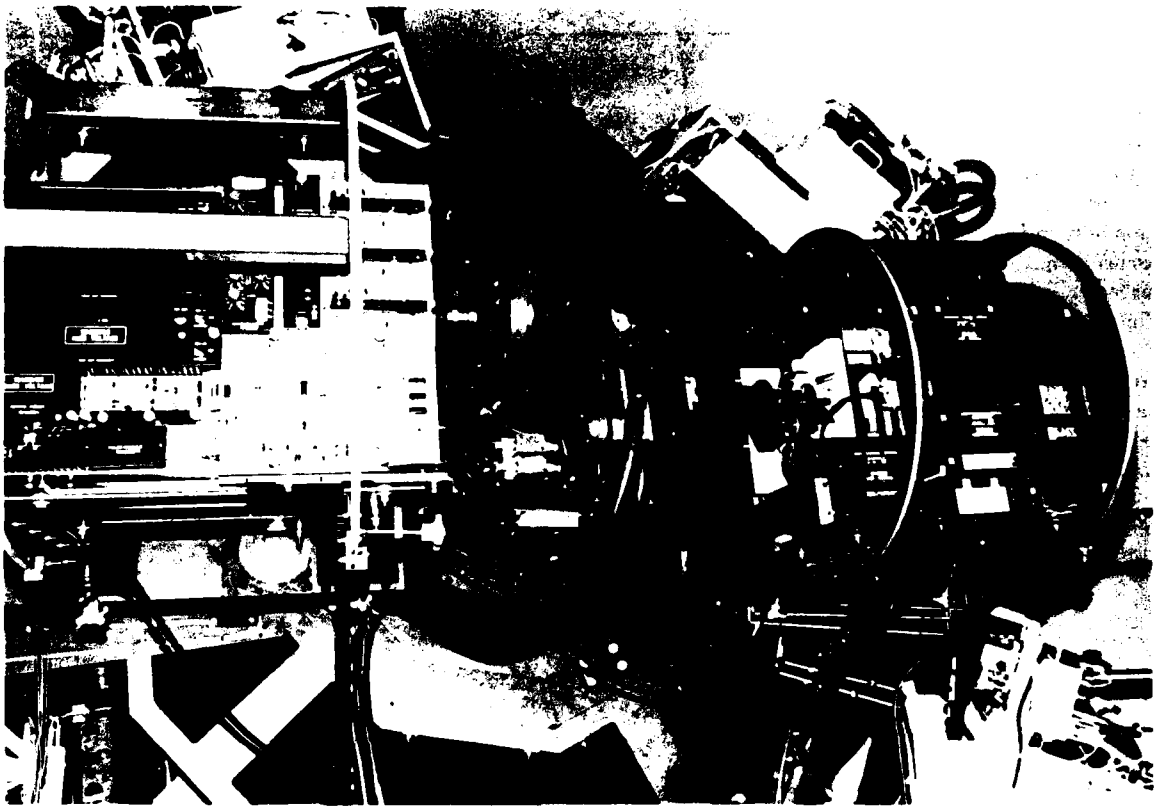


Simulated Multiple Moving Models



Dual Light Valve Installed on ASPT

Title: Advanced Visual Scene Simulation

Description: Conceptual designs for advanced computer image generation (CIG) systems are being developed in the first phase of a technology demonstration program. Advanced algorithms and techniques, which give a higher fidelity representation of the terrain scene than edge based CIG systems, are being investigated. Thus, aspects of CIG visual and sensor simulation being considered include data base structure, color/tonal computations, priority determination, resolution, real-time processing efficiency, image quality, textured surfaces, shadowing, anti-aliasing, terrain/hydrographical cultural features, and special effects. Compatible techniques are to be integrated into a feasible system concept which would minimize objectionable artifacts in present simulations and provide better scenes for training applications. In order to minimize the risks, two competitive contracts were awarded for the first phase. During later phases of this effort, demonstration products validating the design should be produced. Eventually, a new generation CIG system could be produced based on the advances made in this study if cost-effective components can be produced within the state-of-the-art.

Utilization: Higher fidelity visual/sensor simulation would enable training some tasks which are currently not practical due to system limitations. In applications for both real-time and non real-time CIG mission-oriented training, the simulation would be more effective.

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Video Disk Technology

Title: Video Disk Technology Application to Real Mission Visual Simulation Scenarios

Description: A study effort has been initiated to investigate the extension of the Vought Corporation Computer Animated Photographic Terrain View (CAPTV) technology to combat fighter training requirements. The study involves new developments in three areas of the full color wide field-of-view visual system now under construction for the Navy A7-Weapon System Trainer project. The first area of study is the low altitude image transformation algorithms to reduce data base requirements. The second study area is image data base storage architecture and alternate sources such as non-real-time computer-generated imagery. The third study area is the addition of moving models, targets, and other computer-generated imagery effects.

Utilization: The successful development and integration of this technology could represent a major breakthrough in visual simulation. The non-processing intensive nature of the system would allow a quantum leap forward in terms of visual scene detail, texture, and realism compared to the computation bound approach in total computer-generated imagery systems. The terrain textural fidelity capability inherent in this approach may finally provide realistic simulation of real-world tactical environments. Especially notable is the potential for simulation of realistic missions requiring low-level navigation for threat avoidances.

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Title: Combat Environment Simulation Development

Description: The conversion of the Advanced Simulator for Pilot Training (ASPT) to an A-10 and F-16 aircraft configuration created an opportunity for engineering development of simulated combat environments. These environments started with a single valley containing anti-aircraft artillery. Environments have since been developed and improved to the point where realistic terrain models, interactive surface-to-air missiles, and anti-aircraft artillery are all incorporated. Current environments include the Nellis AFB Tonopah range and the Fulda Gap region of Germany. Continuing engineering development includes improved threat models and sensor displays.

Utilization: The A-10 and F-16 cockpits will continue to be used for Tactical Air Command weapon delivery training. Research is currently being conducted in the low altitude flight regime. Planned research includes transfer-of-training studies for both A-10 and F-16

aircraft. Also, weapon effectiveness studies for new weapon systems have been proposed.

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Title: F-16 Aircraft Air-to-Air-Capability

Description: The F-16 aircraft configuration simulator on the Advanced Simulator for Pilot Training will soon have a full air-to-air capability. This capability will include radar, heads-up display, and stores management subsystem integrated to provide the pilot with four different air-to-air combat modes of operation. The pilot will also receive real-time scoring of the 20 mm gun and the AIM9J or AIM9L missile.

Utilization: This capability will provide a device for limited research in the air-to-air realm of combat operations. This will also enhance the present ASPT air-to-ground capability, providing a simulator that is operational throughout the tactical combat environment.

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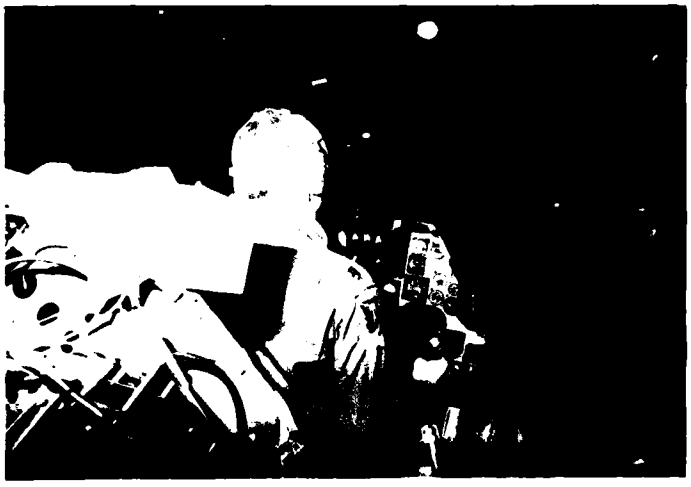
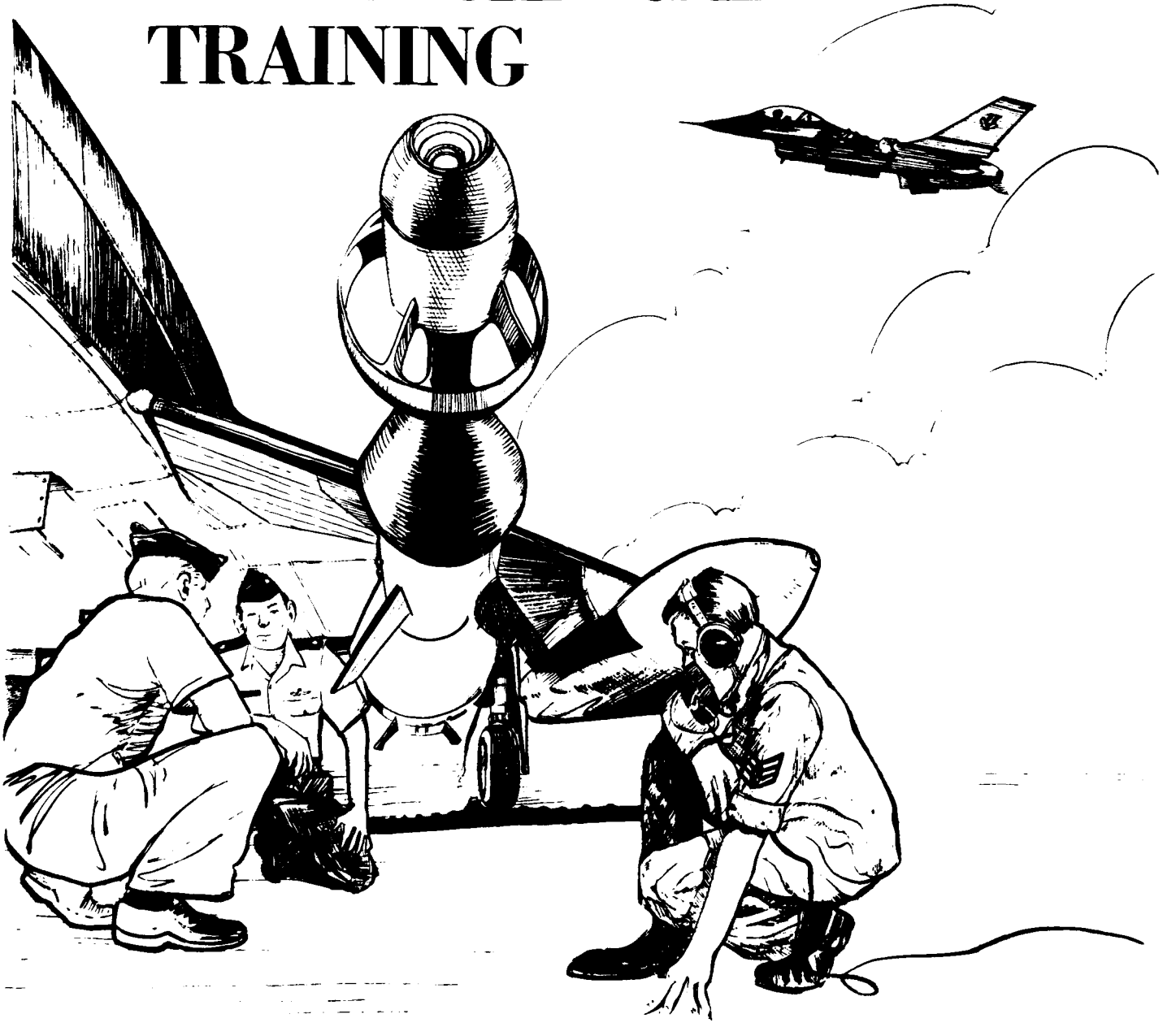
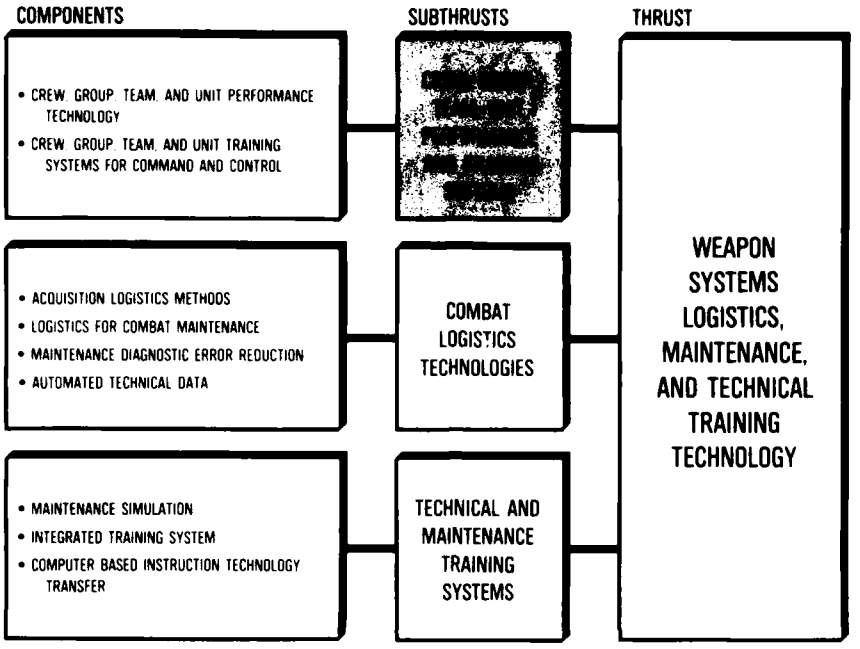


Pilot Maneuvers for Air-to-Air Advantage

WEAPON SYSTEMS LOGISTICS, MAINTENANCE, AND TECHNICAL TRAINING



WEAPON SYSTEMS LOGISTICS, MAINTENANCE AND TECHNICAL TRAINING THRUST

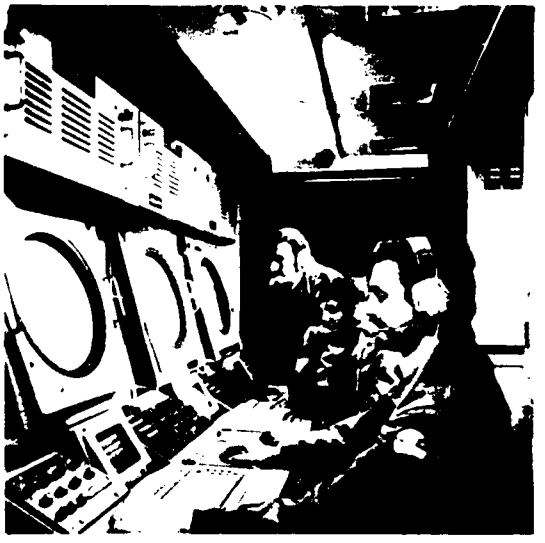


CREW, GROUP, TEAM, AND UNIT PERFORMANCE AND TRAINING

TECHNICAL ACHIEVEMENT

Title: Team Training for Operators of Command, Control, and Communications Systems

Description: This essentially completed program has provided the Air Force with baseline data concerning the conduct of tactical team training within command and control systems. Existing Air Force team training programs were surveyed, and their strengths and weaknesses were described. Information obtained from interviews with training developers, managers, instructors, and students, plus information from observations of ongoing training, provided inputs to an identification and prioritization of elements within team training programs that demonstrate a potential for improvement. The findings are organized into (a) a tactical command and control team training status statement, (b) research recommendations, (c) recommendations for the application of current



Tactical Air Command Control and Communications Team in Operation

technology to command and control team training problem areas, and (d) recommendations for a simulation facility to address significant team training issues. This information is documented in a five-volume contractor-prepared report. A technical paper now being prepared will describe the major findings and will cross-reference the appropriate volumes of the technical report.

Utilization: The results are currently providing guidelines to help define an Air Force program of research and development to address high potential payoff problem areas within team training for command and control system operators. The information provided may be generally useful to those in other services who are addressing similar problem areas. The reports, including the technical paper, will be available through the Defense Technical Information Center and the National Technical Information Service.

Benefits: The work completed allows a realistic focus on Air Force tactical team training problem areas by deriving recommendations from the operational and training environments rather than from an artificially contrived research setting. Resulting research programs should more closely address critical operational and training issues and implementation will be facilitated as a result of the user inputs made.

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CREW, GROUP, TEAM, AND UNIT PERFORMANCE AND TRAINING

ON-GOING R&D

Title: Three-Dimensional Display for Training Weapons Directors

Description: This effort will examine the feasibility of including a three-dimensional computer graphics training device in the training programs for Air Force Weapons Directors. In order to investigate the possible training benefits of such a device, a prototype system is being developed using a commercial graphics computer and a low-cost, off-the-shelf, three-dimensional graphics software package. This software package will be extended to provide the capability to display and interactively control two friendly interceptors flying against an unidentified target on a high-resolution, raster scan, full color cathode ray tube. The primary training issues which will be addressed by this system include: aircraft intercept geometry, air battle and close-air support tactics, and airspace utilization and situational awareness principles, including flight safety.

Utilization: This project will produce the software/hardware capability needed to address critical three-dimensional visual training issues relevant to training programs for Weapons Directors. It is expected that utilization of this capability will result in increased aircraft control effectiveness and/or reduced training time for student Weapons Directors. At the present time, three USAF Weapons Director training schools, including the Interceptor Weapons School, the Basic Weapons Controller Training School at the 3625th Technical Training Squadron, and the Airborne Warning and Control System (AWACS) training program at the 552nd AWACS Wing, are assisting in the development of this system. The initial products from this effort, in the form of a series of prototype video-tape training sessions, will be utilized in the Automatic Positionally Qualified training program at the Interceptor Weapons School and

3-Dimensional Display Undergoing Development for Training of Weapons Directors

will be examined for possible extension and inclusion in additional training programs.

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Title: Tactical Battle Management Research Capability

Description: The near-term objective of this effort is to provide an in-house research capability to study the tactical decision-making behaviors of tactical battle-staff commanders assigned to command and control systems. Such studies will lead to the development of training programs for decision makers and possibly to design guidance for decision-aiding computer hardware/software. The initial version of this system consists of a graphics display terminal and an alpha-numeric display terminal, both of which are "driven" by a software package known as the tactical battle management software. This interactive, user-oriented software can record data of all user-system transactions and communicate with peripheral devices on a real-time basis.

The text and graphic display emulates a generic Combat Planning Node of an Allied Tactical Operation Center for the North Atlantic Treaty Organization Central Region via maps and text. The graphic maps depict military targets and available friendly resources to strike these targets. Material is also presented that describes enemy target and friendly resource characteristics as well as user aids which facilitate the scheduling of missions against potential targets.

Experimental Tactical Battle Management Work Station

Utilization: Initial studies using this system will examine the decision-making behaviors of individual, command-level personnel from operational command and control systems. These data, in combination with data from other related efforts, will serve as a baseline for examination of individual and team decision-making behaviors of tactical battle-staff personnel. A capability to allow examination of group decision-making behaviors is being developed. This time-shared version of the tactical battle management software will be ready for use by the summer of 1982.

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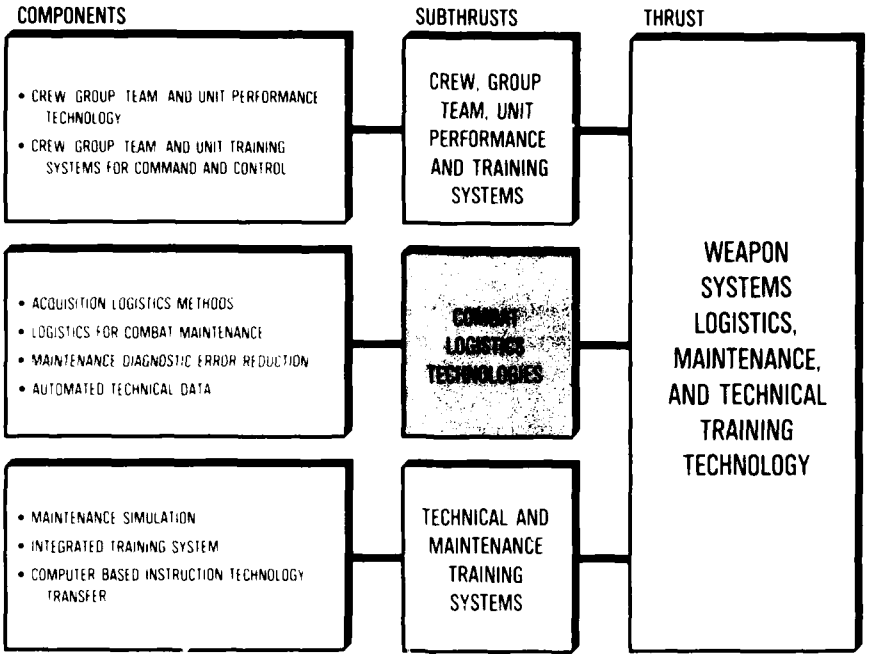

Title: Development of Draft Military Specifications for Maintenance Task Analysis and Logic Tree Troubleshooting Aids

Description: Draft military specifications have been produced for Logic Tree Troubleshooting Aids (LTTAs) and for Maintenance Task Identification and Analysis (MTI& A). A guidance document giving instructions for performing MTI& A processes was also developed. The specifications and guidance document were based upon a review of the state of the art and a survey of recent industry and government experience in applying the technology. The draft specification for LTTA defines the requirement for the content and format of an LTTA (a type of technical manual) to support the troubleshooting requirements of personnel at organizational and intermediate maintenance levels. The second draft specification provides requirements for the procurement of MTI& A. The data base prepared in accordance with the MTI& A specification is used as a basis for subsequent preparation of Job Performance Aids (including Job Guide Manuals, LTTAs), and other types of technical manuals used at the O&I maintenance levels. The third document of this effort provides guidance on how to accomplish the MTI& A. It is designed for use with the

Analyst Working with Task Analysis Data

draft MTI&A specification. The guidance provides an overview of MTI&A processes followed by a listing of fundamental requirements to be performed prior to actual start of MTI&A, and instructions on how to accomplish the analysis.

Utilization: *The specifications will be used to establish* the requirements for technical data being procured to support Air Force weapon systems.

Benefits: The use of these documents will improve the quality of both format and content of new technical data and thereby improve the efficiency of Air Force maintenance personnel. The troubleshooting procedures which result from the LTTA specification will enable all levels of maintenance personnel to troubleshoot more accurately and, thus, to use fewer spare parts. The MTI&A specification will result in technical data that is more complete, more accurate, and more useable by the technician. The result will be more accurate maintenance, especially by first-term technicians.

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Title: *Handbook for Selection of Format Options for* Procurement of Technical Data

Description: This effort developed guidelines for selection of format options and procurement of technical orders. The guidelines identify the types of technical data that can be procured, and the appropriate specifications. The guidelines also tell how to select the best type of technical data for a given application and provide guidance to enable the technical data manager to obtain the best possible product from the contractor. Emphasis is *placed on the responsibilities and concerns of the* technical order managers. The reports include a review of the Air Force technical order system, extensive descriptions of procedural data formats, guidance for determining formats to satisfy particular user needs, and discussion of various aspects of technical order *procurement, development, and management.*

Utilization: The guidelines for selection will be used to establish procedures and guide the acquisition of the Air Force technical orders. The handbook will be a major source of material for a short course on technical data management to be taught by the Air Force Institute of Technology. The use of the handbook will considerably *strengthen the performance of a new or inexperienced* technical order manager.

Benefits: The use of the handbook should significantly improve the quality of technical data procured for Air Force use. The contents of the handbook will provide detailed guidance to the technical order manager about all aspects of technical order acquisition, including determining requirements, selecting options, and managing the procurement process. This will result in technical orders that are timely, correct, and that meet the informational needs of the users. Better maintenance should be the end result.

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Technical Order Manager's Handbook In Use

Title: Unified Data Base Technology

Description: A unified data base technology will be developed for a central automated source of logistics data drawn from basic Air Force systems to support the weapon system design process. Logistics data are those that would assist in obtaining answers to questions about logistics requirements as a function of alternative design/support concepts. Logistics data relate directly or indirectly to reliability, maintainability, ground support equipment, built-in test equipment, task analysis, skill level, skills, crew size, training requirements, technical data, and spares. The basic data systems for this technology are the Logistics Support Analysis Records (Military Standard 1388), Maintenance Data Collection System (Air Force Regulation 66-1), and Logistics Composite Model Technology (Air Force Regulation 25-5). The UDB is programmed for computer availability and a variety of data output modes is available to the user. The feasibility of this technology has been established. This entailed developing an initial definition and a concept of operation. The technology has been developed *and will be tested and evaluated later.*

Utilization: This technology and the resulting enhanced availability of logistics information will allow for a significantly increased consideration of logistics factors throughout the weapon system design process. A significant decrease in logistics costs for modern weapon systems should result. This effort is in support of a larger effort to develop a product performance feedback system. The UDB is concerned with a limited prototype which addresses aircraft only. The Product Performance Feedback System is to address missiles and ground-based electronics also, building on the UDB technology. The product performance feedback effort is also concerned with implementing the technology and interfacing the technology development effort with its future potential users.

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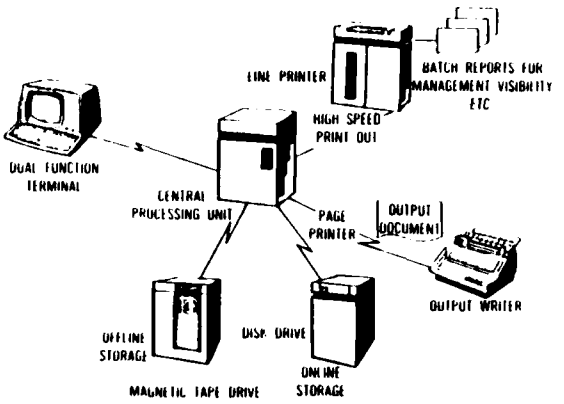
UDB OUTPUT SYSTEM



Title: Analysis to Improve Maintenance Environment

Description: Effective and efficient maintenance of Air Force systems and equipment is an extremely important factor in determining the reliability, effectiveness, cost, and operational safety of weapon systems. The safety of aircrew personnel obviously depends on effective maintenance.

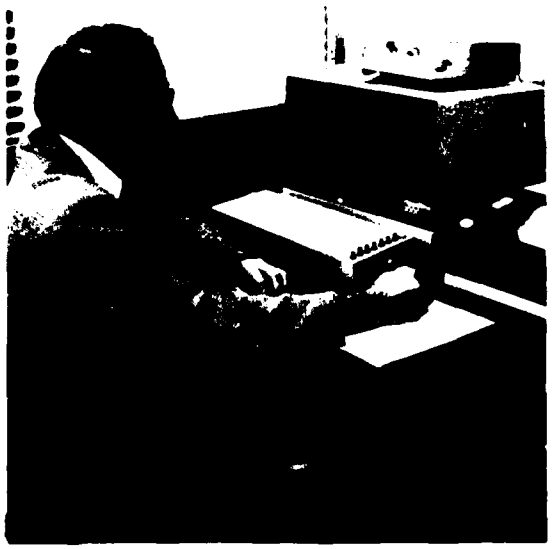
A comprehensive, integrated long-range program is to be developed that will identify the factors that impact the performance of individuals, groups, and organizations performing aircraft and missile maintenance. The program will identify the human-related research areas that are most likely to result in the improvement of the performance of maintenance personnel.

The approach of the study is to examine the problem at all levels of maintenance. This is being done by conducting open-ended one-on-one interviews with all levels of maintenance personnel. The scope of the interviews will range from senior personnel through the working level technician. All the Major Commands, including Overseas Forces and the Reserve Force, will be represented. Interviews have been conducted in all of the stateside commands. Interviews were recently concluded with the

United States Air Forces in Europe and the Pacific Air Forces, including the Command Headquarters. Future interviews will be conducted at Major Command Headquarters, and at Air Force Reserve, Air National Guard, and Missile Organizations. In selecting data collection sites, consideration is given to such things as geographical location, climatic conditions, weapon system, and mission rate. Improvements in both wartime and peacetime maintenance performance are the desired results of this project.

The research is an application of an integrated approach to maintenance research, with special attention to the role of the human in effective and efficient maintenance. It will provide the basis for an integrated research and development program that will identify and quantify the factors that influence maintenance performance.

Utilization: A categorization/coding scheme has been developed from the content of the data collected thus far. As data are collected, they are coded and stored in a computer data base. A software program has been developed which allows great flexibility in manipulating and analyzing the stored data. Data analysis is now underway and will continue throughout the project. The analysis of the data collected will identify opportunities for application of existing technology to improve maintenance. Problems that require research will be identified, and the means for studying them will be proposed. The research plan resulting from this effort will identify future maintenance and logistics research and development needs. The application of existing technologies and the technological advances developed through research programs conducted as a result of this study will significantly improve Air Force maintenance operations.



Staff Scientist Reviewing Data Collected for the Analysis to Improve Maintenance Environment Study

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Title: Computer-Based Maintenance Aids for Technicians

Description: A prototype computer-based maintenance aids system is to be developed and evaluated. The system will store, retrieve, and present information for use by technicians who perform maintenance tasks at the depot level. The goal is to develop a system that is easy to use, is liked by technicians, and provides the technician with all of the information needed for the task. Human factors requirements are being emphasized in the system design. The system will present instructions at three levels of detail. This feature will provide the technician with instructions which are appropriate for his level of experience (very detailed step-by-step procedures with illustrations for inexperienced technicians, less detailed instructions for more experienced technicians). A computer graphics terminal will be used to present the technical data. The presentation of data on the prototype system will be controlled by a mini-computer. Software for the system will be adapted from the Advanced Instructional System software. Technical data for a test bed system will be developed and placed on the prototype system. These data will be used to evaluate the system. The system will be evaluated by measuring the effectiveness of technicians using the prototype system to perform maintenance on the test bed system. In a follow-on effort, prototype systems will be developed which are designed for use at the intermediate and organizational levels of maintenance.

Technician Using Computer Based Maintenance Aids System to Retrieve Maintenance Instructions

Utilization: The technology developed in this project will provide the basis for development of an effective technical data presentation system for the Automated Technical Order System (ATOS) at the Air Force Logistics Command. The technology will ensure that the ATOS data presentation system is easy to use and meets the needs of the maintenance technician for technical data. The operational use of a computer-based maintenance aids system will significantly reduce the costs of maintaining the Air Force technical order system by reducing printing costs and reducing the cost of updating technical orders.

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Title: Maintenance Demand Metrics-Phase III

Description: This is a continuation of the work to develop better predictors of demand rate for aircraft maintenance. The earlier effort developed regression equations which predict maintenance demand rates for aircraft subsystems as a function of environment, design characteristics, and operations requirements. The new effort will develop equations for each type of aircraft (i.e., tactical, bomber, and trainer), as well as specific to individual subsystems (e.g., bombing-navigation, landing gear, engines). The new work also will investigate the causal relationship underlying the regression equations. Data from 61 bases have been collected during Phase II.

Utilization: The new regression equations that are specific to type of aircraft as well as specific to type of subsystem will provide much more precise and accurate predictors of maintenance demand rates, for both the Air Force Logistics Composite Model (LCOM) teams and Aerospace Industries involved in new aircraft developments. This, in turn, will lead to more precise estimations of the support resource requirements. To the extent that causal relationships can be established for individual regression equations, corrective or preventive actions could be taken to reduce the demand for equipment maintenance. For example, if equipment characteristics contained within a regression equation are logically related to the subsystem, then it would seem sensible that changes in those characteristics would effect the maintenance demand rates. However, experimental testing would be required to confirm such logical relationships.

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Title: Evaluation of Technology for Acquiring Supportable Systems

Description: This is the final phase of a four-part effort to develop and field a coordinated human resources technology to support weapon system development. The coordinated technology consists of an integrated assembly of models, techniques, a consolidated data base, and a methodology useful for their combined and timely application throughout the weapons system acquisition process. Its purpose is to greatly facilitate and systematize the evaluation of resource requirements and cost throughout weapon system development, and to increase the feasibility of implementing those considerations as guidelines for design and system support planning. The main thrusts of phase four are (a) to evaluate and

complete the preparation of the integrated technology for operational use, and (b) to develop materials sufficient to aid in transitioning the technology from the Laboratory to the user. To date, the technology evaluation has been completed. The evaluation included a thorough review of all previously developed documentation, exercise of all computer programs and models, and an attempt to apply portions of the technology to an avionics support subsystem in development. Results indicate that the methodology is basically sound and usable. The procedures and models can provide a significant amount of information to aid decision makers in evaluating system alternatives and the impacts each have on cost, readiness, and human resource requirements. The ongoing effort is to complete the technical refinements to selected components of the technology, and to prepare user-oriented documentation.

Utilization: The overall impact of this technology package is life cycle cost avoidance through a more effective application of analytical techniques and a more coordinated sequencing of design development activities which relate to logistics support planning. Use of the coordinated technology in weapon system development programs will significantly increase Air Force capability to more fully consider design, operation, and life cycle ownership consequences as joint tradeoffs. A key benefit of the technology is the flexibility of its components. The methodology is sufficient by itself but can be extended to interface with other tools, techniques, and analysis approaches. It can exist as a stand-alone methodology which also supplement and complement the logistics support analysis process.

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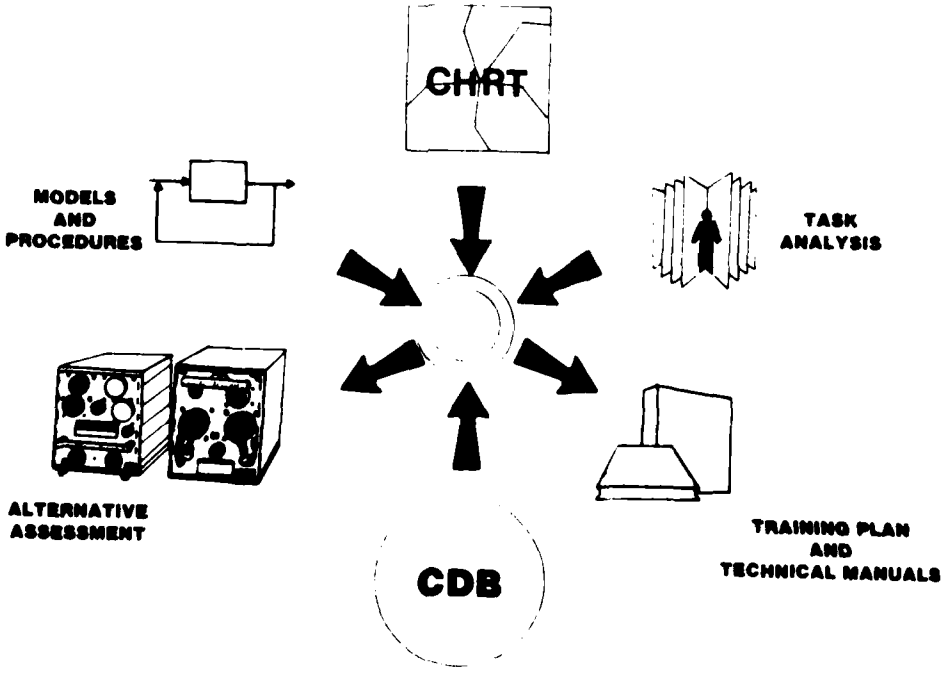
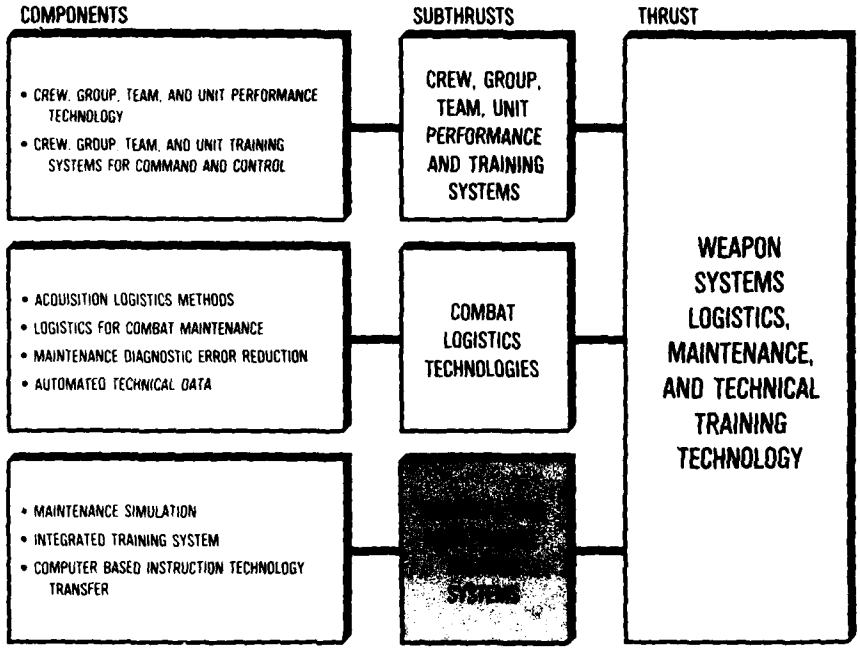


Main Features of the Coordinated Human Resources Technology (CHRT) Methodology

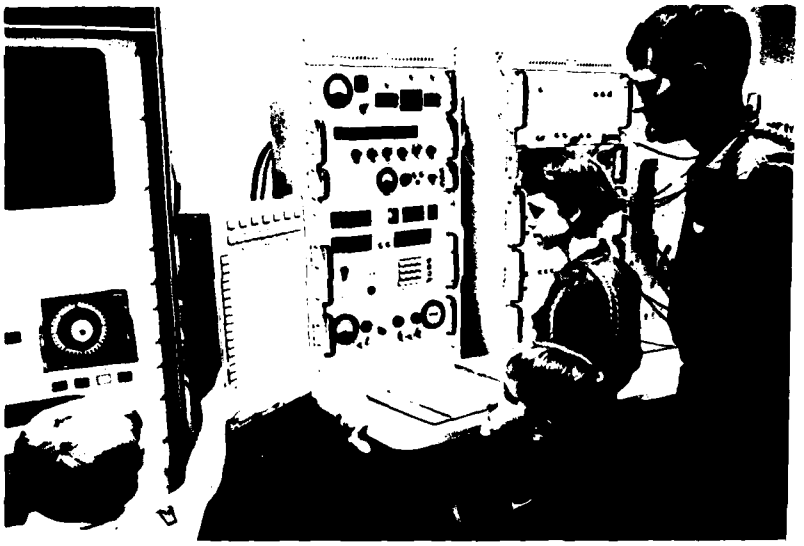


Title: Flat-Panel Simulator for Comparison with a Three-Dimensional Simulator

Description: A flat-panel simulation was developed for the 6883 Converter/Flight Controls Automatic Test Station associated with the intermediate level maintenance of the F-111D aircraft. The simulator is for use in studies of the impact of physical fidelity inherent in actual equipment, three-dimensional simulators, flat-panel simulators, and graphic simulations on technical training and subsequent job performance. The contractor designed and fabricated a two-dimensional simulator that provides comparable training capability to the three-dimensional simulator previously developed. To maximize comparisons between the two simulators, parameters were contrasted insofar as practical. Contrasted areas include (a) physical fidelity, (b) minicomputer versus microprocessor control, (c) FORTRAN programming versus an ATLAS-like language, (d) degree of integration with theory portions of the course, (e) environmental requirements, (f) indigenous versus adjunctive knowledge of results, (g) relative emphasis on procedures and system logic or troubleshooting, (h) degree of performance monitoring, and (i) efficacy of stand-alone part-task trainers associated with the simulator.

Utilization: This effort resulted in a two-dimensional simulator and the associated documentation required for maintenance and modification of the simulator. The simulator will be utilized in future studies intended to improve the cost- and combat-effectiveness of trainers. One area of particular interest is the impact of lowered fidelity on the time required to develop and implement new training programs. Another area of interest is the impact of varying maintenance concepts on life-cycle costs.

Benefits: This device will be evaluated under a separate research effort. The results of this study of the impact of physical fidelity on cost and training effectiveness will then be provided to future designers of training equipment.



Flat Panel Simulation of F-111D 6883 Flight Converter Test Station

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Title: Maintenance Training Analysis and Functional Specification Development for a Minuteman Maintenance Training Simulator

Description: This is one of a series of related research studies performed as part of the Simulation for Maintenance Training project. The purpose is to develop, demonstrate, and evaluate selected applications of simulation for Air Force maintenance training and to build baseline data about techniques, procedures, and principles necessary for broad applications of simulation in maintenance training.

The previous studies demonstrated the potential of simulation for avionics intermediate level (I-level) maintenance training on aircraft-related systems. The purpose of the Minuteman Missile Study was to determine whether the findings of previous studies were extendable to operations level (0-level), electro-mechanical maintenance tasks in the missile field. The specific objectives were to quantify the potential benefits of maintenance simulation under these different circumstances and to develop a functional specification for a simulator which appeared most beneficial from a training/cost standpoint. A secondary objective was to use and further evaluate handbooks containing Instructional System Development (ISD) guidelines developed in an earlier project.

Phase I consisted of an analysis of existing training documentation for five Air Force Specialties involved in organizational level maintenance for Minuteman. Each specialty area was analyzed to determine where advanced technology, low cost maintenance simulators could be used to enhance unit training. On the basis of a detailed training and cost benefits analysis, the Site Security System Maintenance area was selected as the most appropriate for a training simulator.

Phase II consisted of the development of a functional specification for the selected Site Security System simulator using a procedural ISD handbook. Cost benefits analyses indicate that the effective use of the training system described in the specification could amortize in less than four years and has the potential for substantial cost savings in subsequent years.

Utilization: The results of this study indicate that there is a great potential for selected applications of maintenance simulation for 0-level missile maintenance training. A functional specification was developed for one such application - Site Security Maintenance Training. The training analysis and specification development phases served as vehicles to further validate previously developed handbooks on ISD procedures. The handbooks were found to be useful and suggestions for further improvements were made.

Benefits: A functional specification for Site Security Maintenance Training is available for Minuteman and can be used as a basis for subsequent procurement. Lessons learned in this effort may be useful to organizations involved in training for other missile systems, such as the MX.

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Title: Computer Dialog for Generation of Graphics Simulation Programs

Description: The Advanced Instructional System (AIS) is a prototype computer-based instructional system for the delivery and management of technical training. The attractiveness of computer-delivered instruction is enhanced by the use of graphics.

The dialog editor is a tool for interactively producing simulations of equipment and processes by creation and manipulation of graphic, text, and numeric objects. A subject matter expert trained in the use of the dialog program may produce interactive graphics simulations. The need for the author to directly program a computer is obviated by the heavy use of menus as prompts.

Utilization: The major use of the dialog program will be as a tool to support the Interactive Computer Graphics Simulation for I-Level Maintenance Trainer project. The dialog program is an enhancement to the existing AIS. Because of its dependency on the existing mix of hardware, software, and personnel, the program is not a portable product.

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TECHNICAL AND MAINTENANCE TRAINING — ON-GOING R&D

Title: Transportable AIS Software in Support of Technology Transfer

Description: The Advanced Instructional System (AIS) is a computer-based instructional system employing both computer-aided instruction and computer-managed instruction techniques with a capacity to train large groups of students in many different technical courses simultaneously. The design goal of the original AIS was to provide the Air Force with an advanced state-of-the-art computer-based instructional system which would serve as a test bed for conducting research and development in technical training issues. The hardware and software were configured at that time (early 1970's) to provide a system with maximum flexibility for supporting various areas of research and development. Experience has shown that some of these features may no longer be required and, in fact, may be eliminated from a purely operational version of the AIS. Research and development on the AIS has now progressed to the point where transfer to the operational community, i.e., Air Training Command, Tactical Air Command, Strategic Air Command, Military Airlift Command, etc., is desired. This effort will capture the significant investment that has been made in developing improved approaches to technical training.

Utilization: The objective of this effort is to make the training technology contained within the AIS

Adapting AIS Software to a Minicomputer

transportable. The principal purpose of this effort is to develop and demonstrate that one or more of the functional components of the AIS can reside and execute on small, affordable minicomputers. This will be accomplished by converting the existing AIS software to a standard high-order language which is widely available and supported on a number of minicomputers. The Department of Defense standard programming language Ada will be the specification language for the new software. If a suitable compiler is available, Ada will be the implementation language; otherwise Pascal will be used for the implementation. The development machine for the rehosting effort is a Digital Equipment Corporation VAX 11/780. The final product will utilize the development machine as the center of a star-shaped distributed computing network, with small minicomputers at each node servicing local groups of terminals. Links to each node will be established either through electrical communication lines or by exchange of hard storage media, such as disk or tape. Each functional component of the rehosted AIS will be available at each node. Each functional component of the rehosted AIS will reside on and be independently executable at each node. However, each node may not (depending on size of the computer, amount of storage available, and number of terminals connected) necessarily be able to execute all functional components of the rehosted AIS concurrently for all users at that node. The transportable AIS software can be used on a wide variety of hardware types to support individual projects or programs. If a user wanted only limited capabilities, portions of the system could be downloaded to very small hardware configurations. Because of its forward-looking resource scheduling capability, it could be used at bases where flight scheduling is a concern. Overall, it will be applicable to almost any training application.

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Title: Development of Testing and Instructional System Based on Microterminal and Microfiche Devices

Description: Prior research (reported in technical report AFHRL-TR-78-40) showed that the use of a small, inexpensive stand-alone terminal could be used to support testing in a computer-based system such as the Advanced Instructional System. The advantage of such a terminal is both instructional and economic. Results to date indicate that the process of answering test questions using the microterminal rather than computer-readable test forms affects the speed and accuracy with which students complete a test. Over an appropriate amortization period, such as 5 years, a capital investment in low-cost terminals would effect a savings over the recurring material costs associated with test forms. The present research effort is directed toward extending the knowledge base about a new technology such as the microterminal. A basic design assumption for the microterminal was that computing power be focused on student responding rather than on the presentation of information. It was felt that for most instructional purposes, the presentation of information could be as effectively handled by more traditional means of off-line presentations, such as programmed texts. However, the powerful instructional technique of branching becomes difficult to implement with printed materials. For this reason, the two-dimensional accessibility feature of microfiche is seen as desirable. Additionally, in a large computer-based instructional system, the production of microfiche materials is a very direct process through the use of Computer Output Microfiche (COM). COM production techniques were studied under a just completed effort, and the findings showed that COM was a feasible training technology. Conduct of the COM research was performed in the Weapons Mechanic Course at the Lowry Technical Training Center. The essence of the present effort is to combine the computer technology of the microterminal, which focuses on the control of student responding, and microfiche technology, which provides ready access to diverse frame of instructional information. A hardware interface allows the microterminal to "know" which microfiche frame is being used by the student. In turn, the microterminal contains the instructional information on the microfiche. A low-cost form of computer-assisted test has been developed using this technology. Software packages have been developed which will allow the microfiche/microterminal to be linked with a low cost microcomputer. The microcomputer handles test generation and record keeping activities for a testing center where computer-based instruction are not available. AFHRL-TR-80-17, Microterminal/Microfiche System for Computer-Based Instruction: Hardware and Software Development, is an interim report developed under this effort.

Utilization: Although the Microterminal/Microfiche System is only at the prototype stage, it is seen that fully operational units could be used in both resident and field training courses, for support of Extension Course Institute materials, and in large-scale testing operations, such as enlistment testing. The potential benefits of this technology are the reduction of computer form costs for computer-based instruction, provision of interactive instruction for either computer or manually managed individualized courses, reduction in instructional materials costs through utilization of micrographics technology, and increased testing capabilities, including test security.

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Title: Forward Looking Resource Scheduling System

Description: Because of the increasing complexity of the modern day, flight-training syllabus, an inordinate amount of time is being spent in developing daily flight schedules. The objective of this phase of this project (a McDonnell Douglas Corporation (MDC) Independent Research and Development (IR&D) effort) is to reduce daily flight-scheduling manhours by 50% by developing and demonstrating the feasibility of computer-assisted daily flight scheduling. The approach is to build the scheduling system around the existing data base and editor approach of the Air Force Advanced Instructional System. Utilizing students, instructor, course syllabus, and schedule data bases, the system will assist the scheduler by producing a basic schedule that is syllabus specific and conflict free. The scheduler will then fine tune the schedule through an online CRT. Likewise, to maintain currencies, student and instructor data bases will be updated by the operations officer at the end of each sortie. Responding to additional requirements identified during this phase, AFHRL proposes to enhance this forward looking resource scheduling, following the MDC IR&D effort, through the application of existing MIS technology to provide historical data collection and analysis, requirements forecasting, reports generation, and academic assistance capabilities.

Utilization: The current IR&D effort will result in a demonstrable daily flight scheduling capability. The feasibility demonstration will be conducted in one squadron of the Tactical Air Command (TAC) 479th Tactical Training Wing at Holloman AFB during November and December 1981. The end of the test coincides with the end of the MDC IR&D effort. Under a proposed joint TAC/AFHRL effort, the additional capabilities will be integrated into the system, a stand-alone version developed, and the technology transitioned to TAC for implementation in the five TAC Replacement Training Unit bases. Further exploratory and advanced development work is proposed to examine the potential applicability of this technology in the scheduling and management of TAC operational and combat theater operations.

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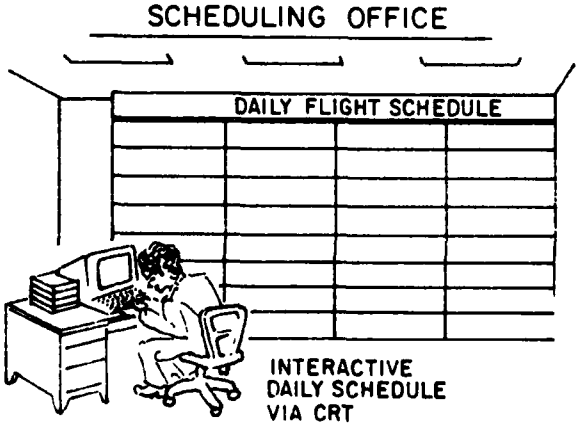

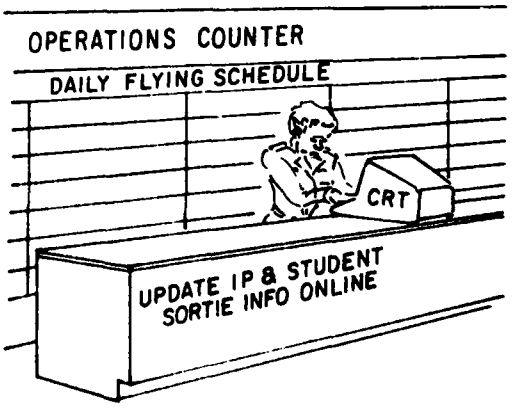

Title: Individualized Student Pre-Course Skill Training for CMI

Description: The question of the unrealized potential of non-conventional instruction (NCI) is being addressed elsewhere from the standpoint of instructor attitudes and performance. There is the realization, however, that many students lack those basic cognitive and coping skills and motivation which enable them to work efficiently at learning. This project is a first step toward identifying and overcoming individual difference characteristics related to deficient training performance. Within the context of the Advanced Instructional System at Lowry AFB, specialized skill training materials to improve student performance in computer managed instruction are being developed, implemented, and evaluated.

Utilization: Validated student skills modules will result from this project. Potential payoff is extremely high. In addition to reducing training time in the immediate course, the positive changes in student attitude and coping skills may transfer to other courses and generalize to other situations which call upon one's interpersonal skills, self concept, and motivation. Requests for these modules have come from both military and civilian education and training organizations.

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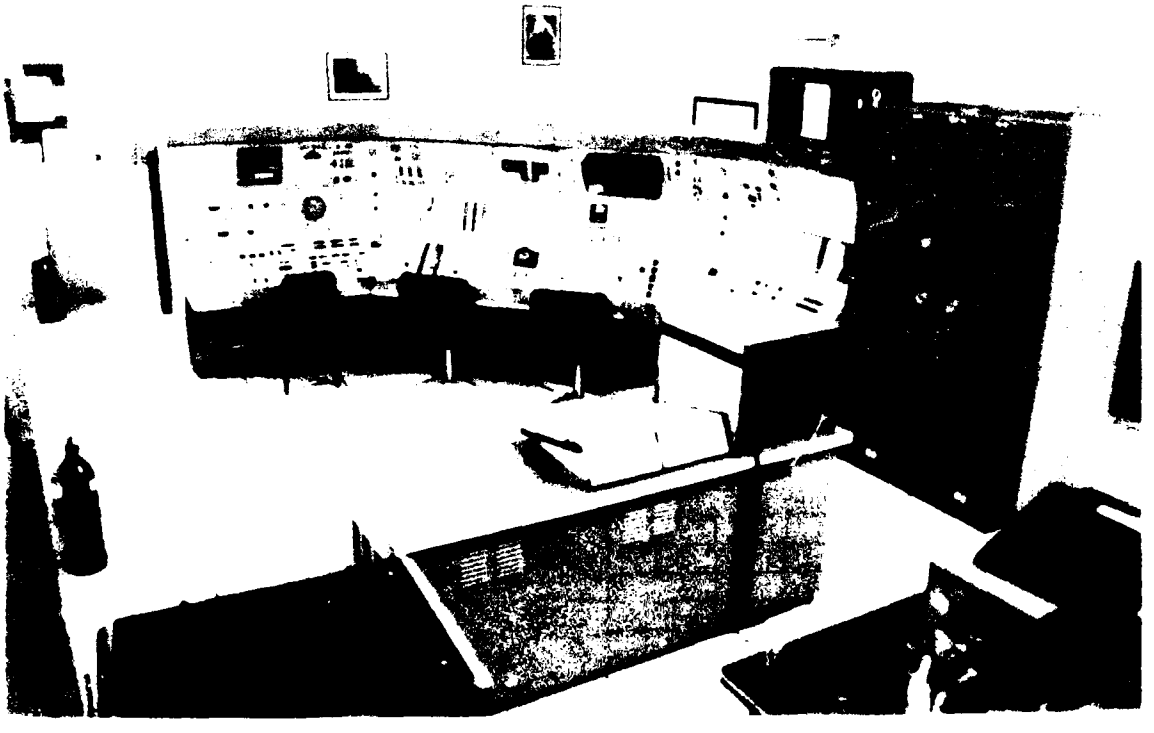
Title: Development of a Flight Simulator Troubleshooting Trainer

Description: Because of increasing aircrew training demands on flight simulator availability, military maintenance personnel, both in the Continental United States and overseas, have less of an opportunity to use flight simulators for maintenance training. To fill this ever-widening gap between maintenance training requirements and training capabilities, a prototype troubleshooting trainer is being developed. To be built to take advantage of state-of-the-art concepts in training



F-111 Simulator — Maintenance Personnel for this Simulator Will Begin Troubleshooting Experience Using the Flight Simulator Troubleshooting Trainer

equipment design and microprocessor technology, this trainer will provide technicians a substantially improved capability for the hands-on practice of troubleshooting many of the more frequently occurring malfunctions in the flight simulator. The technical approach adopted for development of this trainer consists of modeling the major subsystem components of a representative flight simulator, with emphasis on the functional and logic flow relationships of the components, and then constructing a wide range of simulated malfunctions for the technician to practice diagnosing and correcting. To further enhance the overall effectiveness of the trainer, additional instruction features, such as automated performance measurement and automated student feedback, are being incorporated in the device.

Utilization: The first application of the trainer is to be for the F-111 flight simulator, a relatively complex and mature flight simulator. If the approach embodied in the troubleshooting trainer is validated in this initial application, similar trainers could be developed for the full range of present and future flight simulators. Furthermore, the results of this effort may, eventually be generalized to other complex electronic systems that are similar to flight simulators in computer design or architecture when the opportunity for maintenance training is restricted.

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Title: Specification of an Ultrasonic Nondestructive Inspection Trainer

Description: Ultrasonic nondestructive inspection (NDI) technology is used widely for the investigation of the structural integrity of airframes, aircraft engines, and aircraft hardware components within both military and commercial aviation. Recent wide-scale performance testing using NDI has resulted in the formulation of serious allegations challenging the previously accepted ability of Air Force technicians in the field to find flaws in aircraft structures with the precision and reliability demanded by aircraft design engineers. As a result, the Air Force has identified the improvement of the opportunities for field practice of the ultrasonic NDI technique as being an urgent training requirement. Thus, the prime objective of this effort is to develop a detailed specification of a prototype trainer to be used to develop, measure, and sustain the operational proficiency of Air Force personnel to use the ultrasonic NDI technique. A secondary objective is to gather systematic information about the utility of two previously developed preliminary handbooks for the design of training equipment for maintenance personnel. The specification of the trainer will be accomplished through the implementation of the preliminary handbooks in two phases. In the first phase, the performance capabilities of the trainer will be defined, along with the behaviors to be sustained by the trainer. In the second phase, procedures outlined in the handbooks will be followed to determine the engineering/physical characteristics which the trainer must have in order to provide the functional characteristics.

Preparing Aircraft Part
for Nondestructive Inspection
Trainer

Utilization: The result of this effort will be a complete and detailed set of specifications for an ultrasonic NDI trainer which may be used by an equipment acquisition agency to acquire a prototype article. It is anticipated that acquisition of such a trainer will improve the reliability of ultrasonic NDIs within aircraft maintenance programs ultimately resulting in safer, less costly USAF ground and flight operations.

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Title: Comparative Evaluation of High and Low Fidelity 6883 Maintenance Simulators with Actual Equipment

Description: Despite the fact that simulators have been used for years, methodologically sound comparative studies of the instructional and cost effectiveness of simulators and actual equipment trainers are rare. For example, decision makers still lack reliable data on the following major research issues. Do simulators train students as effectively as or more or less effectively than actual equipment? What are the relative life-cycle costs of these devices? Are procedural types of tasks versus more difficult diagnostic types of tasks learned more effectively on simulators or actual equipment? Does three-dimensional (3D) or two-dimensional (2D) simulator technology assist students of lower ability to perform maintenance technician tasks as competently as higher ability students? Empirical answers are required if further simulator training is to produce task competent performers for the least cost!

To provide competent maintenance technicians to the field, expensive actual equipment is customarily employed for training. As a training device, actual equipment does not readily permit the controlled presentation of malfunctions representative of troubleshooting problems occurring frequently in operational settings. Less expensive real-time simulators do possess the capability for troubleshooting training which incorporates hands-on practice to increase troubleshooting skill on a sample of field-related maintenance problems. In addition to improved skills training, properly designed computer-based training simulators also have the potential to release more expensive actual equipment for operational readiness. To this end, objective data are required to determine the conditions and alternative simulation designs that result in job competent personnel for the least cost.

Utilization: The major objectives of the present study are to determine the comparative effectiveness of the (a) 6883 actual equipment trainer, (b) 3D simulator, (c) 2D simulator on dimensions of the following:

1. Task Training Effectiveness
2. Transfer of Training
3. Task Time
4. Life Cycle Costs
5. Attitudinal Acceptance
6. Field Performance

To accomplish these objectives, appropriate pre-course control measures of task related learner characteristics were developed and administered to all trainees during 1980-1981. Additionally, an independent sample of troubleshooting performance tests (TPT) representative of the types of task problems to be encountered in the field were administered to trainees after exposure to the simulator and to the actual equipment trainer training conditions. The TPT consisted of two major task performance categories: (a) procedures following and (b) manual troubleshooting. Transfer of training, time, and life-cycle cost data are currently being gathered to determine the relative effectiveness among the three training devices (actual equipment, 3D, and 2D simulators).

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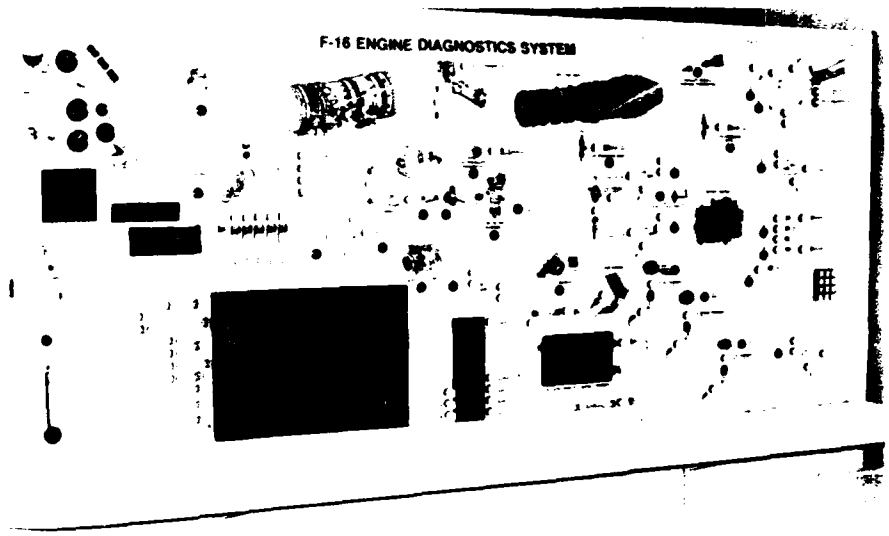
Performance Testing at F-111 6883 Test Station Simulator

F-16 Engine Diagnostics System Simulated Aircraft Maintenance Trainer (SAMT)



Title: Handbooks and Model Specifications for the Design and Development of Maintenance Simulators

Description: The objective of this study is to collect, analyze, and document data in order to develop a set of introductory handbooks for Instructional System Development (ISD) teams and Training System Acquisition managers involved in requirements development, design, and procurement of maintenance simulators. In addition, this effort requires the development of model functional specifications for the design of both organizational and intermediate level maintenance training simulators for utilization in resident school and field training environments. The six-step approach that will be used involves the collection, analysis, and documentation of information on the design, fabrication, and life-cycle maintenance of maintenance simulators. This research is being conducted by a contractor through a process of information requirements analysis to include development of techniques and decision aids based upon an analysis of maintenance task classifications, and development of guidelines/handbooks and model specifications which incorporate the preceding data collection and analysis. The ISD handbook provides procedures for (a) determining the most effective mix of training equipment (trainers primarily used by students to practice required task/part-task activities) for all types of maintenance training requirements, (b) prescribing the most appropriate design features and trainers, and (c) documenting maintenance simulator design so that it can be efficiently translated by a Systems Program Office (SPO) Training Device Acquisition Manager into a procurement specification with the aid of the SPO handbook.

These procedures will be implemented on electronic word and data processing equipment to explore the feasibility of the technique and to assess the impact on the time required in conducting ISD. A separate model specification/handbook will be developed for SPO personnel providing a fill-in-the-blank model specification and a handbook providing background and information relevant to the specific requirement. These entries will be number coordinated with the ISD model specification to assure that training requirements are fulfilled. This will also provide a basis for acceptance testing to verify that the device does in fact provide the required instruction. Partial results of this investigation are technical reports AFHRL-TR-79-23, and AFHRL-TR-80-23.

Utilization: It is anticipated that the resultant documents will be useful to ISD teams during the development of training specifications for maintenance simulators and to the SPO activities in the translation of these training requirements into equipment specifications in such a way that efficient and effective training devices will result.

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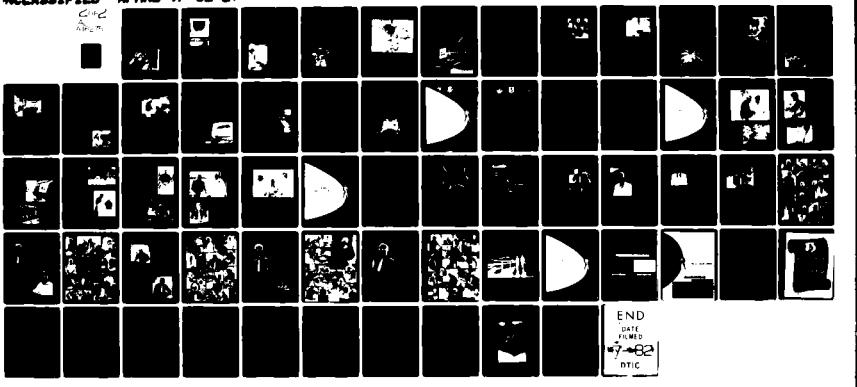

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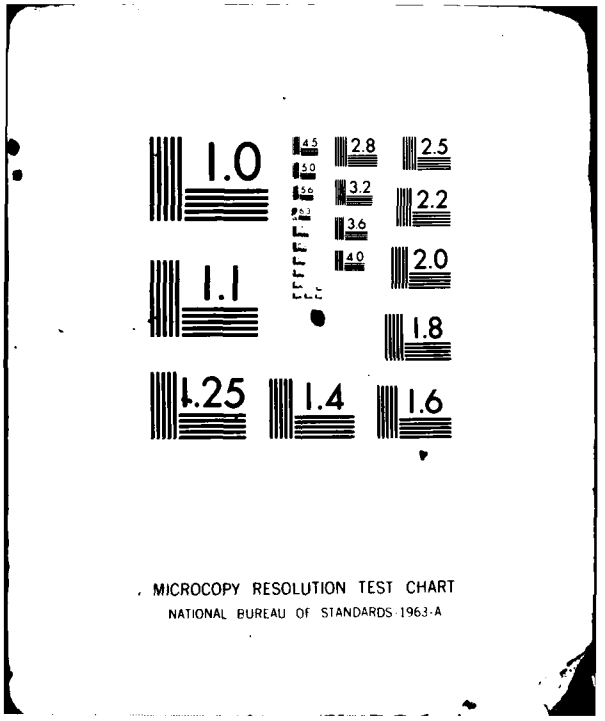
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Title: F-16 Simulated Aircraft Maintenance Trainer Evaluation

Description: To provide competent F-16 maintenance technicians to the field, the Air Force has recently used F-16 Simulated Aircraft Maintenance Trainers (SAMTs) rather than the typically more expensive actual equipment trainers. From the ten SAMTs developed, five were selected to represent flightline knowledges and skills required of maintenance technicians at the organizational skill level.

To determine the training effectiveness of these computer-based SAMTs, a study currently in progress requires (a) the development of objective, criterion-referenced job sample *performance tests* that incorporate critical knowledge and skills required of competent F-16 technicians, (b) the conduct of transfer-of-training studies between each of the SAMTs and subsequent flightline performance on actual F-16 aircraft to determine each SAMT's contribution to job competency, (c) life cycle costs of each SAMT compared to other training alternatives, and (d) recommendations to improve the design and implementation of instructional features, e.g., malfunction practice and student performance monitoring capabilities.

Utilization: Previous research has demonstrated some simulators are less expensive by a factor of two than actual equipment. Determining whether specific F-16 SAMTs are also capable of producing competent F-16 maintenance technicians at less cost than other training alternatives is the reason for this study.

To assist decision making, weapon acquisition and training managers in the F-16 System Program Office also need empirical data to determine (a) the kinds and range of maintenance tasks for which SAMT type devices are instructionally cost effective, (b) how representative and effective are the current simulated malfunction practice problems of the real flightline maintenance problems, and (c) how future simulators might be better designed and utilized to produce competent maintenance technicians. Preliminary data from this effort at Hill AFB is expected in February 1982.

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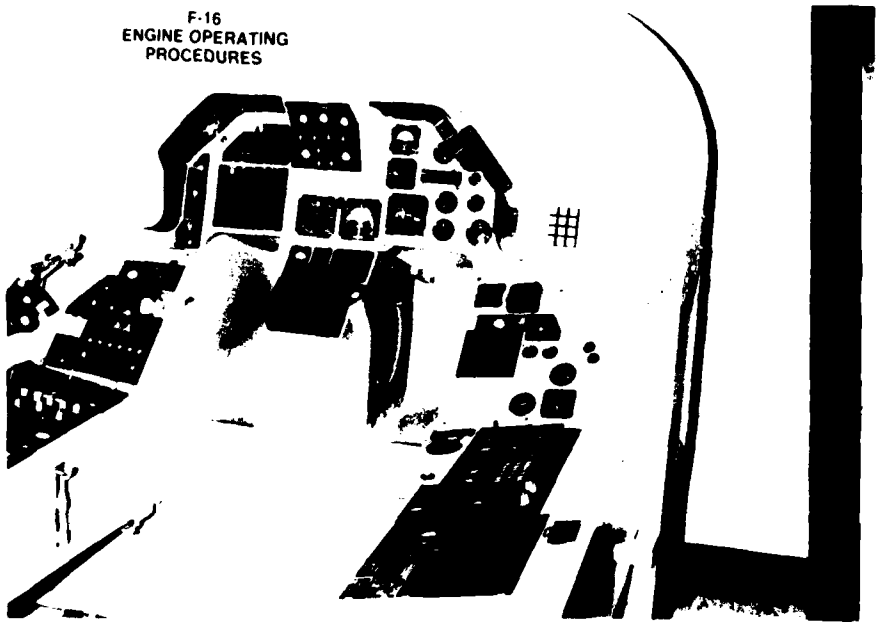
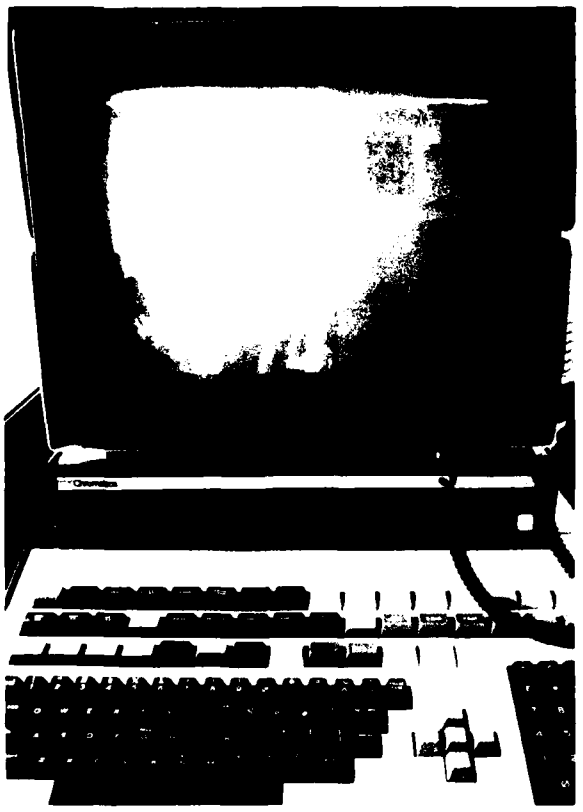


F-16 Engine Operating System Simulated Aircraft Maintenance Trainer (SAMT)



Typical Interactive Computer Graphics Display

Title: Interactive Computer Graphics Simulation for Intermediate Level Maintenance Trainer

Description: The potential for interactive computer graphics to provide part-task simulation capability for maintenance training is very high. The objectives of this effort are (a) to demonstrate the feasibility of using interactive graphics simulation as a cost-effective adjunct in a learning center consisting of an F-111 6883 Converter/Flight Controls Test Station and a three-dimensional simulation, (b) to investigate the training effectiveness of graphics simulation, (c) to develop a functional specification for a low-cost stand-alone interactive graphics learning environment, and (d) to explore such issues as color, fidelity, and resolution requirements, as well as embedded instructional strategies such as the use of advanced organizers. The test bed will be built on the existing research and development capabilities of the computer-based instructional system at Lowry AFB. These capabilities include data collection and analysis, computer-assisted instruction, and computer graphics generation. The basic hardware configuration will consist of a high resolution color graphics terminal and a video disc unit. The video disc unit is capable of representing a variety of adjunct media which could be used for the final design of a simulator: microfiche, video tape, slides, film, etc.

Utilisation: This research will produce a graphics simulation for 6883 test station tasks, specifications for a low-cost device targeted for the training environment and a research test bed for the resolution of issues associated with maintenance training graphics simulations. Furthermore, the test bed can be considered as a prototype system for establishing functional specifications for a variety of part-task training simulations. Such a system could be used by the Systems Program Office in determining least-cost simulations. Graphics simulations have been successfully employed in many equipment operator and maintenance training situations. This effort is extremely important in determining the correct match for a training task and its graphics level simulation. The results of this effort will be used to develop graphics level simulations for new weapons systems and equipment as well as for current systems.

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Title: Personnel Requirements for Non-Conventional Instruction

Description: This effort will investigate the role of instructional support personnel in non-conventional instruction (NCI), e.g., computer-based and instructor-managed instruction. Instructor-perceived problems and the range of instructor roles in NCI will be analyzed. Determinations will be made on possible roles for non-instructor personnel (aides, proctors, helpers, etc.) and on qualifications requisite to those roles in selected NCI settings. Criteria for selecting instructors for NCI, and for training those selected, will also be examined. In tracking this cluster of additional factors which impact instructor morale and performance, this effort supplements those which have dealt only with training in the NCI instructor problem.

Utilisation: The principal products of this effort will be an analysis of problems in NCI, demonstration of proposed personnel specifications, guidelines for improving instructor satisfaction and performance, validated instructor training, and guidelines for instructor selection and manning requirements. These products will obviously find application across the range of military technical training, as well as in the civilian education and training sector.

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Title: Effective Application of Computer-Assisted Instruction Within Different Instructional Settings

Description: The degree to which computer-assisted instruction (CAI) is effective varies substantially from one situation to another. This project will investigate the factors that create those variations in effectiveness, with the goal of establishing predictors of effectiveness of CAI applications. Once all such factors have been so ordered, they will be transformed into a decision matrix, which will ensure that all relevant factors can be weighed in CAI implementation decisions.

Utilization: The ultimate product of this effort will be a course managers handbook that will prescribe the appropriate level of CAI application and will identify the required resources. This handbook is expected to be used for training development decisions in all military technical training.

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Student Preparing to Take a Computer-Assisted Instruction (CAI) Lesson

Title: Computerized Adaptive Measurement of Achievement

Description: In training, achievement tests tapping several domains are typically administered at various points during a sequence of instruction. In such situations, information concerning an examinee's standing within a single domain at a particular time may come from a multitude of sources, including (a) performance on a test of that domain, (b) performance on a concurrent test of a related domain, and (c) performance on relevant domains at an earlier point in the instructional sequence. In previous work a procedure for simultaneously assessing an examinee's standing within each of a variety of domains was developed. In this work, further refinement of this procedure is being made as well as developing procedures for incorporating information from prior assessments. Related studies concerning how dimensions of achievement change over time are also being made. These studies have led to an examination of adaptive testing strategies which make use of this collateral information, as well as characterizing individual growth over an instructional interval. This is a basic research project funded jointly by the Army, Navy, and Air Force.

Utilization: This research holds promise for dramatically affecting the measurement of training outcomes in Air Force training. Testing and measurement in training typically requires a substantial proportion of the overall training requirement. The procedures derived from this research can increase the precision of the training measurement while markedly reducing the amount of time required to accomplish it.

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Title: Task Proficiency Evaluation in Air Force On-the-Job Training

Description: Task level proficiency evaluation procedures were to be developed and specifically oriented to On-the-Job Training (OJT) requirements for both maintenance and non-maintenance applications. These procedures were to provide operational guidelines and training quality-control techniques for new approaches to OJT evaluation. The OJT evaluation procedures that were developed have been described in handbooks for use by OJT administrators and by supervisors in ensuring that task proficiency evaluations are conducted properly.

Utilization: There is a recognized need for better operational procedures to determine whether individual trainees in OJT programs have attained necessary task proficiency. Current OJT task proficiency evaluation procedures are not as objective and standardized as they should be. This effort explored and tried out new alternatives for OJT task proficiency evaluation designed to meet the needs of OJT trainers, and supervisors in the field. The technique selected for futher development involves the application of critical incident analysis, and it has been outlined in handbooks for field implementation. The evaluation instrument developed by this procedure is task specific and will have four distinct levels of users. The first of these is the trainee. Because the evaluation instrument is task specific, it can be used by trainees as a self-test of their ability to perform the task. The second level of users is the assigned OJT trainer. The evaluation instrument allows the trainer to determine trainee proficiency in terms of observable activities. The third level of users is the supervisor. Because the evaluation instrument is task specific and identifies observable activities, the supervisor is able to use it as a proficiency measure for all personnel assigned to perform the task. The final level of users consists of those responsible for determining the current state of OJT training efforts and the qualification levels that result from those efforts. Users at this level would be OJT managers and administrators, quality controllers, standardization and evaluation personnel, and evaluators and inspectors at all levels.

OJT Instructor Explaining F-111 Gun System

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Title: Development of Specifications for an Integrated Training System for Air Force On-The-Job Training

Description: A system definition study of Air Force On-the-Job-Training (OJT) is to be conducted and a detailed functional specification prepared for design and development of a new integrated OJT evaluation and management system. This research will (a) identify requirements and functions at all levels of the OJT program and propose alternative approaches to meeting the requirements and performing OJT system functions, (b) define a primary prototype system, along with alternative systems, to meet the needs of the Air Force OJT program, and (c) by means of trade-off analyses, produce a detailed system development specification for a new OJT system prototype. This specification will subsequently be used to develop and demonstrate a computer-based integrated training system for the development, management, and quality control of OJT. This effort has been expanded to include a cost benefit analysis of the proposed system and a detailed site selection study.

Utilization: The present effort will culminate in functional and design specifications for a new OJT system. The following benefits are anticipated from the implementation of such a system: (a) better techniques for systematic definition of task training requirements and improved task evaluation procedures for OJT, (b) the use of state-of-the-art instructional technology in the OJT setting, (c) the introduction of computer-supported scheduling record-keeping, testing, and training management into OJT, and (d) the development of OJT cost and capacity models. In general, the system to be developed will be useful to managers at all levels of the OJT program, in both maintenance and non-maintenance areas, from base level up through the Air Staff.

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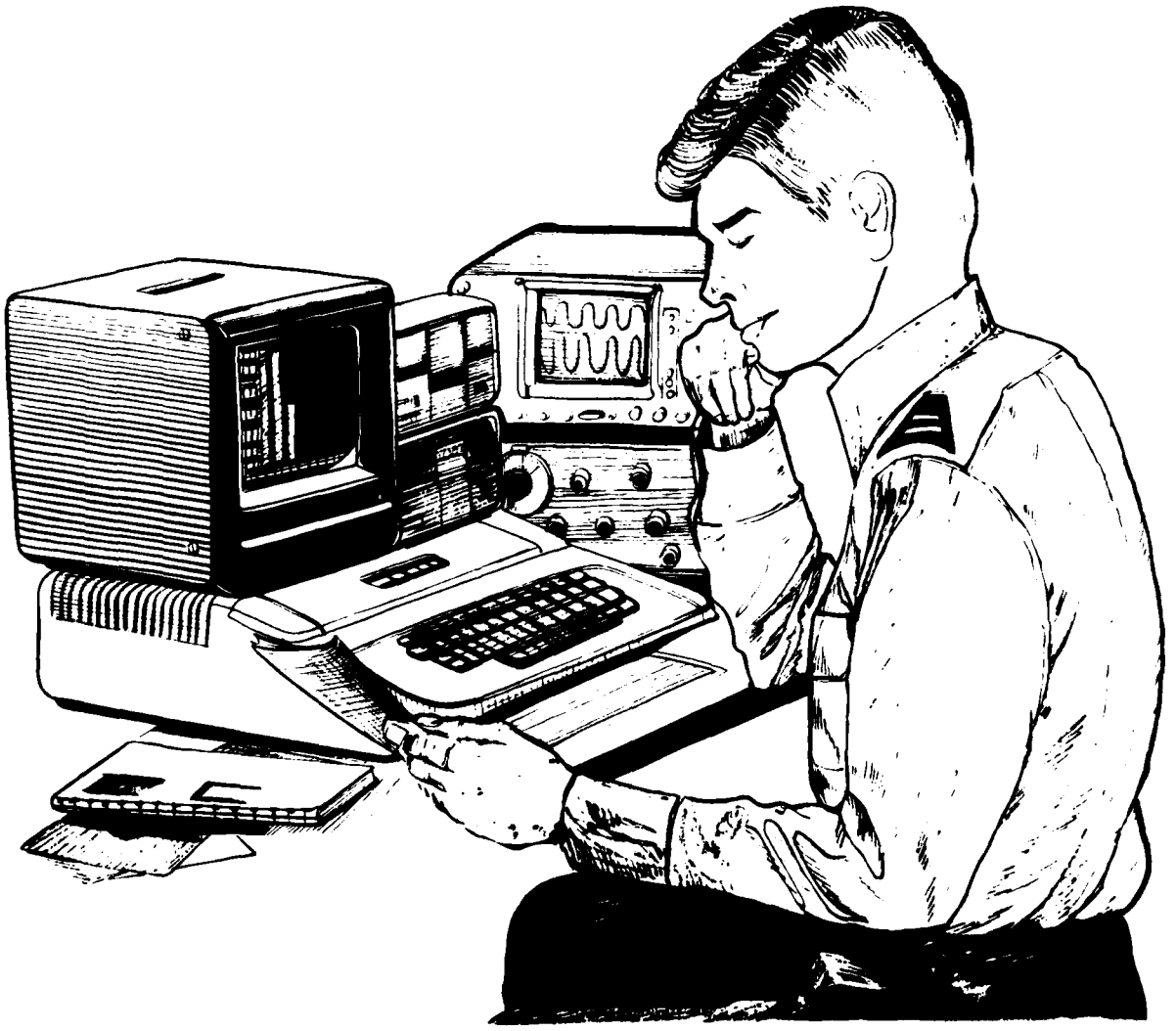
TECHNICAL SUPPORT



TECHNICAL SUPPORT

Title: Technical Support of Comprehensive Occupational Data Analysis Programs

Description: The Comprehensive Occupational Data Analysis Programs (CODAP) system was developed to provide an efficient and effective method of identifying and classifying jobs in a rapidly changing Air Force environment. The Technical Services Division develops, maintains, documents, and provides training in the use of the CODAP system by data processing personnel at the Laboratory and at the USAF Occupational Measurement Center. The basic input to the system is information provided by a large number of supervisors and job incumbents in the occupational area being studied. Because the data are collected at the worker-task level, CODAP provides a base of information that can be viewed in many ways and then used to address new and unanticipated management questions whenever they arise. The purpose of the technical programming support is to improve the operational efficiency of the programs and to develop interactive terminal routines which relieve most of the less critical activities associated with setting up computer runs.

Utilization: In addition to its operational usages in developing and validating the content of training programs, CODAP is being used to address questions about the requirements of jobs that will be integrated with the initial personnel selection process and eventually with the Person-Job Match model. Although developed by the Air Force, all branches of the Department of Defense, as well as the British, Canadian, and Australian Forces, have incorporated CODAP in their operational programs. Many state and county governments also are beginning to use CODAP to validate their traditional testing and selection procedures and, at the same time, to develop performance evaluation criteria. Educational institutions are using CODAP to modify the curricula of the vocational education programs.

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Title: General Purpose Program Development

Description: The Technical Services Division develops, maintains, documents, and provides training in the use of general purpose computer software. This software includes the broad categories of language translators, such as pre-compilers and interpreters; utility programs, such as sort/merge and report writers; general purpose applications programs, such as correlation/regression analysis and multi-dimensioned frequency distributions; and subroutine libraries containing common computing algorithms. The Technical Services Division is responsible for over 460 general purpose and statistical analysis programs and over 2,200 pages of users guides to those programs. Benefits to the Laboratory derived from the development of general purpose programs include a reduction in the number of unique occurrences of a computing algorithm and thus a decrease in the opportunity for error; an increase in individual programmer productivity by reducing the number of special purpose programs to be written and audited; a standardization of products which reduces analysis time by the researcher; and a concentration of program maintenance and enhancement activities into a group specialized in the production of efficient computer software.

Utilization: General purpose software supports virtually all Univac 1100/81 data processing activities related to the AFHRL research programs, as well as the computational support to other agencies, such as the Air Force Manpower and Personnel Center and the USAF Occupational Measurement Center. One such program, PILOT, was designed as a high-level, utility programming language specifically for the development of interactive programs with complete control of all Univac 1100/81 facilities and file types. PILOT was used to create three special interactive terminal systems for use by noncomputer-oriented personnel at AFHRL. These are the Tracking Research Utilization system used by the Applications and Liaison Office; the Risk Information System for Cost Analysis model for the Analysis and Evaluation Office; and the operational Air Force Officer Qualifying Test scoring system operated by the Air Force Manpower and Personnel Center staff located at AFHRL.

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Title: Follow-Up on AFROTC Graduates with Scores of 20 and Below on the Officer Quality Composite of the AFOQT

Description: In the fall of 1971, the Air Force Reserve Officers Training Corps (AFROTC) was authorized to begin enrolling applicants for the advanced AFROTC program without regard to the individual's Officer Quality Composite (OQC) score. Prior to this approval, cadets were required to score 25 or higher on the OQC for admission to the program. After approval, applicants were selected by use of "The Multiple Factor Selection System" (MFSS). This system involves a "whole person" concept in which all available information about the applicant is considered, along with the OQC score which, although still a factor, is no longer a single eliminating element. Comparisons of 320 AFROTC graduates commissioned in FY74 under the MFSS and a comparative sample of 960 non-MFSS AFROTC graduates commissioned in FY74 have been made each fiscal year from 1976 through 1980 to study the long-term similarities/differences in undergraduate pilot training, undergraduate navigator training, technical training, officer effectiveness report ratings, and continuation in the Air Force.

Utilization: The results of this long-term effort will be used by AFROTC to assess the impact of MFSS on the active duty force and to aid AFROTC to determine acceptable performance levels in deciding whether to continue or modify present enrollment requirements.

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Title: Officer Effectiveness Report System

Description: Officers are normally given Officer Effectiveness Report (OER) evaluations once a year. The evaluations are used as (a) a tool in determining the individuals best qualified for promotion, (b) a tool for making assignments, (c) a counseling device, and (d) a general personnel management tool. In addition, these reports aid in the monitoring of the rating trends. The automated OER report system uses the OER records, which have been transcribed to magnetic tape, to produce summary reports on a quarterly and yearly basis for grades of lieutenant through colonel, separately. The reports aid assignment managers, career monitors, personnel managers, and OER monitors.

Computer Data Output Analyses

Utilization: The OER detail and summary reports have allowed Air Force managers, policy makers, major commanders, and separate operating agencies to track the progress of the OER and to identify trends, problems, and areas needing emphasis. In addition, the selection board secretariat uses the statistics in their pre-promotion board preparations. The data have been used in numerous briefings presented throughout the Air Force at all levels. On several occasions, information extracted from the reports has been briefed and discussed with Corona Conference audiences comprised of the Chief of Staff and major commanders. The system contains and reports information not available in any other automated personnel data system. The Air Force is in a better position to monitor the OER system as a result of the summary reports developed by AFHRL.

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Title: File Item Data Organizer

File Item Data Organizer (FIDO)
System Maintenance and Update

Description: The File Item Data Organizer (FIDO) data base containing selected data elements from Air Force Manual 300-4 was designed, developed, documented, and is being kept current by the Technical Services Division. FIDO evolved from the need of research efforts involving present and longitudinal sample selection where codes contained in the AFHRL unique data base had to be identified and interpreted by research scientists. A major FIDO application is the preparation of file edits. In such an application, a microfiche report is prepared, containing both the frequency and English language meaning for each code value within each data element of a file. Use of "on the shelf" file edits can effectively direct the research planner's attention to potential problem areas in construction of working samples from master files. FIDO also contains an automated inquiry/retrieval system vital for the establishment of data bases for personnel research projects and probe analysis to determine the feasibility of proposed major research efforts involving data bases. FIDO is on-line on the Univac 1100/81 computer system at AFHRL. It consists of 688 Air Force and DOD defined data elements used in automated Air Force Personnel Data Systems; these elements include security classification, grade, Air Force specialty code, and major academic field. The update procedures now in use are to be improved so they will provide more accurate and timely data. Also, procedures are to be developed to get this information directly from the Air Force Data Systems Design Center data base; the update procedures are now supplied to AFHRL monthly by magnetic tape.

Utilization: FIDO directly supports virtually all facets of personnel and manpower research conducted by AFHRL. Many research efforts involve longitudinal studies of specific samples cutting across many different data files and code values over varied time periods. Automated availability of Air Force and DOD defined data elements, as well as other nonstandard data elements, with their data items and meanings across time, when combined with heavy usage by programmers/analysts, represents a sizeable savings in work hours. These hours would otherwise be spent in researching hundreds of manuals and/or microfiche by hand in order to find the needed code properly identified for a given historical time period. As FIDO is implemented, scientists may on retrieval specify all code values in effect dating back to the establishment of a given data element or may specify inclusive dates and get only those codes in effect during the interval in question. The data can be displayed on a remote interactive terminal, or a hard copy may be requested showing title, data name, definition/explanation, code values, effective dates, and explanation of code values. The Laboratory staff estimates the system is used approximately 4,000 times per year. The times accessed represent the number of files for which FIDO definitions are obtained. On a large file, such as that for the Uniform Officer Record, distributions can be obtained for 1,954 data elements. A conservative estimate is that an average of 50 data elements are researched each time the FIDO system is accessed, resulting in a total of 200,000 data elements per year.

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Title: Human Resources Research Data Base

Description: A series of data bases containing information on personnel and training systems has been developed and updated with FY 81 data. Software has been implemented to process, organize, and display selected information from a single data base and to consolidate information on a common subgroup from two or more data bases. Procedures are established to receive automated personnel and training data generated in standard and command-unique data systems separately on officers and enlisted personnel which reflect personal characteristics at time of entry, performance outcomes during flying or technical training, career status at periodic intervals and information related to reenlistment or separation. Special files will be created to meet long-term study requirements and longitudinal files will be constructed to facilitate studies in career development. File management and information retrieval procedures have been developed and are maintained under Microform System 4B-73.

The data bases include records on all active duty Air Force enlisted and officer personnel at 6-month intervals and on Air Force Reserve and National Guard personnel. Also included are records of graduates from basic military training, technical training, and flying training programs and from the Officer Training School and Reserve Officers Training Corps commissioning programs. Other records reflect separation and losses from active duty. Special purpose longitudinal files derived from these data bases significantly reduce data processing requirements in many personnel and training research studies.

Utilization: The data bases represent a low-cost means of acquiring and maintaining information used in the development and validation of personnel selection and classification instruments, development of assignment procedures, derivation and revalidation of promotion systems, and special purpose analyses to determine the long range impact of specific personnel and training polices. The availability of these data makes it possible to carry out studies on numerous aspects of the personnel and training systems that would otherwise be infeasible.

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Master Research Data File Development

Title: Technical Training Graduation/Elimination Rates

Description: An analysis of technical training graduation or elimination rates (a) provides personnel managers with data to track elimination rates of enlisted personnel from basic resident technical training courses, (b) provides information on the characteristics of successful and unsuccessful students in basic resident technical training courses with regard to mental ability, aptitude, educational level, race and sex, and (c) appraises the effects of the 4-year, 4-year guaranteed, 6-year and 6-year guaranteed enlistment options on success rates in basic resident technical training courses. Summary reports are prepared quarterly for Air Force enlisted personnel who terminate technical training in each quarter of the fiscal year. Frequency counts and percentages are reported for each reason for termination of training, such as graduation, academic elimination, and medical elimination. Frequency counts and percentages are also reported for average Mechanical, Administrative, General, Electronics and Armed Forces Qualification Test scores for each basic resident technical training course and selected special courses. All of these frequency counts and percentages are reported for each individual by race, sex, race/sex combined, 4-year or 6-year enlistments, academic education level, and mental category.

Utilization: The reports are being used to focus on total attrition from technical training courses with special emphasis on the high-cost electronics courses that require a minimum score of 80 for admission. The reports are used also for briefings at higher echelons and for updating trends tables. Headquarters Air Force, Air Force Manpower and Personnel Center, Headquarters Air Training Command and the Recruiting Service also use these reports.

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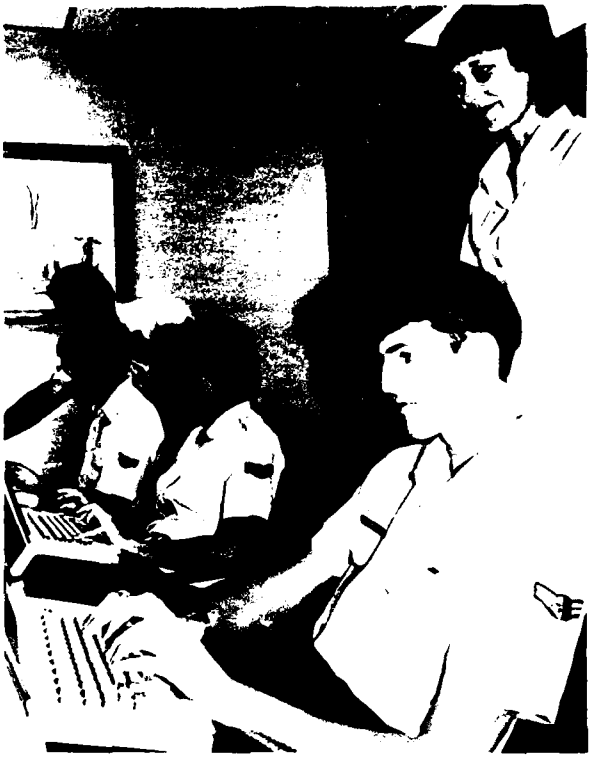
Title: Historical Data Base of Enlisted Personnel by Cohort Year Group

Description: The Cohort Data Base supports loss/reenlistment/extension analyses requirements/trends by fiscal year of accession. This data base has been developed covering accessions and associated loss/reenlistment/extension transactions for a 10-year period and is current through the first half of FY81. Statistical tables, which are prepared semiannually, using this data base reflect (a) percentage of total lost (within each type of loss category), (b) percentage of loss from accessed population at the beginning of a year to cover a 10-year period, (c) cumulative percentage of loss, (d) percentage of those lost in Basic Military Training (BMT) by type of loss category, (e) percentage of those lost subsequent to BMT by type of loss category, (f) total percentage of extending population, (g) percentage of beginning population who have extended and are on extension, (h) percentage reenlisting, (i) percentage reenlisting with/without bonus, (j) percentage reenlisting with less/more than 90 days to expiration of term of service, and (k) percentage of losses eligible/not eligible to reenlist. Statistical summary tables to provide quick reference to the number of individuals accessed in each fiscal year also show the



Data Base Maintenance

(a) number lost, (b) loss rate, (c) retention rate, (d) continuation rate, (e) number reenlisted, and (f) reenlistment rate. These counts and percentages are reported for each of the 10 fiscal years covered by the report.

Utilization: These reports are used (a) to track enlisted retention by cohort year groups, (b) to relate enlisted retention/reenlistment losses to personnel program objectives, and (c) to analyze the retention/reenlistment/losses of cohort year groups by various demographic attributes, such as sex, race, academic education level, Armed Forces Qualification Test group category, term of enlistment, age at accession, number of dependents and marital status. These reports are used by Personnel Systems managers at Headquarters, Air Force, the Military Personnel System, and the Office of the Secretary of Defense.

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Cohort Data Base Design

Title: Air Force Personnel Survey Program

Description: The Technical Services Division provides optical scanning and computational support on the Univac 1100/81 computer system for Air Force personnel surveys approved by the Research and Measurement Division of the Air Force Manpower and Personnel Center. The data reduction and analyses of approximately 30 surveys per year are accomplished by using general purpose computer programs developed by the Technical Services Division. Pre-survey work includes sample selection and the preparation of self-adhering address labels. The Technical Services Division also provides on-site training for the Air Force Manpower and Personnel Center programmers who are responsible for processing survey data.

Utilization: Upon completion of each survey analysis, the raw data files are retained for use in Laboratory research programs. The survey products are used by Air Force managers at all levels. A special Department of Defense Engineer Survey conducted by the Joint Logistics Commanders of the Air Force, Army, and Navy was processed by the Technical Services Division.

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Title: Support to Other AFHRL Divisions

Description: The Computer Programming Branch of the Technical Services Division performs large-scale statistical services and data-processing support for Laboratory research programs. These services are performed in response to approved work requests initiated by all AFHRL divisions. In addition to the processing of work requests, the Quality Control Section of this branch reviews that processing to ensure complete and accurate results.

Utilization: During FY81, more than 250 work requests were completed by the Computer Programming Branch. At any one time, approximately 350 work requests are open for processing. The following examples of research projects illustrate the diversity of the work performed.

Technical Support

Scheduling Data Processing for Civilian Appraisal System

Occupational Research Data Base: Three data files were generated for the Occupational Research Data Base (ORDB) statistical display system. These files consisted of information extracted from Uniform Airman Record (UAR) and Airman Gains and Losses files. These data are extracted annually, summarized by duty Air Force Specialty Code, career ladder, and career field for first-term airmen, second-term airmen, career airmen, and total and annual input (calendar year). The 1978 ORDB data file was based on 495,089 UAR records of airmen who were active during 1978 and consisted of 3,141,807 statistical variable data records. The 1979 data file was based on 512,617 active 1979 UAR records and consists of approximately 3 million statistical data records.

Civilian Appraisal System: The Promotion Potential Appraisal System required the simultaneous analyses of policy capturing data for 23 job families for the civilian appraisal research team in the AFHRL Manpower and Personnel Division. The Computer Programming Branch organized a special team of programmers supervised by a senior programmer/analyst to develop specialized software and apply that newly developed software to the analyses of the 23 job families. This technique proved so successful that, after the project became fully operational, the team was reduced from four to two members and still was able to complete the 23 studies, plus two follow-up analyses, 8 weeks ahead of the original projected completion date.

Armed Services Vocational Aptitude Battery (ASVAB): The "Hierarchical Composition of Aptitude Indexes, ASVAB 6 and 7" study was processed for the AFHRL Manpower and Personnel Division. The purpose of this study was to compare aptitude indexes obtained by hierarchical grouping procedures, optimum weighting by least squares method of subtest scores, and conventional aptitude indexes derived from the percentile form.

Strength and Endurance: The "File Verification and Generation for Strength and Endurance Followup Surveys" was performed for the AFHRL Manpower and Personnel Division in collaboration with the Air Force Aerospace Medical Research Laboratory. The purpose of this study was to create analysis files from survey data gathered on eight enlisted specialties. The analysis files were subsequently used as input designed to assess the physical job requirements of strength and endurance related to particular specialties.

Reading Ability: The "AFRAT XA and XB Normative Analyses" study was performed for the AFHRL Manpower and Personnel Division. The purpose of this study was to analyze two experimental forms of an Air Force Reading Abilities Test (AFRAT XA and XB) which are to be used to develop a remedial reading program in the Air Force.

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Title: Support to Outside Agencies

Description: The Computer Programming Branch of the Technical Services Division performs statistical services and data processing support for approved agencies outside AFHRL. The Branch initiates the work requests on behalf of the outside customers. These work requests are then processed in the same manner as those for the AFHRL divisions.

Utilization: During FY81, over 25 studies were performed for outside agencies. The following items illustrate the range of these activities.

Air Force Accounting and Finance Center: Records on retirees being considered under the "Fulton CG Decision" were selected from the AFHRL Historical Data Base and provided to the Air Force Accounting and Finance Center (AFAFC). AFAFC has reported that the provided data have saved an estimated 10,000 man hours and an enormous amount of calendar time. Paying the affected retirees was both timely and efficient.

Transfer of Technology: During FY81, computer software developed by the Computer Programming Branch was shared with other agencies approved by the Air Force Systems Command. These agencies were the Maryland Center for Productivity at the University of Maryland; the Australian Department of Defense; the Los Angeles Unified School District; the Institute of Nuclear Power Operations; the City of Springfield, Missouri; and the United States Army.

Surveys and Testing: Optical scanning and data processing support for personnel surveys and special testing were performed in support of the University of Texas at Austin, the Joint Logistics Commanders, the Electronic Security Command, and the Federal Bureau of Investigation.

Officer Quality Composite: The "Equivalency of Officer Accessions FY77, 78 and 79" was performed for the Air Force Manpower and Personnel Center. The Officer Quality Composite of the Air Force Officer Qualifying Test was statistically compared between males and females for possible gender differences in assignment to 33 career fields open to both.

Reading Skills: The "Reading Skills and Requirements (Dec 80 UAR)" study was performed for the Air Force Extension Course Institute (ECI). Reading grade level for all enlisted personnel of skill level 5 and below on active duty as of December 1980 was computed using a conversion technique developed by AFHRL. ECI uses the reading skills and requirements reports in conducting its text quality control program. This report is essential when interpreting the relationship between reading grade level of ECI course materials and the reading skills and requirements of the student body.

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Special Studies are Performed in Response to Requests from Outside Agencies

The Technical Services Division of AFHRL maintains a general purpose Univac 1100/81 (U1100/81) computer system to support research and development programs. Programs include extensive personnel research at AFHRL, medical research at the School of Aerospace Medicine, both headquartered at Brooks AFB, and occupational measurement by the Occupational Measurement Center at Randolph AFB.

Technical Services Division Supports Research and Development Programs

The U1100/80 system includes a 3100-square-foot computer room, and a 2100-square-foot tape library which houses between 15,000 and 20,000 active tape files. The tape library is a historical data base of Air Force personnel files dating back to the mid-1940s. It contains 37 unique data files, the largest of which is the Airmen Reenlistment and Loss file containing approximately four million records dating from 1955 to 1979.

The computer hardware itself is designed to accept data tapes written in all standard formats. This allows the laboratory to accept data collected by other organizations on their computer systems. It also permits AFHRL to prepare tapes in formats acceptable to other organizations. The U1100/81 system supports all major programming languages to include FORTRAN, COBOL, and System 2000 which have the heaviest usages. Over 300 people are authorized use of the U1100/81 through a variety of access routes. Means of access include dial-up telephone lines, dedicated telephone lines (these service Luke and Williams AFBs, Randolph AFB, as well as AFHRL contractors and the School of Aerospace Medicine at Brooks AFB) and directly connected terminals (32 at AFHRL).

In addition to the central computing facility at Brooks AFB, AFHRL has computer resources at Williams AFB, Lowry AFB, and Wright-Patterson AFB. The Automated Data Processing Equipment (ADPE) at Williams AFB consists of nine Systems Engineering Laboratory (SEL) 32/75 computers, three SEL 8600 computers, one SEL 7200 computer, a Univac 400 terminal system consisting of two CRT terminals and a printer, a Univac 700 remote batch terminal, and a Univac 200 terminal and printer. The ADPE at Williams is used to support the Advanced Simulator for Pilot Training, which in turn supports the primary mission of the AFHRL Operations Training Division.

Located at Lowry AFB is a Control Data Corporation CYBER 73-16. This system provides support for computer-managed instruction and computer-assisted instruction for three operational Air Training Command courses. The system is used as a research tool for the development and evaluation of computer-based education and training.

A Digital Equipment Corporation (DEC) PDP 11/20, also at Lowry AFB, currently supports software and instructional material development for maintenance training simulation utilizing microprocessors. The system is interfaced to the CYBER 73-16 and the PLATO IV Systems to provide graphic hard copy capability for either system.

Located at Wright-Patterson AFB is a DEC PDP 11/45 System which supports a research and development project for ground operations training. The objectives are to reduce training time and to improve performance of weapons directors in missile and space command and control systems. The project will utilize a special purpose, high resolution, color raster scan three-dimensional graphics display system.

LABORATORY OPERATIONS CENTER

The Laboratory Operations Center (LOC)was established to test the feasibility of combining word processing and data base management in the same system. The LOC is the focal point for collecting and displaying data used in the management of the AFHRL technical program. Using the Generalized Data Base Management System (System 2000), the LOC has established a Management Information System reflecting status and resources data for work units in the Laboratory's research and technology program. AFHRL personnel can retrieve data and reports using System 2000 and the LOC data base. The LOC can provide various types of color output such as textual, pie charts, bar charts, and line graphs suitable for viewgraph and 35 mm projection. In addition to the operational requirements, the LOC is developing software that will enable the AFHRL product divisions to update the data base directly using the Wang 2200VS terminals and to retrieve data as desired through the Wang or any other data processing terminals.

Audio teleconferencing was introduced to the headquarters and remote divisions in May 1981 to demonstrate the overall capability. Various audio teleconferencing equipment is being tried in order to determine the type of system that best fulfills the AFHRL requirements. A large screen projection system was installed in April 1981, primarily to project color graphics. Current capabilities allow projecting video images from standard television, video disk, and video tape. This system will be used to project color graphic displays in near real time using a minicomputer to produce the graphic illustrations using the System 2000 data base. It will become the foundation for a future management teleconferencing system at AFHRL and will ultimately support data, graphics, voice, and slow-scan or freeze-frame television images. Remote divisions will be similarly equipped and thus provide the capability to conduct full-scale teleconferences between two or more locations.

OFFICE AUTOMATION

Office automation of AFHRL operates within the Laboratory Operations Center (LOC) and has two functions. The one that would be most apparent to an AFHRL visitor is the office automation function, which has largely done away with the use of conventional typewriters. The Paperwork Reduction Act (PL 96-511) of 1980 has part of its requirements met by this reduction of typewriter usage. Throughout AFHRL, word-processing computer terminals serve as the correspondence-handling medium for creating, editing, revision, transmitting, and even receiving correspondence. Written communication to the outlying divisions and among the outlying divisions is by electronic mail and is also possible without a printed paper copy. The second function is that of communication with the LOC data base and occurs through a direct connection to the Univac 1100/81 System 2000 data base. AFHRL is currently using the Wang Laboratories VS80 computer for both the word processing and the data base functions.

EXECUTIVE SUPPORT

The Executive Support Branch develops and implements policies, procedures, and standards relating to administration management and practices, military and civilian personnel and manpower actions, and materiel actions. The office provides staff guidance, assistance, and surveillance over other echelons in areas of functional responsibility for the Laboratory Commander. The office staff evaluates administration, personnel, and materiel procedures in other functional areas within the Laboratory and operates the following programs: manpower and organization; forms, publications and reports management; document security; military and civilian personnel administration (including training programs); and organizational supply. Further, the Executive Support Branch is the principal focal point for host-tenant support agreements for the Laboratory and off-base divisions; represents the Laboratory in dealings with other agencies and higher headquarters in all areas of functional responsibilities; and serves as focal point for Inspector General visits and reports.

TECHNICAL EDITING

The ***Technical Editing Office*** serves as the focal point for publishing the results of research and development projects. Technical editing, copy editing, and final composition of reports, journal articles, professional papers, brochures, and other documents are accomplished in this office. Guidance is provided to authors and contract monitors to ensure that technical reports comply with government regulations and professional standards. Further, the office staff composes the camera-ready final copy of reports, tests, survey forms, questionnaires, and brochures; maintains liaison with the Public Affairs Office to obtain clearance of technical reports for public release; coordinates printing requirements; and distributes technical reports, special reports, technical papers, and TRACEs (a 1,000-word summary of a technical report).

SCIENTIFIC AND TECHNICAL INFORMATION

The ***Scientific and Technical Information Office (STINFO)*** plans and directs the STINFO program, including the Technical Library, to meet the information needs of scientific and technical personnel in managing, monitoring, and conducting research and development. STINFO plans and directs the recording of the corporate history and develops and maintains contract data management policies and procedures. STINFO implements Air Force foreign disclosure policies and procedures and arranges for authorized release of military information to foreign governments and foreign nationals. The Office maintains close liaison with foreign technology personnel to ensure that foreign research results are available to Laboratory personnel. Further, the Office serves as the focal point for small business and potential contractor programs, patents/inventions/copyrights, overseas travel, and security and policy review.

MANAGEMENT AND SCIENTIFIC INFORMATION SYSTEM

The Management and Scientific Information System (MASIS) is designed by and for research and development program managers in the Air Force Systems Command. The system integrates financial, technical program, and procurement status data into a single data base. Even though all the information systems at the Department of Defense level are still being designed to satisfy the needs of a single functional area, the integration of the laboratory information into a single data base permits maximum use of the data with a minimum amount of input.

Work unit data in MASIS are recorded and retained at the funding action level. For in-house work, the funding action is initiated for the annual estimate of resources. Estimates are updated to actual amounts at the close of each fiscal year from data extracted from the Job Order Cost Accounting System. Funding action for a specific contract or grant is linked to the basic contract or grant record. The basic contract and all follow-on contracts or grants that are a part of the same work effort are mechanically linked together.

The MASIS programmed subsystems are designed for flexibility. The computer programs, rather than being a collection of independent programs that must each be altered when changes are made to the system, are instead a highly integrated system of programmed subsystems that provide the flexibility and responsiveness required of a management information system.

Today, MASIS represents the most comprehensive common system link among all Air Force Systems Command laboratories.

JOB ORDER COST ACCOUNTING SYSTEM

The Job Order Cost Accounting System (JOCAS) consists of more than 80 interactive computer programs used by the Air Force Systems Command for the mechanized accounting of all its resources. All funds and labor are channelled into this system by the base finance units and the laboratories. AFHRL receives over 40 JOCAS reports monthly detailing the resources expended by current month, as well as by year-to-date accumulations.

The JOCAS reports provide resources information to assist managers in optimizing their use of manpower and funds and also in planning for future requirements. Each work unit is identified by a unique job order number and all resources directly supporting a particular work unit are charged to that unique number. One of the primary uses of JOCAS is to identify and track all reimbursement earnings to assure that the reimbursement programs are earned fully, that the proper organization is billed for these earnings, and that these earnings are credited to the unit which earned them.

Various JOCAS reports are analyzed to detect trends in the use/expenditure of AFHRL manpower and funds. Studies are conducted to identify AFHRL direct and indirect labor trends for total laboratory manning, as well as for scientific and engineering personnel and technicians. Similarly, studies identify the funds expenditures in various categories, such as customer, technical planning objective, direct, indirect, and systems. These studies show historical trends over several years and provide valuable management information for optimizing the use AFHRL resources.

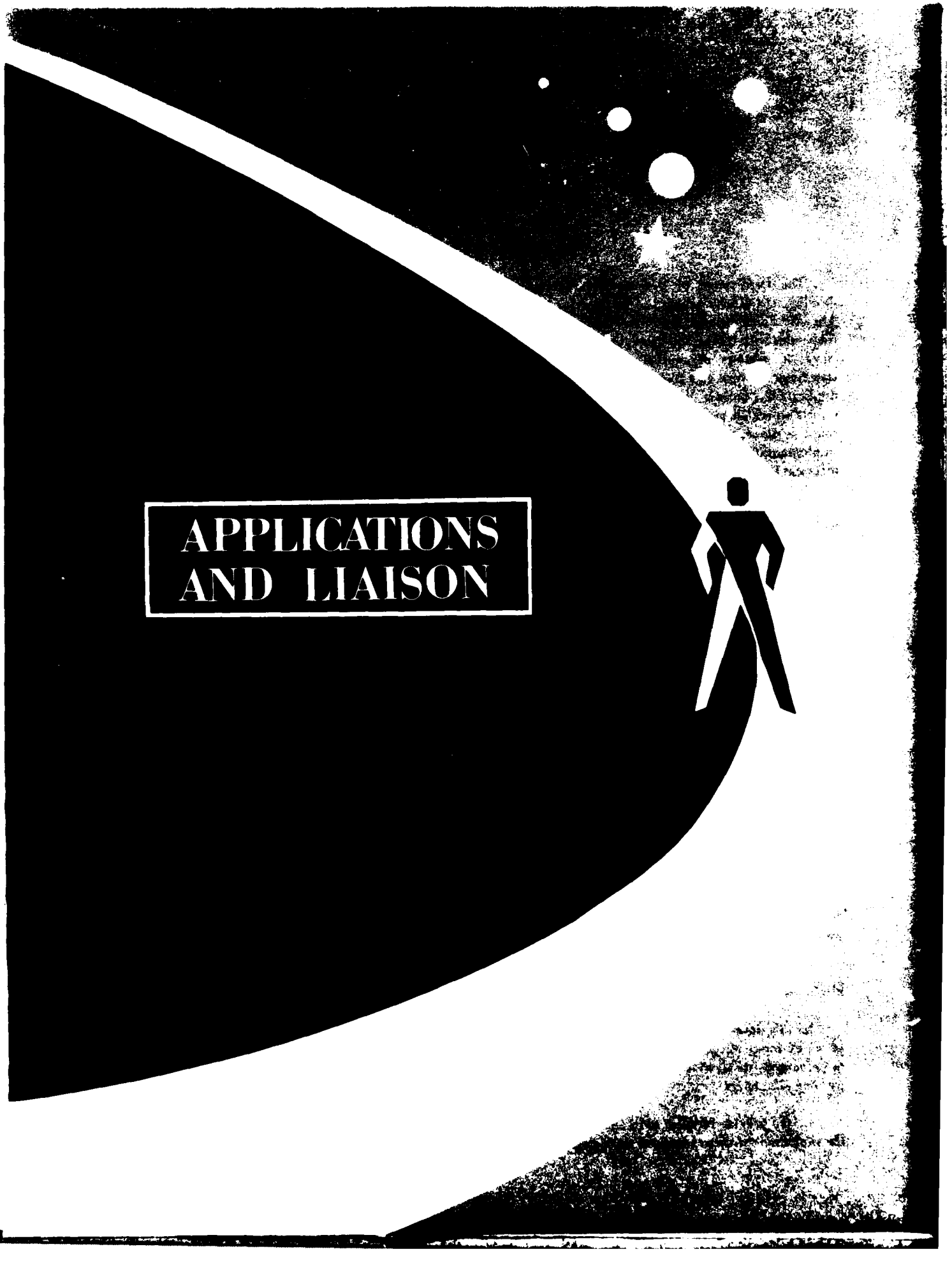
LIBRARY FACILITIES

The AFHRL Library provides services for the headquarters staff offices, and those divisions on Brooks AFB as well as for divisions and offices located in other geographical areas. These services include the acquisition of books, journals, and other library materials.

The Library has online access to the Information Central System at Wright-Patterson AFB, DIALOG Information Services, Inc. at Palo Alto, California, and the Defense Technical Information Center's Defense RDT&E Online System at Alexandria, Virginia. During the fiscal year, the library staff accomplished 136 online literature searches.

The Library continued its policy of not binding journals available on 16mm microfilm and of converting backfiles to microfilm. There are now 536 microfilm cartridges in the collection and one cartridge microfilm reader/printer.

The Library participates in two consortia—the San Antonio Area Online Users Group and the Health Oriented Libraries of San Antonio (HOLSA). The journal holdings of this library are included in the HOLSA union list of serials. Library holdings at the end of the fiscal year were 12,995 books and bound volumes of journals, 11,334 technical reports (2,680 of these are on microfiche), and 392 journal subscriptions. The office collection at the Logistics and Technical Training Division, Wright-Patterson AFB, consists of 305 books. The Technical Training Branch, Lowry AFB, has 241 books and 46 journal subscriptions. The collection at the Operations Training Division, Williams AFB, includes 392 books and 23 journal subscriptions.


APPLICATIONS
AND LIAISON

TRI-SERVICE COOPERATION

The Department of Defense has advocated joint development efforts among the services for some time. The Air Force Human Resources Laboratory routinely cooperates with comparable laboratories of the Army and Navy on matters of mutual interest. We exchange statements of work on a routine basis, avoid unnecessary duplication, "borrow" from each other, engage in joint efforts where all parties are benefited beyond what any could do alone, and even track the lessons learned with implementations of our basic technologies in the different environments provided by the separate services.

Several Memoranda of Agreement (MOA) examples will show the kinds of cooperative efforts carried out by the tri-service agencies.

A March 1980 MOA defines a joint effort of projector technology development to be conducted cooperatively by AFHRL and the Army Program Manager for Training Devices (PM TRADE) with both services contributing funds and in-house resources to its accomplishment. This program will develop and evaluate a new display format for simulators and aircraft with an air-to-ground combat mission.

This Memorandum of Agreement lists the following objectives:

a. To provide for joint Army-Air Force participation in the development of visual displays for crew training simulators, to include the following specific items:

(1) Continued participation by Air Force in Scanned Laser Visual System (SLVS) development conducted by PM TRADE.

(2) Development of high resolution, high brightness light valve color TV projectors.

b. To develop new techniques and technology for advanced computer generated imagery and its adaptation to advanced display techniques for real-time crew training simulators.

c. To provide for joint participation in conducting the evaluation of these advanced technologies.

The products of this effort would be mutually beneficial to all services. The Air Force will obtain information on the engineering feasibility and training utility of the light valve projection system versus the helmet-mounted display for meeting the resolution requirements of air combat simulation. The Army will obtain data on the utiliity of a small high resolution area within a lower resolution wide field of view to meet the visual display resolution requirements for effective attack helicopter simulation. Trade-off studies can also be made between the inset raster display technique and the helmet-mounted display for presenting high resolution targets. In addition, the Army will receive engineering and training data from helmet-mounted-display research pertaining to the performance effects of varying resolution levels for specific air-to-surface weapons delivery tasks. This program will extend to approximately the end of FY83.

Another tri-service cooperative effort centers on the need for an advanced instruction delivery, management, and evaluation capability.

Military training is a major activity. On an average day in FY81 about 204,000 active duty personnel and about 30,500 National Guardsmen and Reservists underwent some type of formal training in one or another of nearly 9,000 organized courses of instruction developed and maintained by the military training organizations. The cost of this effort was about $8.771 billion in FY81, and the support of about 184,400 military and civilian personnel was required for formal instruction, instruction support, school administration, and student supervision. About 1.8 million officer and enlisted active duty personnel benefited from this activity in FY81.

Every index indicates a diminishing ratio of training resources to training requirements. The solution to this dilemma is to increase training productivity through application of available and emerging high technology. The tri-service agencies are investigating the feasibility of establishing a Joint Service Computer-Based Instruction Development Center. The agencies have already developed a truly integrated tri-service architecture for advanced computer-based instructional systems.

These examples give some indication of our joint projects and common interests. Our technology base is common across the Department of Defense and must be integrated to an unusual degree with our sister-Service Laboratories. Our Laboratories' missions are not identical, however, so we must also coordinate with other Army and Navy Laboratories and organizations such as Naval Training Equipment Center and PM TRADE.

AFHRL maintains an MOA with the Army Military Personnel Center (MILPERCEN) at Alexandria, Virginia, for backup computer processing support in case of extended computer outage.

In May 1981, the Commanders of the three military personnel and training research laboratories, Col Ronald W. Terry (AFHRL), Col Franklin Hart (ARI) and Captain James Kelly (NPRDC) teamed with the Personnel and Training Group of the National Security Industrial Association (NSIA) to present "The First Annual NSIA/DOD/Industry Conference on Personnel and Training Factors in Systems Effectiveness." Viewed as the manpower, personnel and training analog to the DOD/Industry "Training Equipment Conference," an annual event focused upon hardware centered issues, the Tri-Service/NSIA organizers of this conference perceived the need to provide a non-hardware personnel and training forum.

The objective was to provide a forum for industry and government attendees to review and discuss the major applications, features and thrusts being pursued in the areas of personnel performance and training technology by the military services and industry, with particular emphasis being placed upon the incorporation of manpower, personnel, and training considerations in the system acquisition process.

It was generally concluded by both materiel and personnel and training conference representatives that, in the face of rising personnel costs and declining manpower base, personnel and training must be made part of the acquisition process. Some of the policies exist but there are no adequate ways to measure or validate competing proposals or contractual performance in meeting design goals with respect to personnel and training considerations.

Plans are underway for the Second Annual Conference in 1982 in San Antonio, to follow up on the results and recommendations of the first conference. Colonel Terry, Commander of AFHRL, will co-chair the 1982 conference. The theme will be "What Differences Can the Personnel and Training Technologies Make in *Systems Effectiveness.*"

APPLICATIONS AND TECHNOLOGY TRANSFER

Technology transfer (T^2) is a major effort of the Applications and Liaison Office of AFHRL. Technology transfer is the process through which the Laboratory ensures that R&D products find their way to users who will apply the results of R&D efforts. The Laboratory has developed formal processes which monitor, evaluate, measure, and feed back the impact of R&D products, including basic and applied research.

DoD Applications:

The main objective of the Laboratory is to develop R&D products that impact the primary mission of the Air Force. After users receive these products they evaluate the timeliness, completeness, clarity, implementation feasibility, relevance of the findings, and the overall impact of the research on the Air Force. AFHRL uses the results of these evaluations to judge the overall value of the Laboratory's R&D efforts and to make adjustments on ongoing programs, if appropriate. It has been found that about 90% of Research users are satisfied with Laboratory R&D efforts, a very high percentage for any R&D programs. However, the Laboratory is constantly striving to increase user satisfaction with R&D products.

Research and development is a dynamic process, constantly adjusting to changing environments. Air Force needs are identified years before actual R&D products are delivered. A few typical examples of outstanding AFHRL research products which significantly impacted Air Force operational capabilities within recent years include: (1) the Advanced Simulator for Undergraduate Pilot Training (ASUPT) which led to the development of full visual Combat Training Simulators such as the F-16 and A-10; (2) the Logistics Composite Model (LCOM) which provided a methodology for realistically determining maintenance and manpower requirements on new weapon system; and (3) the Weighted Airman Promotion System (WAPS) which led to the establishment of an equitable promotion policy for AF enlisted personnel.

Non-DoD Applications;

An ancillary objective of the laboratory is to disseminate the results of our R&D to state and local governments and the private sector. Public Law 96-480, the Stevenson-Wydler Technology Innovation Act of 1980, provided all federal research agencies with the legal and obligatory means for planning and consummating the transfer of R&D products outside of federal organizations so the public could gain maximal return on their investments. Although technology transfer in this context has been a continuing endeavor of AFHRL in the past, the new law provides a standardized and systematic basis for accomplishing this transfer from the initial planning process through to follow-up assessment of utility after delivery.

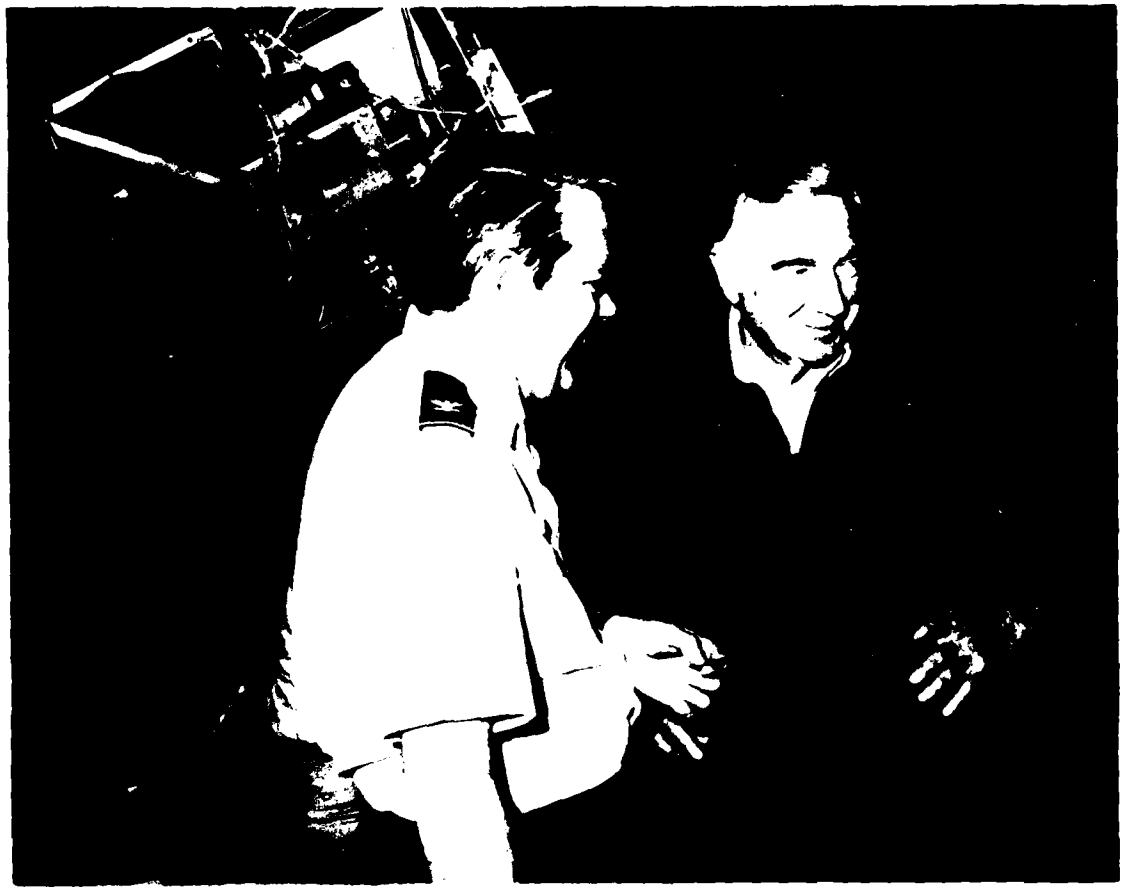
To carry out this broader function of technology transfer, an Office of Research and Technology Applications (ORTA) has been established within the Applications and Liaison Office of AFHRL. This office is taking an active role in fulfilling the requirements of the Stevenson-Wydler Act: assessing the possibilities for transfer of R&D products now being worked to state and local governments and to the private sector; disseminating information relevant to this process; and cooperating with outside agencies to ensure a smooth transition takes place.

Some examples of the types of transfer covered by the Act which AFHRL has successfully transferred in the recent past are: (1) the Comprehensive Occupational Data Analysis Programs (CODAP); (2) the Advanced Instructional System (AIS); and (3) the Person-Job Match (PJM) System.

Briefly, *CODAP* is a complex computer-based analysis system dealing with job and task description and is used to determine the capabilities people filling various jobs should have. It has been adopted by several universities, state and local government agencies, industries, and by friendly foreign military forces, as well as by all branches of the U.S. Department of Defense. *AIS* is a broad software system that deals with planning, developing, scheduling, and conducting training programs. Portions of this technology have been transferred to the Canadian forces for use in training their pilots and maintenance personnel. The *PJM* system is designed to mesh the aptitude of job seekers with properties of available jobs to maximize overall personnel assignments. This technology is currently being applied to a non-DoD Pupil-Teacher-Match study.

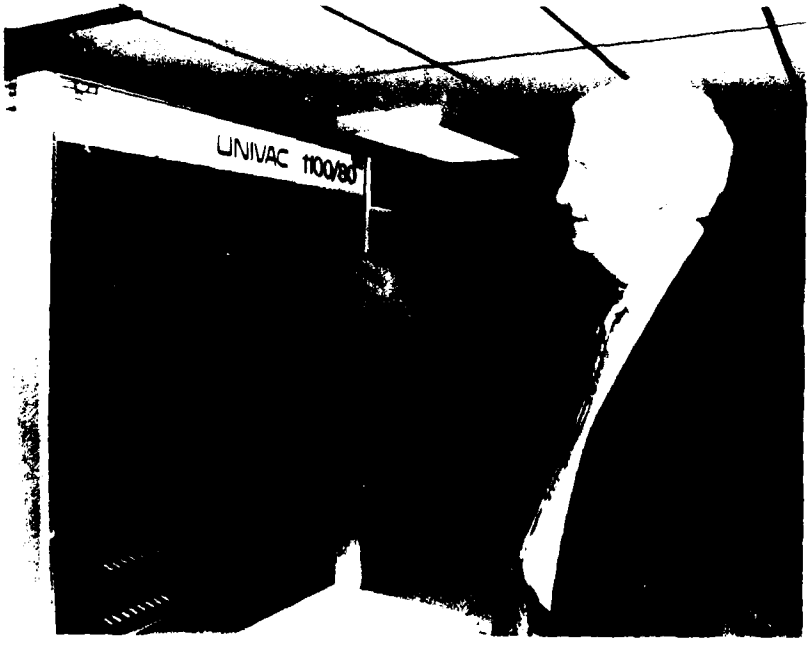
SPECIAL EVENTS

In March 1981 Walter B. Cronkite visited Williams AFB to film a segment on flight simulation for his television science series, "Universe."



The Operations Training Division officially unveiled its new Science Annex at a dedication ceremony on 16 April 1981. Completed in less than a year, the Science Annex provides 9500 square feet of office area for AFHRL/OT behavioral scientists. The Annex's advanced modular office design also includes a number of energy-efficient concepts.

Senator Barry M. Goldwater was the honored guest speaker at the April 1981 dedication of the new Science Annex at the Operations Training Division, Williams AFB, AZ.

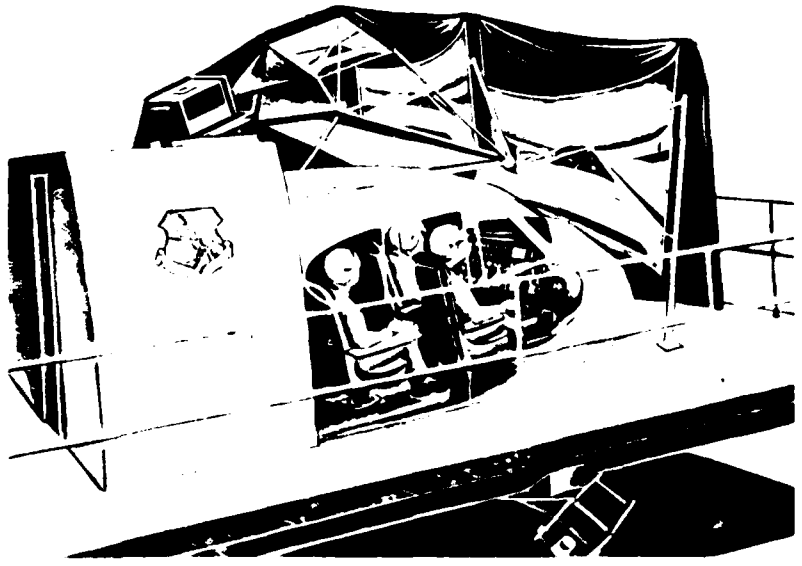


ENHANCED COMPUTER CAPABILITY. In April 1981 installation was completed on a Univac 1100/81 (U1100/81) computer system at the Air Force Human Resources Laboratory/ Technical Services Division, Brooks AFB, TX. This replaces a Univac 1108 system which had been in operation since 1973.

The U1100/81 provides a two-fold increase in word memory and a 75% increase in processing speed.

Presently, there are over fifty remote terminals processing in interactive and batch modes using dedicated communication lines, dial-up ports and direct cabled connections to the U1100/81 computer system. These terminals are located at military bases, AFHRL and SAM contractor sites throughout the United States.

AFHRL/OT received and installed major portions of Boeing's B-52/KC-135 Weapon System Trainer which was the losing system in a comprehensive competitive fly-off. The subsystems installed include the B-52 Defensive and Offensive Stations, a Digital Radar Landmass Simulator (DRLMS), and a three-channel color visual system with texturing and Electro-Optical Viewing system capabilities. These subsystems were received, installed, and checked out by the contractor and AFHRL/OT during the spring of 81. They provide the AFHRL/OT research complex with the capability of ASPT in-cockpit radar, Forward Looking Infrared Radar and Electronics Visual Systems simulations. A long-range plan is in progress to contribute vital data for SAC's future strategic mission simulator programs. The scope of the research will encompass visual cue requirements, training syllabus development, hardware design, display and control technologies, and training effectiveness studies for Digital Radar Landmass, Forward Looking Infrared Radar, and Low Light Level Television simulation systems.



Audio teleconferencing was introduced in the headquarters and remote divisions in May 1981 to demonstrate the overall capability. Various audio teleconferencing equipment is being tried in order to determine the type of system that best fulfills the AFHRL requirements. A large screen projection system was installed in April 1981, primarily to project color graphics. Current capabilities allow projecting video images from standard television, video disc and video tape. This system will be used to project color graphic displays in near real time using a minicomputer to produce the graphic illustrations using the System 2000 data base. It will become the foundation for a future management teleconferencing system at AFHRL, and will ultimately support data, graphics, voice, and slow-scan or freeze-frame television images. Remote divisions will be similarly equipped and thus provide the capability to conduct full-scale teleconferences between two or more locations.

CONFERENCES/SYMPOSIA HOSTED BY AFHRL

The 1981 Image Generation/Display Conference II, Scottsdale, AZ, 10-12 June 1981.

DoD Technology Advisory Group for Education and Training, Lowry AFB, CO, 1-4 September 1981.

Semi-Annual Simulator Research and Development Coordination Meeting, Wright-Patterson AFB, OH, April & November 1981.

General Robert T. Marsh, Commander, Air Force Systems Command, visited the Air Force Human Resources Laboratory headquarters on 23 June 1981.

General Marsh, in comments to assembled Laboratory personnel, expressed his pleasure in visiting AFHRL, reflected on his past association with the work of the Laboratory, and reported that AFSC and the Manpower and Personnel community were working together to secure additional resources to expand the R&D work of the Laboratory.

Prior to his assignment as Director, Command Post for European Forces at Mildenhall AFB, England, Col Tyree H. Newton was presented the AFHRL Management Award 23 July for his management of the Manpower and Personnel Division at Brooks AFB, Texas.

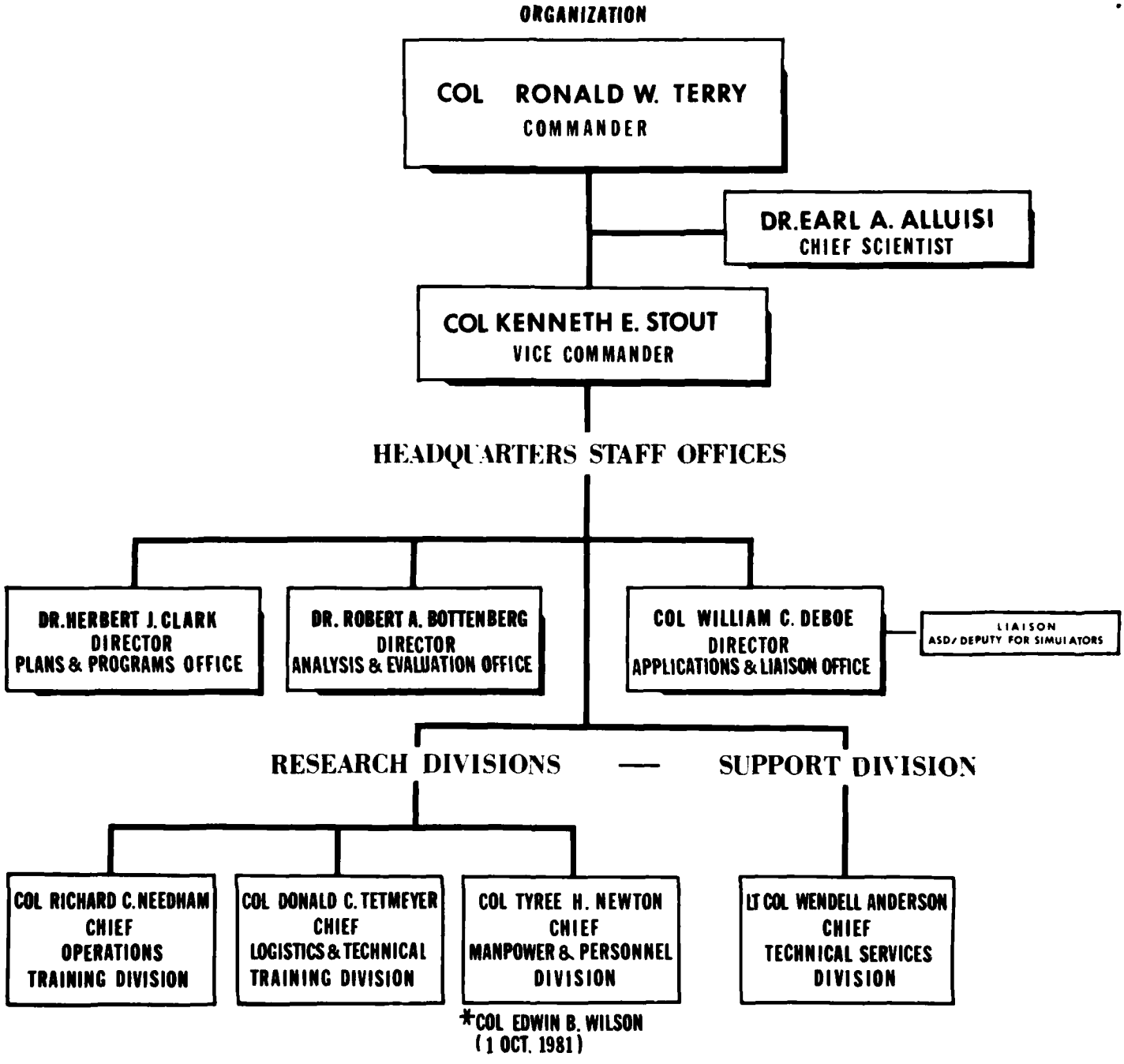
The 1981 Donald B. Haines Award for Outstanding Scientific or Technical Achievement was awarded to Mr. Charles R. Rogers of AFHRL's Technical Services Division for his design, development and implementation of new computerized policy capturing procedures for the Promotion Potential Appraisal System (PPAS) for Air Force civilian employees.

Col Edwin B. Wilson became Chief of the Manpower and Personnel Division succeeding Col Tyree H. Newton. Col Wilson came to AFHRL from the Pentagon where he was Chief of the Analysis Division under the Directorate of Personnel Plans.

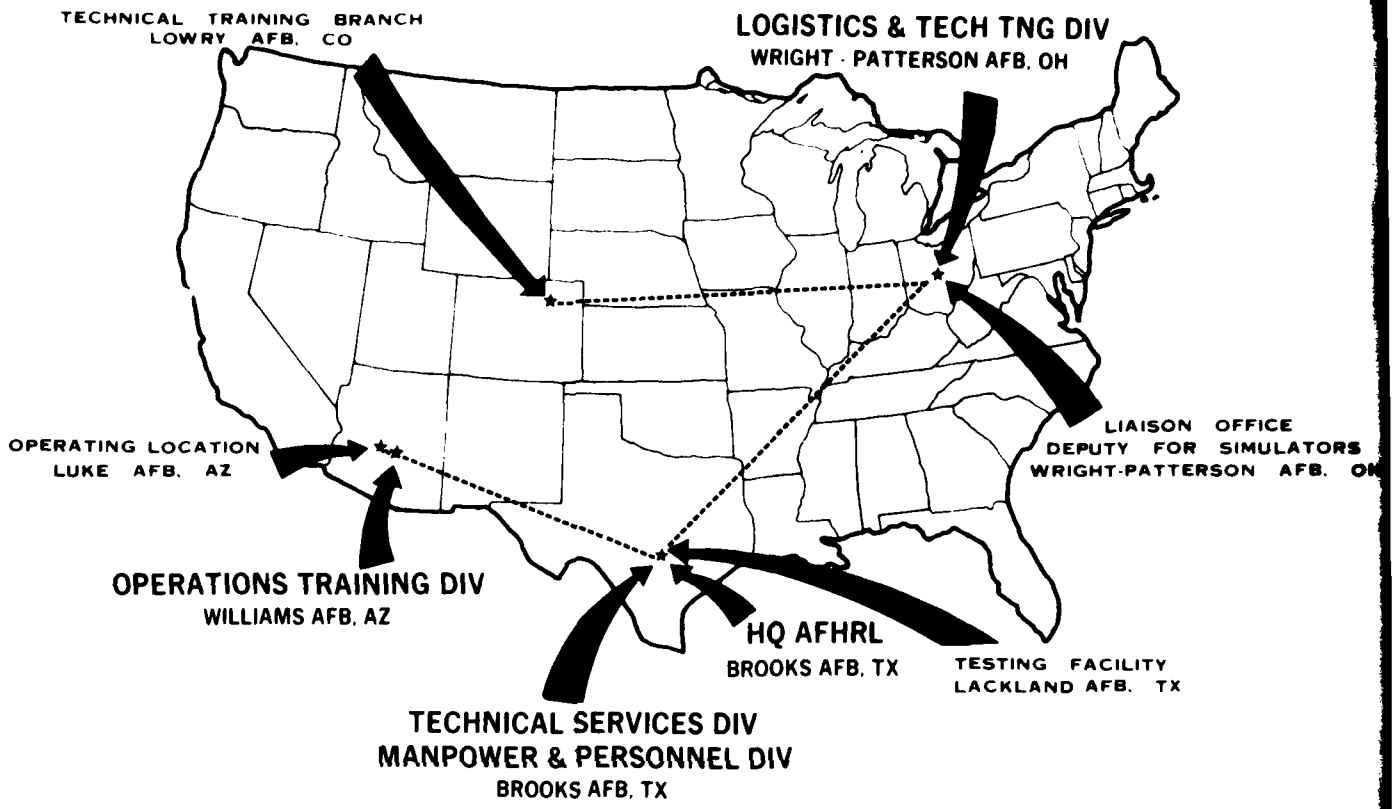
Dr. Robert A. Bottenberg (center) was recipient of three different awards in 1981. On 23 June General Marsh presented him the AFSC Outstanding Handicapped Employee Award for 1981. Subsequently, 5 October, Dr. Bottenberg was honored by the equivalent award for the entire Air Force. And 8 October, at the Pentagon, Dr. Bottenberg received the Department of Defense Outstanding Handicapped Employee Award.

AFHRL ORGANIZATION

AIR FORCE HUMAN RESOURCES LABORATORY



AFHRL GEOGRAPHICAL LOCATIONS



AFHRL GEOGRAPHICAL LOCATIONS

The accompanying map depicts the geographical locations of the AFHRL divisions and activities. The Logistics and Technical Training Division located at Wright-Patterson AFB, Ohio, conducts R&D on combat logistics, technical and maintenance, plus team training and team performance on ground-based systems. A Technical Training Branch of this division, at Lowry AFB in Colorado, is collocated with a Technical Training Center of Air Training Command (ATC) which provides the Laboratory a close working relationship with ATC on R&D related to training. The Operations Training Division at Williams AFB, Arizona, conducts basic research plus exploratory and advanced development to improve the quality and combat effectiveness of aircrews. Also in Arizona, Luke AFB is an Operating Location supporting the Operations Training Division, conducting research with Tactical Air Command on simulation training for air-to-air combat. In San Antonio, Texas, the Manpower and Personnel Division at Brooks AFB supports the Air Force personnel system by developing improved methodologies for procurement, selection, assignment/reassignment, utilization, evaluation, and retention of personnel. The Technical Services Division, also at Brooks, plans and directs the AFHRL scientific and technical information program. Also in San Antonio is a personnel testing facility at Lackland AFB. Finally, AFHRL has a liaison office with the Deputy for Simulators of the Aeronautical Systems Division at Wright-Patterson AFB, Ohio.

AIR FORCE HUMAN RESOURCES LABORATORY PAST AND PRESENT

"1981 marks forty years in which AFHRL and its predecessors have contributed to the defense of this nation. As long as there are people who fly or support aircraft for this purpose, the need for such an institution will continue."

The Air Force Human Resources Laboratory (AFHRL), established in July 1968, continues a long tradition in military psychology which spans three quarters of a century. In the spring of 1917, the first U.S. military psychological effort had its inception in the U.S. Army—Sanitary Corps, starting with the problem of enlisted classification. Between 1917 and 1919 nearly two million men were examined by means of the Army Alpha and Army Beta group tests. The results of these tests were used to identify the mentally incompetent, to classify according to mental capabilities and to assist in selecting potential officers and NCOs. Following World War I, however, military psychology experienced a period of hibernation from 1921 to 1939. However, with the advent of World War II, there was a resurgence of interest. For example, in 1939 the Army General Classification Test (AGCT) was developed. In its various forms it was administered to over 9,000,000 men before the end of World War II.

Among the first AFHRL predecessor organizations were the Psychological Research Units, active between 1941 and 1945. Psychological Research Units were located in Montgomery, Alabama; San Antonio, Texas; and Santa Ana, California. Through an ongoing developmental process these initial research units merged into the Human Resources Research Center established at Lackland AFB, Texas in July 1949. Continuing organizational development replaced the Human Resources Research Center with the Air Force Personnel and Training Research Center in February 1954. In 1958 the Personnel Research Laboratory became an element of the Wright Air Development Center. As of 1 February 1962, it was transferred to the Aerospace Medical Division of Air Force Systems Command, and continued operation at Lackland AFB until July 1968. At that time, AFHRL was established with headquarters at Brooks AFB, Texas.

Since World War I, the military services have developed progressively more accurate and efficient tests to screen applicants for enlistment and to identify the differing abilities required by the widely divergent military occupational specialties. Today AFHRL continues the task of matching the right person with the right job. Ongoing research and development include the development of aptitude and interest measures; methods for collecting, analyzing, and modeling occupational information; and the establishment of physical, aptitude, experience, and education requirements for specific jobs. However, personnel selection and assignment is only one area in human resources research today. Equal, if not greater, attention is given to research and development to improve tools and techniques for incorporating logistics factors into the design, development, evaluation, and life cycle costing of Air Force weapon systems. Also R&D encompassing the utilization of simulators, flying vehicle operation, and missile and space systems constitutes a high percentage of AFHRL efforts. Other efforts focus on flying training technology; on developing, testing, and evaluating existing and newly-developing hardware, programs, procedures; and on techniques for improving all phases of flying training programs. The laboratory is conducting research in flying skills maintenance and reacquisition, low-level navigation, air-to-air refueling requirements, air combat maneuvering, and pilot performance in hostile high-threat environments. Thus, it is evident that the complexities of modern warfare have greatly expanded military research requirements. As in the past, the "Lab" stands ready to meet these challenges in the future.

HEADQUARTERS STAFF OFFICES

VICE COMMANDER

Colonel Kenneth E. Stout

The Vice Commander assists the Commander in the performance of his command function and commands the Laboratory during absences of the Commander. The Vice Commander chairs the Laboratory's Corporate Planning Group (CPG) and the Corporate Planning Group Executive Committee (CPGEC).

The Corporate Planning Group is responsible to the Commander for recommendations and priority assignments on laboratory policy, short- and long-term goals, and overall mission and thrust alternatives. The CPG consists of the Vice Commander, the Chief Scientist, the Directors of Headquarters Staff Offices, the Division Chiefs, and the Executive Officer (Recorder). The CPG meets at least once annually.

The Corporate Planning Group Executive Committee consists of the Vice Commander, the Chief Scientist, the Directors of Headquarters Staff Offices and the Executive Officer (Recorder). The CPGEC acts for the CPG between CPG meetings, and meets at least once monthly.

Normal functions of the CPGEC are the following:

a. Upon the Commander's approval, the committee may disseminate policy or guidelines to, or request reports or information from, any AFHRL organization element or other offices and agencies.

b. The committee reviews the Technical Advisory Board recommendations regarding the Laboratory's RDT&E program for compliance with policy, goals, objectives, and priorities.

c. CPGEC forwards recommendations regarding the RDT&E program to the Commander, with comment.

d. Upon the Commander's approval, the CPG Executive Committee forwards the Commander's Approved RDT&E Program to the operating RDT&E Divisions and Headquarters Staff Offices through the Plans and Programs Office.

e. Finally, the committee makes recommendations to the Commander for assignments of Divisional and Headquarters Staff Office responsibilities for added efforts, including new technical thrusts.

PLANS AND PROGRAMS OFFICE

Dr. Herbert J. Clark
Director

The Plans and Programs Office plans, implements, and monitors execution of the AFHRL Research, Development, Test and Evaluation (RDT&E) program. Staff members perform long-range planning that combines higher headquarters guidance, Air Force user requirements, and technological opportunities. This office publishes all planning documents and prepares budget submissions to higher headquarters. The Plans and Programs Office effects program implementation by processing financial and budgetary documents and monitors the progress of all support, contractual, and in-house RDT&E efforts. Finally, the office provides the resource management required to execute effectively the RDT&E program.

The Director of Plans and Programs is responsible to the AFHRL Commander for the proper operations of the Plans and Programs Office and bears staff responsibility for the Laboratory Headquarter's mission in plans and documentation, operations, programs, and financial management. The Director serves as a member of the CPG and the CPGEC.

Dr. Robert A. Bottenberg
Director

The Analysis and Evaluation Office develops cost and *benefit analysis techniques* and provides consulting services regarding the design of a research and development (R&D) investment strategy for the Laboratory. These activities are categorized under three interrelated areas:

a. *Benefit Analyses and Portfolio Selection.* The development of analytical cost and benefit analysis techniques and procedures is a prerequisite to the actual evaluation of proposed R&D resource allocation. The analytic procedures will establish a theoretical framework for weighting the criteria that will be used in the R&D portfolio selection process. The validation of models used to describe the multiple criteria nature of project selection decisions is an important part of this methodological development effort.

b. *Subthrust Modeling.* Work flow models are prepared and estimates are obtained regarding program dollars, program duration, program manpower requirements and program success probabilities for AFHRL technical subthrusts. Computer simulations are then used to estimate the probability of various outcomes and to identify critical paths. The computer simulations often highlight the need for changes in the subthrust architecture. Thus, this is an iterative process.

c. *Special Studies.* Economic and cost analysis studies of proposals for new efforts are conducted on request. The objective is to provide information that can be used to help aid decision-makers in choosing among alternative programs and in planning, allocating, and controlling resources. During FY81, the Analysis and Evaluation Office

(1) Assisted in providing overall guidance for implementing Air Force and AFHRL economic and cost analysis policies.

(2) Developed techniques and procedures for estimating program resource requirements.

(3) Identified cost data needs and devised cost information systems.

(4) Evaluated research plans for use of appropriate economic and cost analysis methodology.

(5) Conducted special analyses assessing the cost-effectiveness of Laboratory research results and recommendations.

One specific tool which the Analysis and Evaluation Office uses to obtain quantitative statistical summary information on subthrust efforts is the Risk Information System for Cost Analysis (RISCA). This is a system that performs Monte Carlo simulation of a network model representing the project, thereby enabling the analyst to observe the statistical performance of the simulated project hundreds of times before recommending dedication of resources to the actual project.

Interactive software for Venture Evaluation and Review Technique (VERT) is being developed so that analysts in the Office of Analysis and Evaluation will have access to this analytical tool in the near future. VERT is similar to RISCA in that it performs Monte Carlo simulation of a network. It is more powerful, however, in that it provides the analyst with access to many more of the commonly used statistical distributions in the model building process. It also allows greater flexibility in establishing interrelationships and dependencies among various elements of the model.

The Director of Analysis and Evaluation is responsible to the AFHRL Commander for the proper operation of the Analysis and Evaluation Office and bears staff responsibility for the Laboratory Headquarters' mission in analysis and evaluation of planned and ongoing research, development, test, and evaluation. The Director serves as a member of the Corporate Planning Group and of the Corporate Planning Group Executive Committee.

APPLICATIONS AND LIAISON OFFICE

Colonel William C. DeBoe
Director

The Applications and Liaison Office is charged with facilitating the introduction of RDT&E end products into operational use. Such efforts are directed toward improving the relationship between researchers, sponsors, and users of end products by encouraging closer coordination from the initial determination of a problem through the implementation of a product. The Office manages the RDT&E utilization tracking program which assesses the degree of user satisfaction with Laboratory products. The Applications and Liaison staff evaluate Independent Research and Development (IR&D) technical plans of private industry, collect external evaluations, and conduct on-site project evaluations of IR&D performed at AFHRL designated firms.

The Applications and Liaison staff advise the Laboratory Commander and inform Division Chiefs on user acceptability and implementation of RDT&E end products. Further, the staff conducts follow-up analyses of Laboratory RDT&E with user groups to assess specific successes, failures and lessons learned. Public Law 96-480 mandates that the office track and report on all AFHRL projects that could have an impact on civilian R&D. Finally, the office publicizes the Laboratory research program, specifically through publication of an annual report, newsletters, and informational flyers and brochures.

The Director of Applications and Liaison is responsible to the Laboratory Commander for the proper operations of the office and bears staff responsibility for the Laboratory Headquarters' mission in RDT&E applications and liaison. The Director serves as a member of the CPG and the CPGEC.


HEADQUARTERS
STAFF
PERSONNEL

AFHRL RESEARCH AND SUPPORT DIVISIONS

Colonel Tyree H. Newton
Division Chief

MANPOWER AND PERSONNEL DIVISION

With the anticipated decline in the service-eligible population during the 1980s, one of the major problems facing the Air Force today is manning. To alleviate this projected manpower shortage, the Manpower and Personnel Division has initiated a research program designed to improve ways to attract the most qualified individuals, optimally assign them where they will be most productive, and retain a sufficient number in the career force to meet operational requirements.

To support the Division's major thrust area, i.e., manpower and force management, research is conducted to develop management tools, procedures and associated technologies to improve procurement, selection, classification, utilization, productivity, and retention of Air Force personnel. Results of this research provide a substantive basis for personnel decisions in all phases of the military life cycle to maximize the utilization of talent and to insure that manpower resources are allocated to maximize the return of personnel investment.

Matching the right person with the right job requires job analysis and individual qualification assessment. Ongoing research includes the development of aptitude and interest measures; methods for collecting, analyzing and modeling occupational information; and establishing physical, aptitude, experience, and education requirements for specific jobs. The Division also meets research and development requirements for the Armed Services Vocational Aptitude Battery to support Air Force single managership of the tri-service battery.

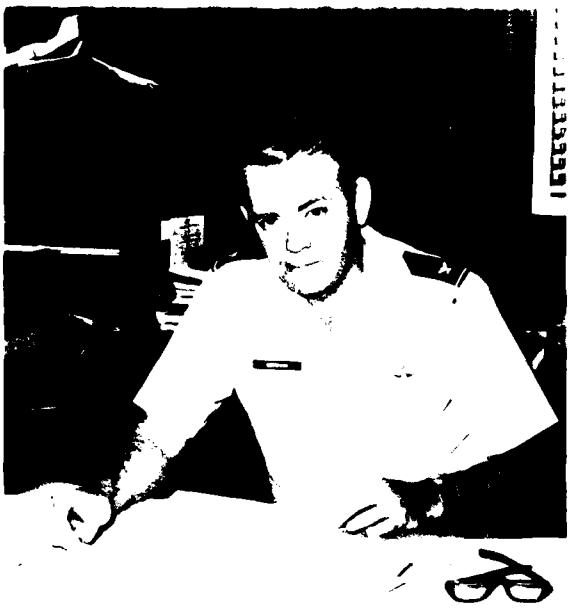
The Division has developed a computer-based person-job match system that has been operationally integrated in the Air Force Recruiting Service Procurement Management Information System. This system computes applicants' best job options by comparing their interests and abilities with those of their contemporaries and Air Force needs. Recruiters indicate that the system, in matching the applicants' abilities and interests and the Air Force needs, virtually guarantees placing "the right person in the right job."

In order to maintain sufficient quantity and quality of personnel in the career force, the Division is also conducting studies to improve personnel utilization, job satisfaction, productivity, workgroup effectiveness, and career motivation. In addition, efforts toward the development of measures of job performance have led to the development of a performance appraisal system for Air Force civilian personnel.

Dr. Nancy Guinn
Technical Director

MANPOWER
AND
PERSONNEL
DIVISION

OPERATIONS TRAINING DIVISION



Colonel Richard C. Needham
Division Chief

Responsibility for research and development in flying training technology for the Air Force Human Resources Laboratory resides with the Operations Training Division. This Division develops, tests and evaluates existing and newly developed hardware, programs, procedures, and techniques for improving all phases of flying training programs. The Division is collocated with the Air Training Command (ATC) at Williams AFB, Arizona, and has an operating location at Luke AFB, Arizona, with the Tactical Air Command (TAC). The Division facilities are accessible to the Air Force flying commands (ATC, TAC, Military Airlift Command, and Strategic Air Command) and serve the Navy and Army as well. The close proximity to the Luke Instrumented Air Combat Maneuvering Range, Tactical Fighter Weapons Center, and Air Force Flight Test Center enhances its interface with the operational community.

The thrust of the Operations Training Division's activities is oriented toward air combat tactics and training. Three major components are involved: engineering simulation technology; the combat mission trainer; and, air combat training research.

The Advanced Simulator for Pilot Training (ASPT) simulates A-10 and F-16 aircraft. This capability enables the Division to conduct research in a broad spectrum of areas of interest to the tactical fighter community. These include defining simulation equipment and techniques which may lead to improved training transfer and better operational simulators. In addition, since the simulator is configured with front line fighter/attack aircraft, additional research in evaluating the utility of future aircraft modifications and unique sensor components can be conducted.

The Division is conducting research in flying skills maintenance and reacquisition, low-level navigation, air-to-air refueling requirements, air combat maneuvering, air-to-ground continuation training, operational test and evaluation, and A-10 and F-16 syllabus development. Research efforts also include simulator visual and force cue requirements and development of advanced simulator hardware systems. The combat mission trainer concept utilizes fiber optics and helmet-mounted displays packaged in a transportable system that will provide tactical training at the squadron level. The Division is currently engaged in the development of special function trainers using video-disc and microprocessor technology which will provide part-task training in a wide variety of settings.

The Division has initiated research efforts to investigate pilot performance in simulated hostile high-threat environments. Research efforts to date include determining pilot performance in hostile situations, impacts of programmed threat proficiency, chaff, and Electronic Countermeasures protection. Refinement of these simulation efforts will have a major impact on increasing Air Force readiness by improving training for hostile flight regimes in the high-threat environment.

Dr. Milton Wood
Technical Director


OPERATIONS
TRAINING
DIVISION

LOGISTICS AND TECHNICAL TRAINING DIVISION

Colonel Donald C. Tetmeyer
Division Chief

The prime objective of this Division's thrust area is to provide the technology to ensure effective and efficient support of Air Force operations. This support includes planning and management of both materiel and human resources. Special attention is devoted to maintenance. Also included as an objective is the technology to ensure effective team performance in ground-based systems. The area consists of three interrelated sub-thrusts: (a) Combat Logistics; (b) Technical and Maintenance Training; and (c) Crew, Group, Team, and Unit Performance and Training.

The first sub-thrust pertains especially to the logistics aspects of Air Force weapon systems. It includes technology to improve maintenance diagnostics, technology for integrated logistics support of weapon systems, improved techniques for planning maintenance and logistics for combat environments, and technology for automating logistics elements such as technical data.

The second sub-thrust pertains to technical training, with special attention to training maintenance personnel. A new system is being developed for job-site training and proficiency certification. Work is continuing in technology for maintenance simulation and in transitioning developed technology for computer-based instruction to extensive use in the Air Force.

The third sub-thrust is aimed at improving the performance of non-flying crews, groups, teams and units. Special attention is being given to teams involved in command, control, and communication systems because of the pressing current needs for improvements in those systems.

R&D investment in the area of these sub-thrusts promises unusually high payoff. The potential to reduce cost and increase weapon system supportability is high because this area of technology is quite underdeveloped and initial big-step improvements can be made. The sub-thrusts have been the subject of unusual high-level interest. Special scientific and operational study groups have stressed the need for increased R&D in the sub-thrust areas.

Dr. Ross Morgan
Technical Director

LOGISTICS
AND
TECHNICAL
TRAINING
DIVISION

TECHNICAL SERVICES DIVISION

Lt Col Wendell Anderson
Division Chief

The Technical Services Division plans, allocates, and controls facility and manpower resources. The Division directs the scientific and technical information program, including the technical library, to meet the information needs of scientific and technical personnel in managing, monitoring, and conducting Research and Development (R&D). Further, the Division provides a full range of technical editorial services, plans and directs the recording of the corporate history, provides staff administrative services, and serves as the focal point with supporting organizations. The Division develops data bases, maintains data files, and operates the computer system to support the Research, Development, Test, and Evaluation activities of the Laboratory; and provides project analysis and computer programming support to the other Divisions of the Air Force Human Resources Laboratory.

The Chief of the Technical Services Division is responsible to the Laboratory Commander for the proper operations of the Division and serves as a member of the Corporate Planning Group and of the Corporate Planning Group Executive Committee.

The organizational elements within the Technical Services Division are the Technical Editing Office, Scientific and Technical Information Office, Executive Support Branch, Computer Operations Branch, Computer Programming Branch, and Management Information Center.


TECHNICAL
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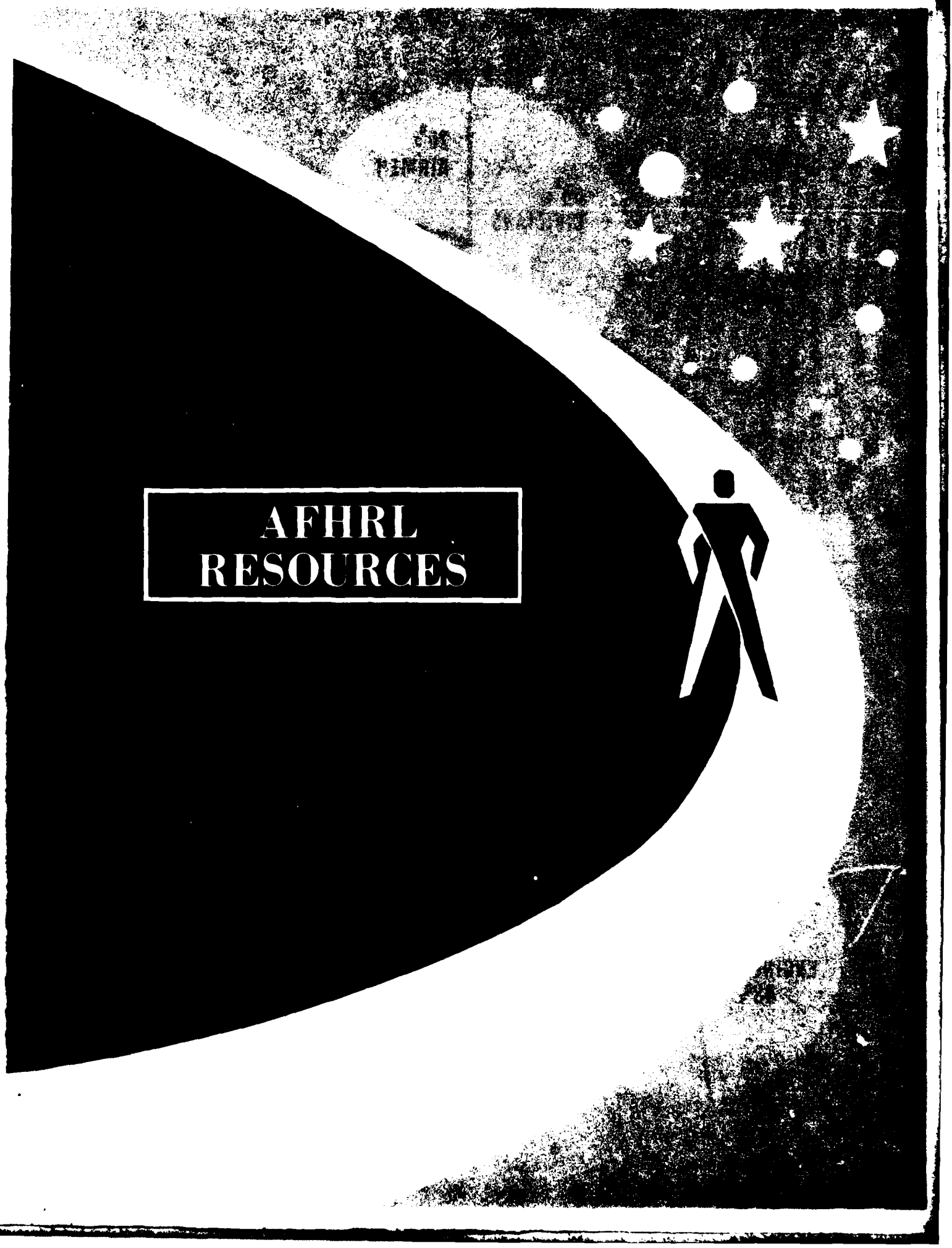
DIVISION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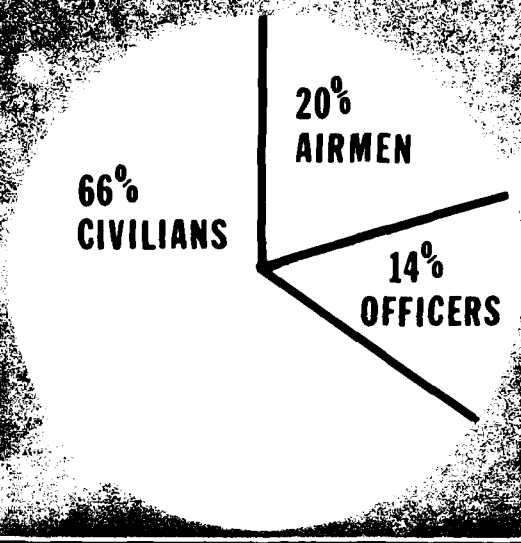
RESOURCES



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BY DIVISION

MANPOWER & PERSONNEL	77
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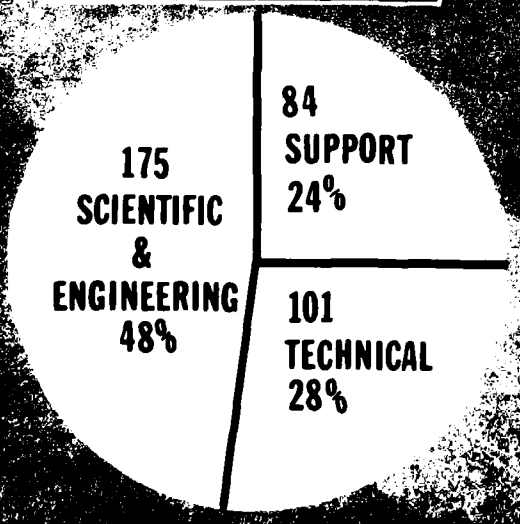
HEADQUARTERS	35
TOTAL	360

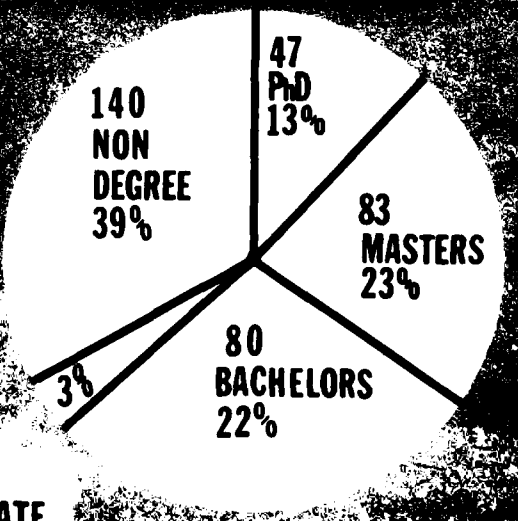
CLASSIFICATION

OFFICERS	52
AIRMEN	72
CIVILIANS	236
TOTAL	360

PERSONNEL TYPE



ACADEMIC DEGREES



FISCAL HIGHLIGHTS

FUNDING SUMMARY ($1000)

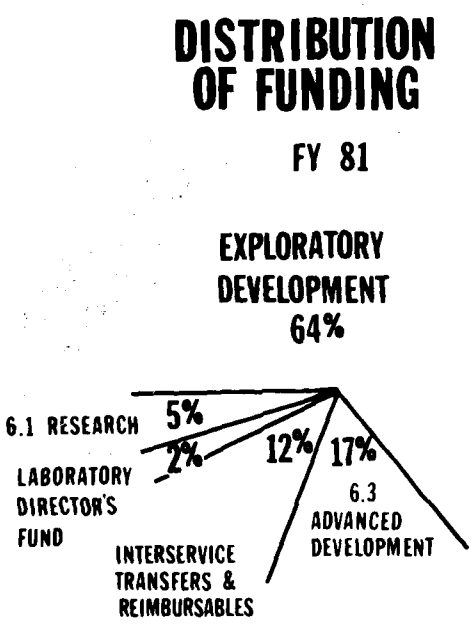
		FY 78	FY 79	FY 80	FY 81
LABORATORY DIRECTOR'S FUND		450	720	702	580
RESEARCH	6.1	1,278	1,324	1,584	1,330
EXPLORATORY DEVELOPMENT	6.2	10,865	15,680	15,185	18,181
ADVANCED DEVELOPMENT	6.3	9,448	4,590	3,595	4,839
INTERSERVICE TRANSFERS & REIMBURSABLES		953	2,095	4,210	3,570
TOTAL		22,994	24,409	25,276	28,500

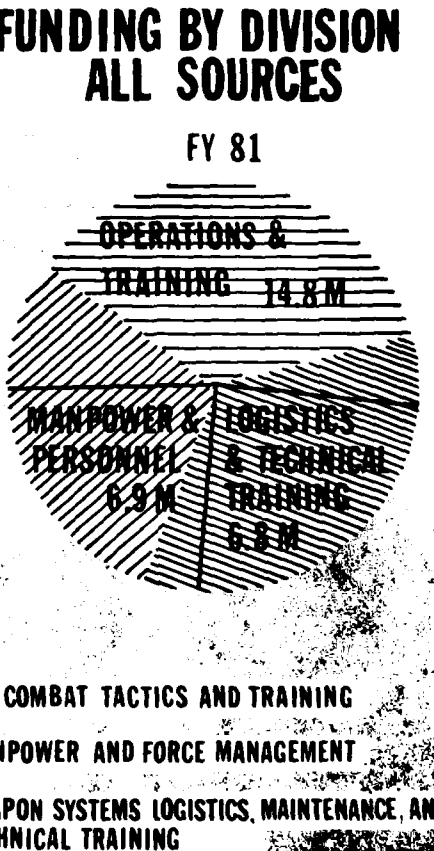
INVESTMENT STRATEGY

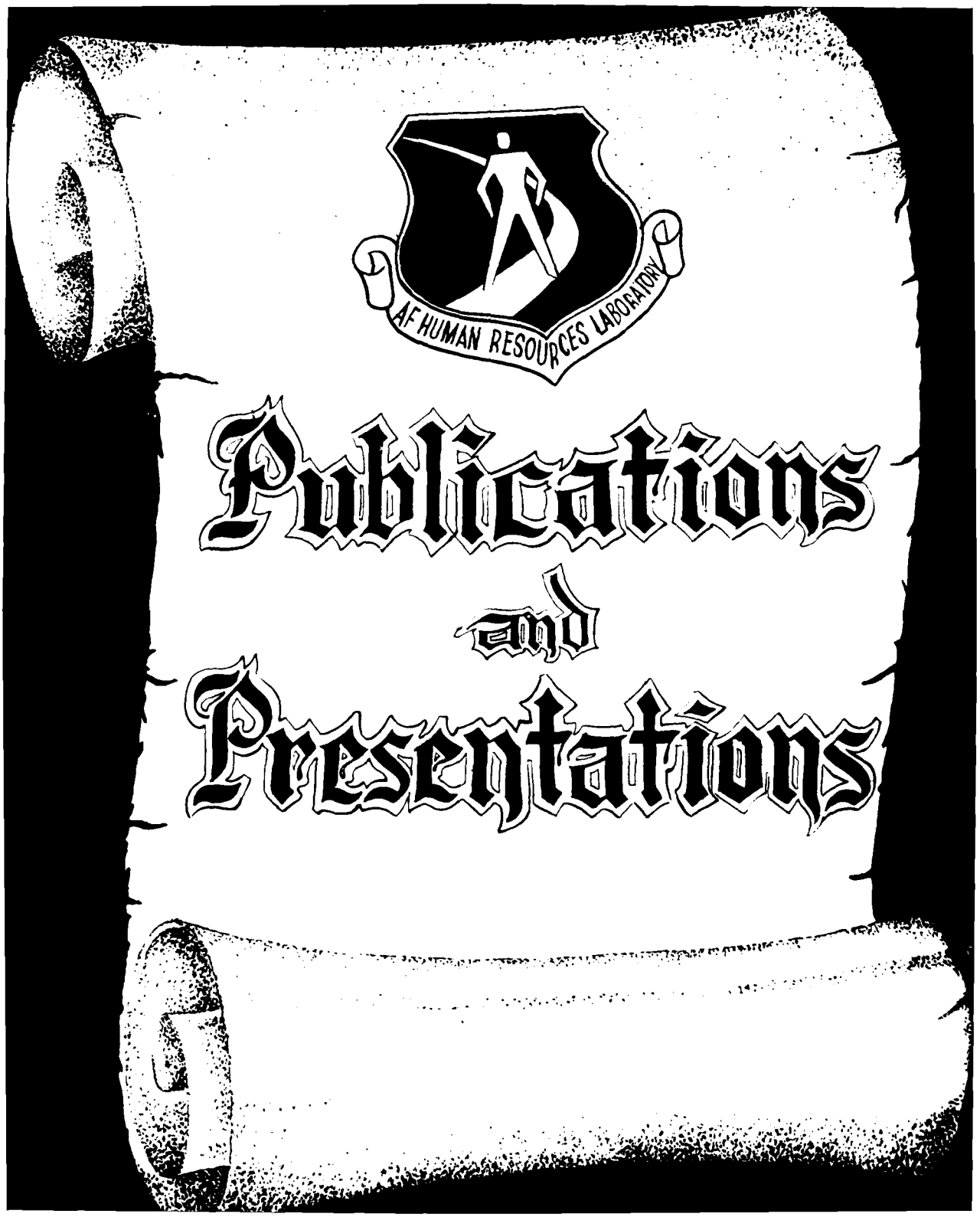
As a consequence of our mission, AFHRL efforts and products directly impact all functional areas of the Air Force. There are unlimited possibilities for the application of these technologies. Competing demands in the face of resource constraints make it imperative to prioritize the allocation of available AFHRL resources. An investment strategy is being developed in which project selection and program emphasis are determined on rational quantitative grounds. The potential for achieving force-multiplier effects is a principal component guiding the development of this investment strategy. Technologies which appear to have order-of-magnitude implications for force effectiveness will be vigorously sought out, and resources applied to such efforts. Attention will also be given to affordability considerations of technology products in the development of our investment strategy. It is AFHRL policy to apply its available resources to projects and programs which have been requested by and coordinated with customers who are ultimately responsible for implementing technolgy development. We recognize that cultural, organizational, and policy barriers can inhibit development and implementation of innovation.

The time-lag between the conception of a beneficial new idea and its adoption is often considerable. The Battelle Columbus Laboratories documented the amount of time required for ten innovation processes, products, or techniques to move from point of conception to the point of actualization in terms of acceptance in the marketplace. These products included the heart pacemaker which took 32 years to reach realization; hybrid corn which required 25 years of incubation; and the video tape recorder which was marketed in six years. The average lag in knowledge utilization among these ten innovations was 19.2 years. Though the consequences of scientific development lag are unfortunate enough, they are compounded by hostility and overt resistance to change which are not uncommon.

With this in view, it will be AFHRL policy to invest a significant fraction of its discretionary resources in the development of a research and technology base which is not contingent upon the prior coordination of potential users. Within this group of investments, it will be AFHRL policy to set aside some resources for projects which would not otherwise be supported. This approach is based on the observation that some of the most significant and far-reaching results of research and development have come from scientific efforts which were neither supported nor considered feasible within the scientific environment of the time. The potential for dramatic improvements in force effectiveness justifies the investment of resources in a limited number of such projects.






AF HUMAN RESOURCES LABORATORY
Publications
and
Presentations

AFHRL PUBLICATIONS

Something new has been added to the Laboratory's technical applications program. Effective 1 March 1981, AFHRL began processing two new kinds of reporting documents in addition to the Technical Report (TR): i.e., Special Reports (SR) and Technical Papers (TP).

The Special Report is specifically directed toward users of research and development findings and contain recommendations for implementation based on these findings. Such a report is issued on completion of work in response to a Request for Personnel Research, Technology Need, or Logistics Need but may also be issued at other times when management deems it appropriate. The intent is to provide a report that is shorter than the usual TR, that speaks in non-technical language, and that emphasizes results and applications; i.e., what AFHRL has found that will help the user solve current or anticipated problems.

The Technical Paper, like the TR, is directed more toward the research and development community but, in general, is less rigorous than a TR. While it may be of extreme value to some researchers, it may not have the wide audience that a TR does. Some examples might be professional papers presented, briefings, technical memos, bulletins, notes or working papers having permanent value, lessons learned, computer documentation, and concept papers. The intent is to preserve information that has long-term value but that due to its limited audience, may not justify the costly and time-consuming processing requirements that the usual TR entails.

The TR will *continue* to be published as usual. It serves a vital need for both the research and development and user communities. However, these two additional categories of reports meet some special needs that the TR system did not.

All three kinds of reporting documents are available at the Defense Technical Information Center for qualified users and at the National Technical Information Service for the general public. These reports are announced in the *Technical Abstracts Bulletin* and the *Government Reports Announcements and Indexes* published by the two organizations, respectively. They will also be announced in the annual AFHRL bibliographies.

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