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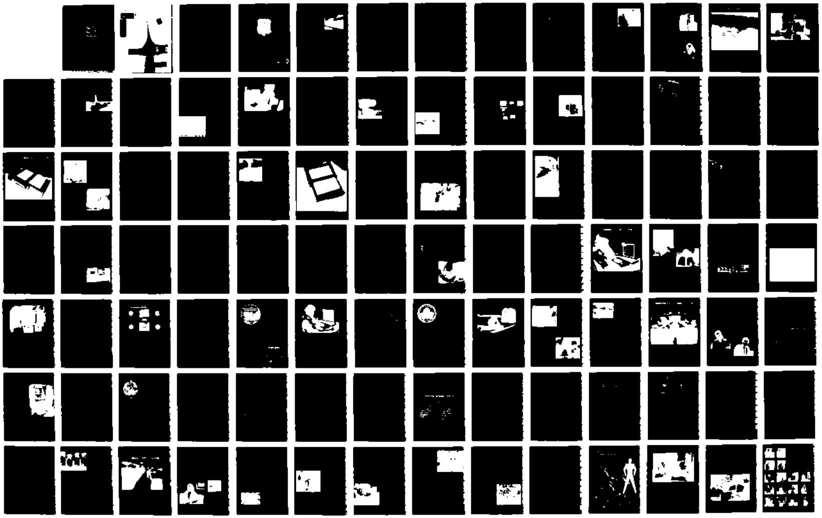

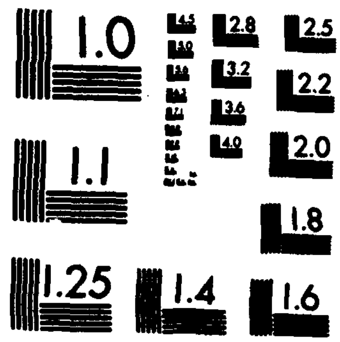

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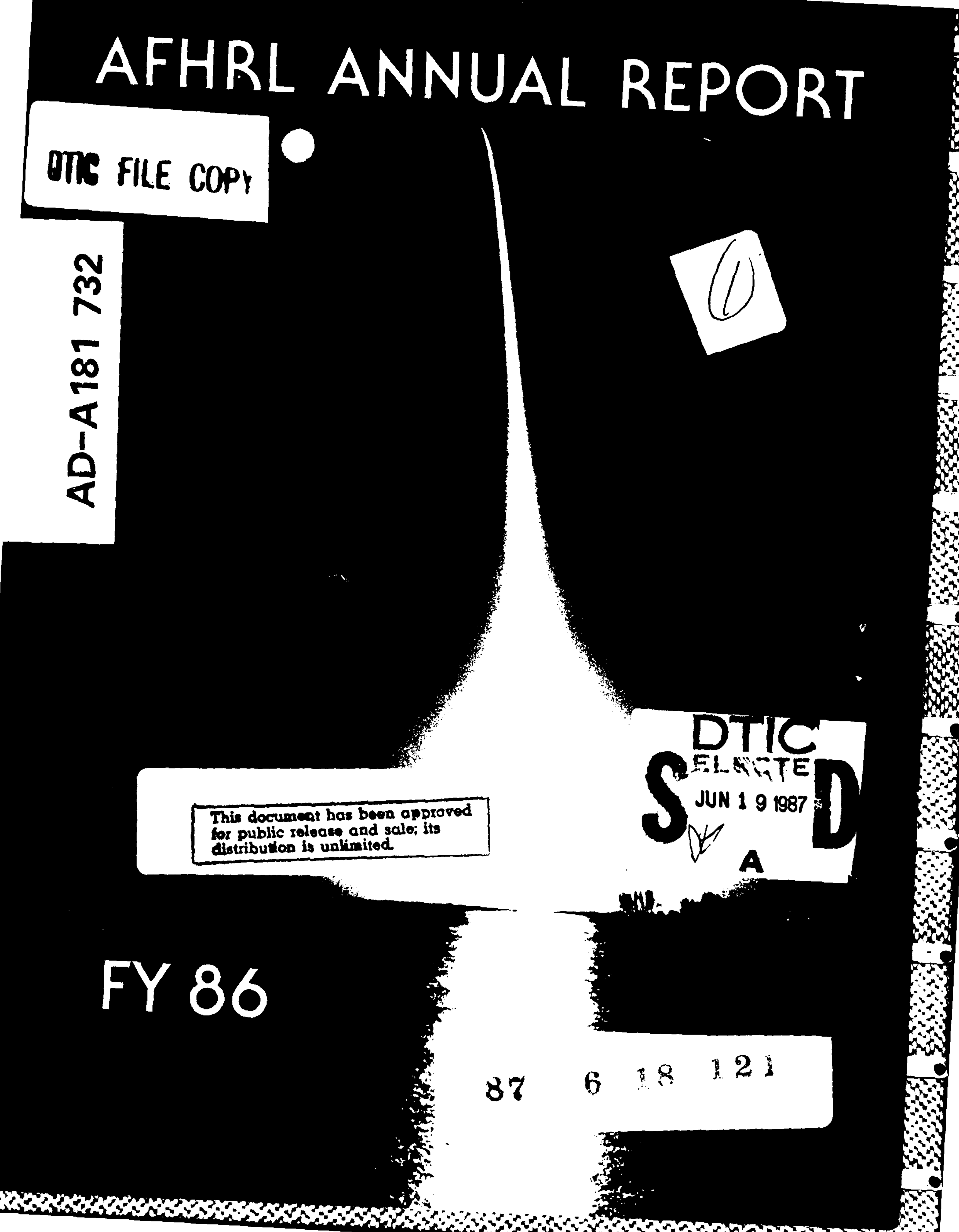
AFHRL ANNUAL REPORT



FY 86

AIR FORCE HUMAN RESOURCES LABORATORY (AFHRL)

A designated organizational element of the Air Force Systems Command, aligned under the Aerospace Medical Division.

DENNIS W. JARVI, Colonel, USAF
Commander

DR. EARL A. ALLUISI
Chief Scientist

ACKNOWLEDGMENTS

Prepared by the AFHRL Scientific and Technical Information Office on the basis of the research and development efforts of the AFHRL scientists, engineers, and associated contractors, with the assistance of numerous individuals from the AFHRL divisions and command and staff.

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

Department of the Air Force
AIR FORCE HUMAN RESOURCES LABORATORY
Brooks Air Force Base, Texas 78235-5601

Cover photo by Don Fike of the University of Dayton Research Institute. "Atlantis" Space Shuttle Launch, Tuesday, November 26, 1985, 7:20 PM. The fire and intensity of the Atlantis against the dark sky, full of unknown possibilities, embody the R&D mission of the Air Force Human Resources Laboratory in its continued quest for excellence.

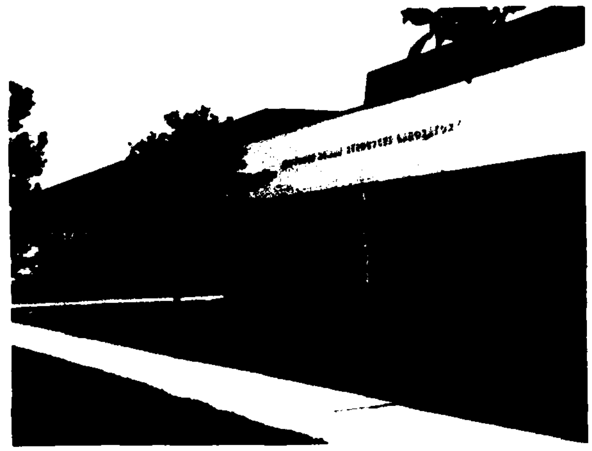
AIR FORCE HUMAN RESOURCES LABORATORY
FY86 ANNUAL REPORT

SIGNIFICANCE OF ORGANIZATIONAL EMBLEM

The emblem is symbolic of the Laboratory, and the Air Force colors, ultramarine blue and golden yellow, are used in the design. The color blue alludes to the sky, the primary theater of Air Force operations and yellow to the sun and excellence of personnel in assigned duties. The silhouette of man represents Human Resources generally, and the progress line is symbolic of improvement of man through research and application of that research. The stars are representative of the goals of human research, which are unlimited.

AFHRL MISSION

The Air Force Human Resources Laboratory (AFHRL) is the principal AFSC organization charged with planning and executing the USAF exploratory and advanced development programs in manpower and personnel, education and training, simulation and training devices, and logistics and group aspects of human factors, for research and development (R&D) related to personnel, flight training, simulation, logistics, and technical training.



ORIGIN

In the late 1960's, the Secretary of the Air Force and the Air Force Chief of Staff decided to redefine the Air Force's R&D efforts in the related areas of personnel and training. In August 1967, the augmented Psychology and Social Sciences Panel of the USAF Scientific Advisory Board conducted a study concerning such R&D work. In its report, the board developed certain standards needed for a successful program: (a) the requirement for managers of these R&D efforts to possess and display a keen interest in the entire program, (b) the proper allocation of sufficient funding commensurate to the work being accomplished, (c) the acquisition and retention of well-trained and highly qualified people, (d) the recognition that the "human factor" involved in personnel and training R&D makes it a unique entity that cannot be compared to the hardware R&D in the Air Force's respective physical science laboratories, (e) the need for R&D functions to be geographically close to the organizations that most effectively applied the results of that work, and (f) the need for a proper balance between finding solutions to current problems and the achievement of long-range R&D goals. On July 1, 1968, AFHRL was established with an organizational structure that has allowed it to effectively carry out its mission over the last 18 years.

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PRODUCTS

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  - ASVAB High School Counselor's Manual
- Conversion Tables & Deliberate Failure Keys for ASVAB Forms 11, 12, & 13
- Air Force Officer Qualifying Test, Form P1, P2, Operational Booklets
  - Air Force Officer Qualifying Test
  - Prototype NATO Standard Pilot Testing System
- EURO-NATO Joint Jet Pilot Training Program Analysis
- Air National Guard Pilot Selection System
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- CODAP ASCII Software
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  - Computerized Training Decisions Systems
- Knowledge Engineering Tools for Training
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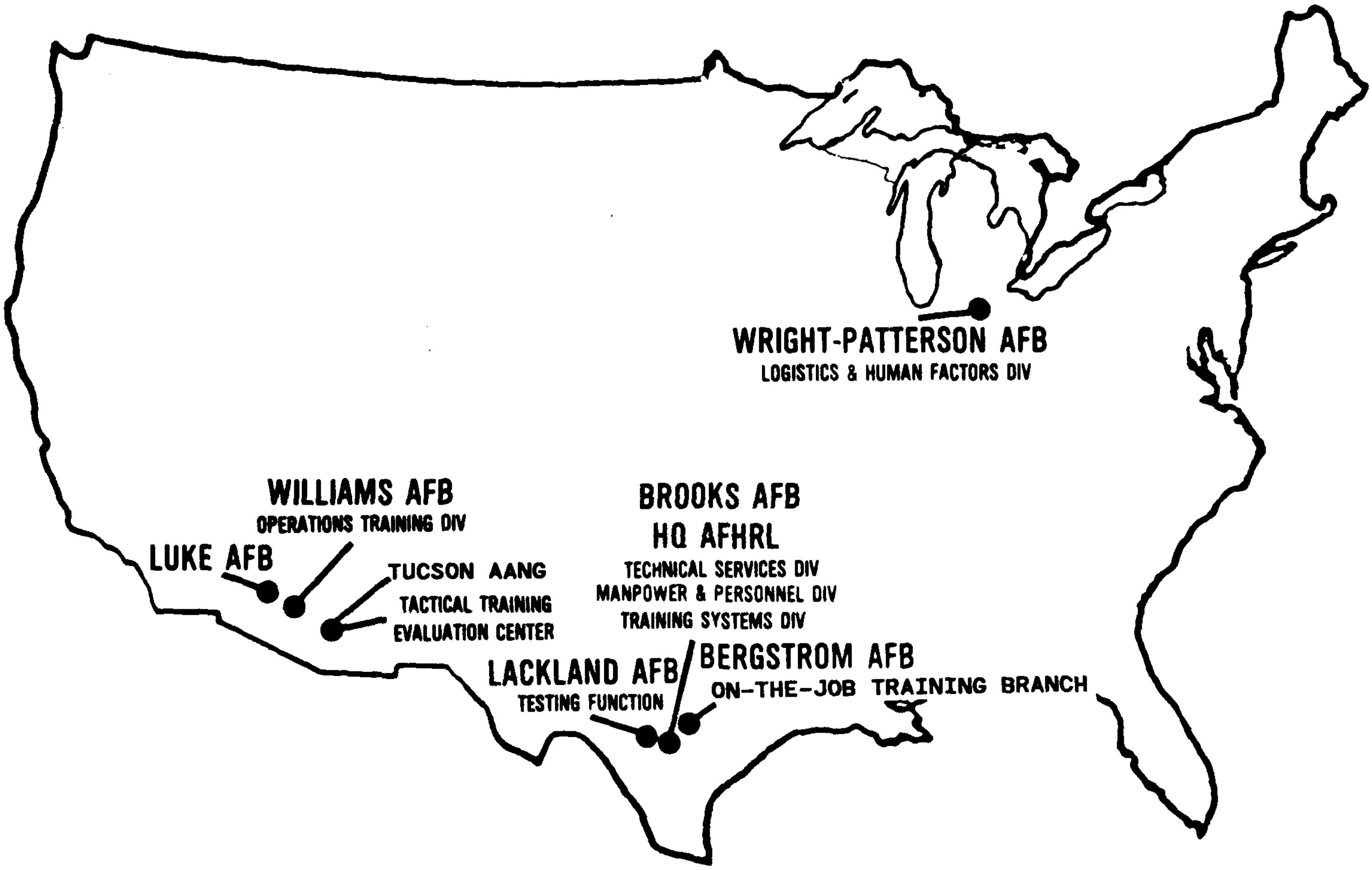
AFHRL GEOGRAPHIC LOCATIONS



MESSAGE FROM THE COMMANDER

As Commander of the Air Force Human Resources Laboratory, I take great pride in reviewing our accomplishments over the past year. 1986 has been a banner year. We've transitioned several products to the Air Force. This book is designed to describe them.

AFHRL is the Air Force's Manpower, Personnel, Training, and Logistics Laboratory. Its aim is to improve the combat readiness of our forces.

The Manpower and Personnel Division conducts R&D in personnel selection, classification, assignment, evaluation, and retention. This R&D improves the quality of the work force.

The Training Systems Division conducts R&D that improves management and training delivery in on-the-job, computer-based, and classroom training; integrates training with manpower and personnel factors for improved job performance; and helps to ensure a highly skilled work force.

The Logistics and Human Factors Division conducts R&D in aircraft maintenance in combat environments, in logistics, and in team training for command and control. This Division also is investigating the management science and human factors aspects of weapon system technologies for consideration of logistics factors in each step of the development and acquisition process.

The Operations Training Division is responsible for R&D in pilot training and combat mission training, and the application of technology to develop training simulators. Their R&D efforts serve to ensure operational effectiveness through a combat-ready, quality force.

Along with the Technical Services Division, which manages databases and develops software in support of the R&D, these divisions work together to build a stronger and more effective Air Force.

Dr. Earl A. Alluisi, Chief scientist — Dennis W. Jarvi, Colonel, USAF, Commander

AFHRL's developments cover a wide spectrum, from new personnel and testing techniques to innovations in electronic combat training. AFHRL has developed its enlisted and officer selection and classification tests. Pilot and navigator selection programs have also been implemented.

The future looks bright and challenging for AFHRL as we aspire to broaden our scope in the areas of space exploration, improved R&D for the Air Force Reserve and Air National Guard, training effectiveness, and artificial intelligence. AFHRL will play a crucial role in Space Command's upcoming selection and training of system operators, maintainers, pilots, and astronauts. Artificial intelligence R&D will be applied to complex weapon system support and training.

DENNIS W. JARVI, Colonel, USAF
Commander

PLANS AND OPERATIONS OFFICE

The Plans and Operations Office plans, implements, and monitors the execution of the AFHRL R&D program. The Office performs long-range planning, including front-end analyses, that combines higher headquarters guidance, Air Force user requirements, and technological opportunities. The Office Staff evaluates Independent Research and Development projects of industry, tracks Laboratory accomplishments, and prepares technology transition plans. Office personnel publish all planning documents and prepare all budget submissions to higher headquarters. The Office effects program implementation by processing all financial and budgetary documents. It monitors progress of all support, contractual, and in-house efforts, and provides the resource management required to execute an effective R&D program.

Dr. Herbert J. Clark
Director, Plans and Operations Office

EXECUTIVE SUPPORT OFFICE

The Executive Support Office 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 operates the following programs: manpower and organization, reports management, document security, military and civilian personnel administration, including training programs, and organizational supply. Further, the Executive Support Office is the principal focal point for host-tenant support agreements for the Laboratory and 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.

Captain James E. Watson
Director, Executive Support Office

OPERATIONS TRAINING DIVISION

OPERATIONS TRAINING DIVISION

Colonel Michael C. Lane
Division Chief

The Operations Training Division of AFHRL has a unique role as the only Air Force agency devoted to the exploitation of science and technology to improve aircrew training. The Division's R&D programs dynamically contribute to the effectiveness and efficiency of flying training throughout the Air Force. Formed in 1969 as that integral part of the AFHRL responsible for flying training, the Operations Training Division performs its mission through two primary functions: (a) behavioral R&D to solve flying training problems through improved technology and (b) engineering R&D to develop devices that become vehicles for research and training. The people who staff these two areas form a diverse multidisciplinary team of specialists ranging from psychologists, research instructor pilots, and human factors specialists to aerospace engineers, mathematicians, and computer technologists. With this uncommon mix of expertise, the Division converts training needs into the knowledge and products needed to improve the combat effectiveness of the operational commands.

Operational Unit Training Branch

The Operational Unit Training Branch (OTU) is responsible for exploratory development R&D programs directed toward solving operational problems in Air Force aircrew training at the individual, crew, and team levels. Branch projects address all facets of aircrew training which concern acquisition, maintenance, and reacquisition of flying knowledge and skills for such units. This Branch's primary objectives are to increase force effectiveness and survivability through enhanced combat readiness and flying safety. These goals are accomplished through R&D focused upon electronic combat training systems, development and implementation of aircrew performance measurement, simulator instructional strategies and technologies, total training system design, training system/device evaluations, and the development of part-task trainers capable of supporting unit training needs. OTU's products are databases, procedures, and training devices validated through experimentation, field studies, and demonstrations. This Branch's activities promote the use of new training methods and efficient simulation utilization.

The major efforts of the Branch are documented in the descriptions of ongoing work in performance measurement, training system design, electronic combat, and part-task trainer R&D. There are, however, several other noteworthy Branch activities.

Current trends within the USAF point toward: (a) developing and implementing integrated weapon training systems; and (b) contracted-out training. To date, such an approach has not been implemented or evaluated for fighter/attack-type weapon systems. One industrial firm has responded to this opportunity by establishing a center for advanced airmanship that combines academic and simulator training for the F-5 aircraft. In support of the Tactical Air Command (TAC), AFHRL has designed, and is actively supporting, an evaluation of this training concept (i.e., combined academics and simulation training) as it applies to the fighter training community. A two-part evaluation is underway. Part I is focusing on the evaluation of training hardware and courseware from the perspectives of technical accuracy of training materials, completeness of training materials, and related human factors concerns. Part II is focusing on training transfer and effectiveness issues. Results of the evaluation will be available in April 1987. In a related effort, a program has been initiated that will examine the feasibility, potential payoffs, and implementation requirements for applying similar ground-based training concepts to TAC's fighter lead-in training program.

At the Division's Tucson operating location, our Tactical Training Evaluation Center (TTEC), established in 1985, is collocated with the 162d Tactical Fighter Group of the Arizona Air National Guard. This working relationship has provided the Operations Training Division with the opportunity to participate first-hand in Low-Altitude Training (LAT) R&D. This is the only LAT program currently authorized for the Tactical Air Forces, and it has already resulted in the development of a unique LAT flight course and training manuals. Development of a part-task trainer for visual cues is underway and will be used to enhance training on low-altitude flight. In the near future the TTEC will serve as an operational training research laboratory for a number of projects, such as an in-house effort on visual cueing, evaluation of an in-flight data-recording capability, and transfer-of-training studies on air-to-air radar intercept tasks. Long-range plans include in-depth analysis of aircrew performance, combat readiness, and workload.

In support of aircrew selection and classification R&D being conducted by the Manpower and Personnel Division, OTU is involved in a validation effort for the Basic Attributes Test (BAT). Data have been collected on 30 F-15 student pilots out of the total of 75 required subjects. When data collection is completed, these data will allow the correlation of performance on each BAT predictor with actual flight performance and instructor pilots' subjective evaluations. These data will then be used to further refine the BAT for screening before undergraduate pilot training, and to help identify potential students for Fighter-Attack-Reconnaissance (FAR) aircrew training when the dual-track program is implemented.

The Instructor/Operator Station (IOS), including instructional support features, is a critical component in providing aircrews with training not available in the aircraft. OTU is responsible for R&D in Air Force use of, and production of guidelines for, optimal instructional support features and development of human factors databases for IOS design, and is working on a generic IOS design guide. The primary users for these products are the Aeronautical Systems Division and the Major Commands. However, DOD contractors and foreign governments are also using these guidelines in the development and acquisition of simulator IOSs and instructional support capabilities.

Another important role played by many of the people on the OTU staff is that of consultant, or subject-matter expert. Serving in this capacity, OTU personnel have given Air Force agencies valuable assistance concerning electronic combat training, aircrew training device evaluation, computer-based instruction and management, and use of training resources. Although these interactions account for only a small portion of total duty time, they have significant impacts that directly result in changing the way the Air Force conducts its aircrew training.

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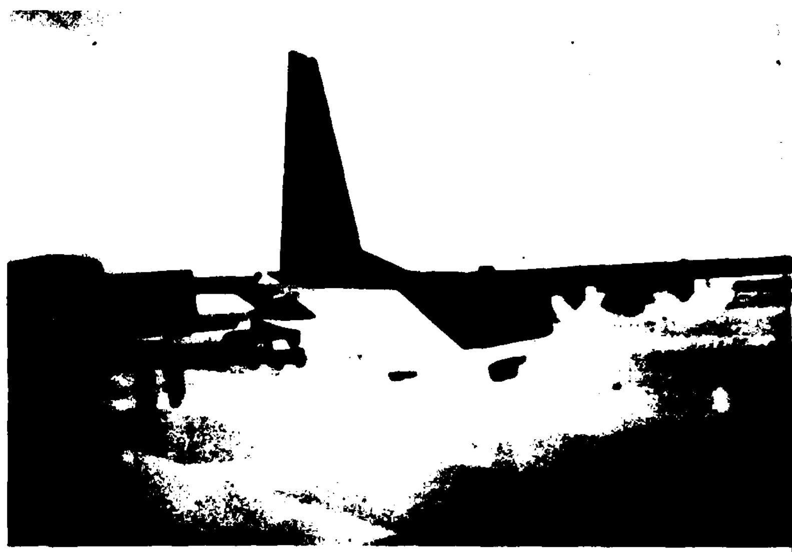

Computer Generated Image, C-130

Training System Design

The Military Airlift Command (MAC) mission is quite broad, and the system supporting the training required for this mission involves such diverse functions as training development, delivery, management, analysis and evaluation, and support. Specifically, as related to the C-130 weapon system, the problem facing MAC is that exercises and operational readiness inspections have revealed the need for more extensive aircrew combat tactics training. However, flight hours for practicing combat tactics are not available, due in part to the demands of initial and upgrade training, as well as the proficiency requirements of continuation training. Thus, C-130 aircrew training must be made more efficient to free mission-critical resources so they can be devoted to raising combat skill levels. The Air Force Scientific Advisory Board has recommended increased use of simulators and part-task trainers to add to the safety and proficiency of noncombat training, so as to allow for reallocation of flight hours to realistic combat training.

In response to this challenging training problem, the Operations Training Division initiated an R&D program to develop a total aircrew training program for the C-130 weapon system that will encompass the full scope of training experiences extending from initial entry through continuation training. The system will make effective use of advanced training concepts, techniques, and state-of-the-art hardware. The prototype system will be developed for implementation at Little Rock AFB, where all training phases are collocated and ground training devices include the Weapon System Trainer, which has a full-mission visual simulation capability. The total program, known as the Model Aircrew Training System (MATS) will be comprised of: (a) a training system that includes all syllabi, learning objectives, performance standards, evaluation procedures, selection of training media, and quality control techniques and (b) a computer-based support system to provide for training program development, instructional delivery, evaluation of crew performance, and total system management. The program will serve as a model for application of state-of-the-art training system development, management, and delivery techniques to a wide range of Air Force training needs.

The MATS R&D has been completed, and final reports of findings and recommendations are in press. These reports contain: (a) a detailed review and analysis of C-130 mission and task requirements; (b) a review of state-of-the-art in training technology and system evaluation techniques; (c) a review of current C-130 training resources and practices; and (d) a description of the system architecture for a mission-oriented, proficiency-based, training system. They provide specific recommendations for implementation of a new integrated approach to training for the C-130 which is individualized and self-paced and utilizes concepts from modern learning theory. They also recommend a computer-based subsystem for the delivery and management of instruction as well as the allocation and scheduling of all training resources, including the aircraft.

The MATS program developed a package consisting of a functional design specification, a development and implementation plan that provides guidance concerning personnel requirements, cost and scheduling information, and a test and evaluation plan. This test and evaluation plan provides a detailed life-cycle approach (a) to evaluate the extent to which C-130 aircrews acquire and maintain proficiency; (b) to assess the development, implementation, and operation of the C-130 MATS itself; and (c) to evaluate the value of MATS as a general model for application to other systems. This plan also includes recommendations for an ongoing R&D program to provide a basis for the design and/or evaluation of new concepts in aircrew training and to upgrade the effectiveness/efficiency of the MATS itself.

The findings and recommendations from the MATS effort have been utilized by Simulator Special Project Office of the Aeronautical Systems Division in the development of the Request For Proposal (RFP) for the C-130 Aircrew Training System (ATS). They have also been used by MAC Headquarters as a basis for planning for the implementation, test, and evaluation of the new C-130 ATS and have been provided to all bidders on the C-130 ATS RFP for guidance. In addition, the findings and lessons from this effort have been applied to a number of other programs including the C-5 and C-17.

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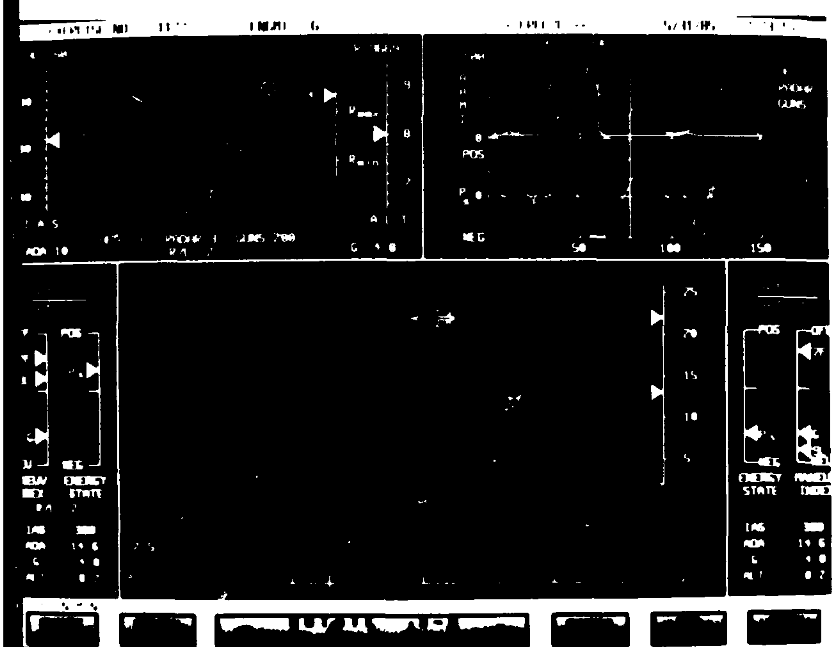
Aircrew Performance Measurement

The Operations Training Division has developed an Air Combat Maneuvering Performance Measurement System (ACM PMS) that will be used to conduct R&D aimed at providing TAC with valid measures of aircrew performance necessary for evaluating the effectiveness of present and future air-to-air combat training devices. This project is in part a response to the Defense Science Board 1982 Summer Study that called for greater R&D emphasis on performance measurement. The ACM PMS is a performance data collection and analysis system that will be implemented on the Simulator for Air-to-Air Combat (SAAC) and the Air Combat Maneuvering Instrumentation (ACMI) range at Luke AFB. The ACM PMS will support R&D on: (a) measurement development, validation, and refinement; (b) the use of computer graphics for real-time information display; (c) the use of computer graphics to support post-mission debriefing; (d) training effectiveness of the SAAC and the ACMI; (e) simulator visual requirements; and (f) providing selection criteria for the FAR pilots in dual-track training programs.



Air Performance Measurement Graphics

R&D plans have been developed for applying expert systems technology to the areas of real-time performance monitoring and graphic post-mission debriefing. These efforts should significantly enhance the instructor pilot's ability to instruct student pilots using the ACM PMS in conjunction with the SAAC or ACMI.

An Air-to-Surface Performance Measurement System (AS PMS) is currently being developed in parallel with the ACM PMS. The AS PMS will take advantage of existing ACM PMS hardware and software, and be implemented at Williams AFB to improve the Laboratory's ability to conduct training effectiveness R&D.

Also part of the performance measurement program is the Airborne Measurement Concepts (AMC) effort for advanced tactical aircraft. This effort will define the airborne performance measurement requirements necessary to support tactical training in the 1990s. Areas to be addressed will include embedded electronic countermeasures training, real-time kill assessment and removal, and data linking of multiple aircraft. R&D on the Air Combat Maneuvering Performance Measurement System should provide the AMC effort with procedures for conducting computer-assisted mission debriefing.

The Division's R&D in performance measurement is being conducted with ASD in support of the Training Effectiveness Plan (TEP), and will provide performance metrics for other TEP programs, such as those addressing the visual and sensor requirements necessary for supporting future tactical aircrew training.

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Air-to-Air Intercept Trainer

Part-Task Training R&D

The Air Force has an urgent need for effective yet low-cost training devices and methods. Major Commands (MAJCOMs) continually seek training technologies that can improve the proficiency and readiness of their combat aircrews. One goal, implicit in the search for effective, least-cost training solutions, is the capability to offload expensive training devices such as Full-Mission Simulators (FMSs) and aircraft by using part-task training devices of advanced design with which aircrews can acquire needed basic cognitive and procedural skill components. Low-cost computer technologies now offer the potential to satisfy many training requirements, providing that effective part-task approaches and methodologies can be identified or developed.

Part-task training R&D began with the assessment of technology applications as a means of improving combat aircrew training effectiveness. Surveys of the Strategic Air Command (SAC), the Military Airlift Command (MAC), and the Tactical Air Command (TAC) showed that a wide variety of training requirements could be supported using low-cost, part-task trainers. Three experimental investigations were conducted to determine the potential of microcomputer-based part-task devices for training procedural tasks. The findings showed that part-task trainers (a) effectively train procedural and cognitive tasks without the need for costly cockpit repeater instruments and controls, (b) can be used to offload FMSs for basic skills training, and (c) represent large cost-avoidance potential as applied to operational unit training programs.

The Operations Training Division's R&D is focused toward developing a sound scientific foundation upon which to determine part-task training strategy. Specifically, the intent is to generate a database sufficient to support the identification and selection of training strategies and the design of devices for specific types of training tasks. Database development includes both theoretical and empirical research. A comprehensive review of the existing psychological literature related to part-task learning was recently completed, and several methodology experiments have been conducted. The database, when completed, will be accessible via an automated Decision Support System (DSS). The DSS will facilitate the analysis of specific training tasks in order to determine optimal sequencing of task sub-parts and to identify other relevant training methods. At present, a preliminary DSS has been developed for demonstration purposes. As theoretical and empirical data accrue from R&D, they will be used to augment the database.

Another promising avenue of R&D in part-task training is the use of computer-based analytical models. These models replicate the decision-making behaviors of a pilot performing the task in the real world. The knowledge or rule base contained in the models can be varied to represent different levels of performance proficiency. By manipulating the computer model, scientists can determine the cause-effect relationships that influence skill development. The modeling process can then be used to predict learner behavior on the task and to determine appropriate training methods. Thus far, analytical models have been developed for an air-to-air radar intercept task and a 30-degree dive bombing task.

To give substance to this program, experimental trainers are being developed for each of the MAJCOMs. The purpose is twofold. The trainers are to serve as state-of-the-art part-task training demonstrations. Each trainer is focused upon a single part-task training problem in which new design concepts and training methods are developed and evaluated in close concert with the user command. Design concepts include high-fidelity simulation of relevant task portions, performance measurement embedded within software, and automated on-task guidance and feedback to the learner. The second purpose of this program will be realized as device designs mature and are validated and part-task trainers are transferred to the user commands. Three such trainers are under development: a low-altitude awareness trainer for the Air National Guard; an air-to-air radar intercept trainer for F-16 pilot training for the Tactical Air Command; and a threat avoidance and tactics trainer for the Strategic Air Command.

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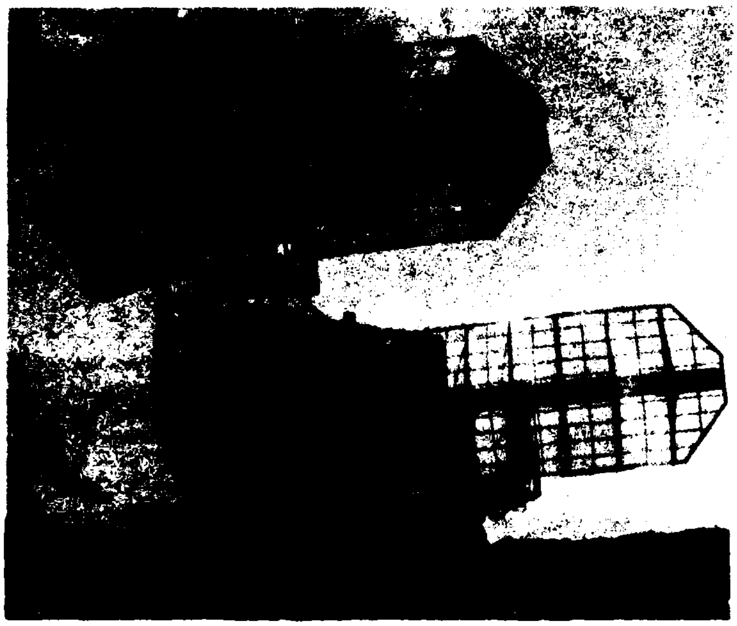
Electronic Combat Training Effectiveness

The modern battlefield is populated by ever-increasing numbers of sophisticated air-to-air and surface-to-air threat systems. To survive in this environment, the aircrew must be able to recognize critical cues and make quick decisions concerning the appropriate tactics to employ. Electronic Combat (EC) training is intended to prepare the aircrew to take advantage of threat system vulnerabilities and their own weapon system capabilities to avoid, defeat, or destroy the threat. The problem of providing realistic EC training is substantial; however, EC-capable ranges are limited in number due to cost and airspace considerations. Security and safety considerations place limits on the practice of realistic tactics in-flight.

Flight simulators suffer from difficulties in maintaining currency with aircraft EC systems, which change ever more rapidly as the capability of reprogramming increases. Such considerations have led the Tactical Air Command toward systems such as the On-Board Electronic Warfare Simulator (OBEWS) for in-flight training and the EC part-task trainer for ground training. However, the effective use of such systems depends on understanding what contributions they can make to training both individually and in an integrated training program.



Electronic Combat Environment

The Operations Training Division is addressing this problem through an R&D program aimed at the initiation and evaluation of an integrated EC training program for the F-16 aircraft. This program can then serve as a model for other weapon systems, and as the basis for examining the costs and benefits of various investment strategies for EC training systems. This R&D program is multifaceted and involves such efforts as: (a) enhancements to existing threat modeling capabilities in OT's flight simulators to support the evaluation of realistic tactics training issues; (b) development of enhanced part-task training capabilities, such as use of real-time, three-dimensional representations, to evaluate their contribution to EC training; (c) investigation of the sensitivity of tactics to pilot performance variations to determine criteria for training; and (d) development of a methodology for investigating the costs and benefits of various EC training systems.

In the past year, OT has assisted TAC in identifying the requirements for a computer-based training system capable of delivering the training necessary to support a variety of radar warning receiver and electronic countermeasures systems. The THREATVAL effort has identified a set of high-fidelity threat models and associated visual cues capable of providing real-time threat simulation on the OT flight simulators. These models will be implemented during FY87. The TACTRAIN effort has investigated the sensitivity of tactics to performance variations, and a final report is in preparation. The development of a cost/benefit methodology for EC training systems has been initiated. In addition, a report concerning the results of R&D addressing feedback requirements for EC range training systems, skill retention, and transfer of training from the flight simulator to the aircraft has been published.

The overall goal of these efforts is to develop a technical database on EC training systems which can support a cost/benefit model for training and provide an objective basis for investigation of alternative investment strategies for such systems. Initial results suggest that this is a productive approach, but will require a coordinated effort from a number of different vantage points.

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Technology Development Branch

Current Tactical Air Force simulator training is typically limited to procedures and emergency tasks due to the lack of adjunct full-field-of-view, high-performance visual systems. Combat skills for the most part cannot be trained on these "blind" devices.

The Technology Development Branch (OTE) is working to solve two problems preventing deployment of high-quality visual systems for use on fighter aircraft simulators within the Tactical Air Forces (TAF). The first problem is that technology has not yet been developed that can provide a full-field-of-view, high-resolution visual system which can support air-to-air combat training. The visual system must also provide enough scene content to support high-speed, low-altitude air-to-ground weapons delivery training. The second problem is to ensure that the cost of such devices is low enough to be affordable to the TAF for use on their fighter Weapon Systems Trainers (full mission simulators).

F-16 Dome Simulator
Visual

The visual system technology problem is in fact a two-part problem, as the visual system consists of two sub-systems: the imagery source and the image display. The imagery is provided by a very complex and costly device called a Computer Image Generator (CIG). The most challenging mission for the CIG is, by far, air-to-ground weapons delivery. This mission calls for very detailed scene content to be presented at very high speeds over large areas of terrain. When this problem was first studied in the late 70s, it was soon realized that the information bandwidth for this mission was well beyond the capability of computer image generators of that era. OTE conducted an industry-wide competition to develop a computer image generator to meet TAC needs. The resulting image generator, called the Advanced Visual Technology System (AVTS) was delivered by the contractor to AFHRL in September of 1984. It has been tested and evaluated and found to meet all specifications. It can produce out-the-window imagery to support TAC air-to-surface combat (low-level flight, dive bombing, strafing, and SAM evasive maneuvers) and air-to-air combat (1 vs 1, 2 vs 1, and 2 vs 2). This image generator is now being integrated into the Division's simulator R&D facility. Work is also underway to develop displays that can present this imagery to the pilot. Both dome displays and helmet-mounted displays are being designed, built, and tested against the TAF requirements.

The other major problem preventing mass deployment of full-field-of-view visual systems throughout the TAF is the very high unit cost of such systems. The Operations Training Division is making a two-pronged attack on this problem. The first is to address the visual and sensor fidelity issue of "How much is enough for accomplishing training of given combat tasks?" Experimental investigations are proceeding to determine the minimum visual system component requirements necessary to support the Tactical Combat Mission. One example is an R&D effort to determine the required display image resolution and brightness needed to train air-to-air combat.

The other major fidelity issue relates to combat mission simulation requirements. To this end, OTE is developing the only Air Force two-ship, F-16 full-mission air-to-ground weapons delivery simulator. It will also be capable of simulating the much easier air-to-air mission. It will be used to determine training requirements for TAF two-ship team training. This simulator will also serve as a prototype for two-ship training in future Replacement Training Units. Both of these fidelity-related programs will define simulator requirements such that over-designed and over-costed training devices can be avoided.

The other cost-driven effort is the development of visual systems that offer the potential of much lower sub-system unit costs than current technology now affords. For example the Variable-Acuity Small Dome Display and the Fiber-Optic Helmet-Mounted Display will cost in production less than one-tenth of today's dome display technology.

Another serious shortcoming in the training of tactical combat pilots is the inability to include a large number of skilled and unpredictable players in the simulation. This Branch is addressing that problem by initiating a program called WARNET. It is, in concept, a pilot-centered large network of tactical combat simulators. It is in the formulative stage at this time and will be the subject of long-range planning and analysis over the next year.

This applied research work is supported by basic research work in human visual perception and cognition. The current work is in the areas of color perception, visually induced motion, and visual attention. New work will be started in retina form perception. The ongoing work in color perception will be expanded to the study of color constancy and contrast. All of these R&D efforts have as a goal a solid contribution to the scientific understanding of perceptual and learning phenomena, the knowledge of which will result in high payoff for the Division's long-range R&D program.

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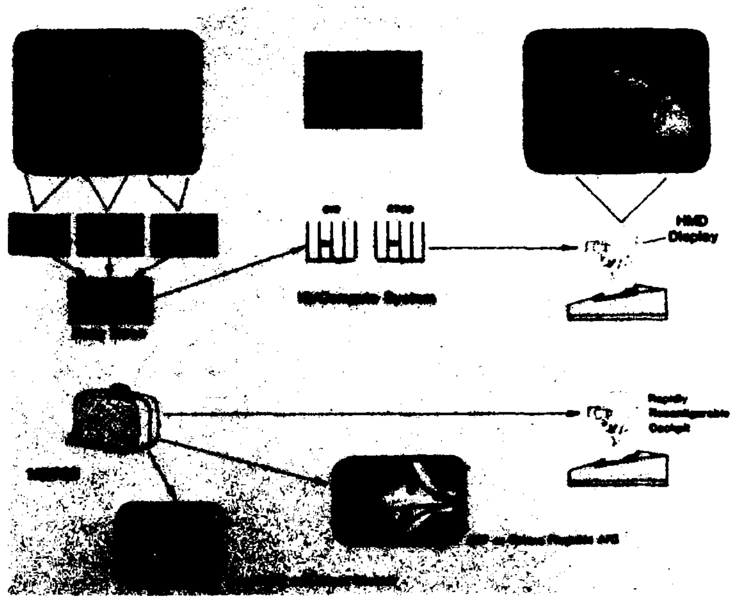

Aircrew Combat Mission Enhancement R&D

Aircrew Combat Mission Enhancement

Aircrew Combat Mission Enhancement (ACME) is a Project Forecast II technology initiative designed to provide pilot-centered combat training for the Tactical Air Forces. ACME's objectives are to develop, integrate, and evaluate the technologies required to simulate tactical air warfare for aircrew training and mission rehearsal.

These objectives capitalize on recent simulation opportunities resulting from technological breakthroughs in microcomputers and networking which promise to overcome some of the current limitations in tactical aircrew training. These training limitations are the result of such factors as dwindling airspace, increasingly complex and "expensive-to-shoot" weapon systems, unavailability of ranges, limited threat encounters, restricted flight profiles, inability to conduct realistic force-on-force training, and inadequate tactical simulation facilities.

As a Project Forecast II initiative, ACME will develop new simulation technologies for tactical aircrew training. These technology developments will culminate in multi-ship, transportable combat mission trainers. This technology will be demonstrated with A-10, F-15, and F-16 combat mission trainers. In addition, provisions have been made to allow the Air Force Wright Aeronautical Laboratories (AFWAL), Air Force Human Resources Laboratory/Logistics and Human Factors Division, and Armstrong Aerospace Medical Research Laboratory to demonstrate other applications of this technology for Command and Control wargaming and crew station design. Several of the ACME technologies also have potential application to Super Cockpit.

To develop these combat mission trainers, ACME will focus on combat-essential tasks and will rely on new approaches to simulation. The specific technologies to be developed within ACME include: smaller, lower-cost computer image generators; improved display systems; local and long distance simulator networking; distributed microprocessor-based computational systems; and improved database development techniques. These technologies will be developed in cooperation with AFWAL, Defense Advanced Research Projects Agency, Defense Mapping Agency Aerospace Center, and Rome Air Development Center, as well as the Army and Navy.

System requirements and engineering feasibility studies should be completed during FY87. Engineering development of a transportable two-ship F-16 will begin in FY88. Multi-ship A-10 and F-15 development will also begin in FY88 as part of project WARNET.

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F-16 Dome Simulator

Visual Systems Technology

There are two functional issues of concern in the area of simulator visual systems technology. First, current technology will not support the broad spectrum of Air Force flight simulation training requirements. Although this technology may be adequate for tanker-transport-bomber applications, it does not satisfy tactical fighter training needs. Modern fighter-attack aircraft are characterized by cockpits which attempt to maximize the out-of-the-window view of the pilot. This wide-field-of-view requirement, when coupled with the need to detect and determine target aspects at great distances, places extreme demands on the visual system because high resolution and wide field of-view are incompatible from a design standpoint. Consequently, there is a need to develop technology that will support the tactical flying mission. Secondly, knowledge concerning the degree of realism required for effective training in this area is still imprecise. Although perfect realism may be a desired goal from the pilot's viewpoint, it is also very expensive. R&D is needed to determine the effects of reduced realism and thereby specify those levels of realism necessary for the most effective pilot training possible.

This program will benefit two areas. Since there are continuing advances in technology, it is likely that image generation systems will be developed that will produce imagery which approaches real-world fidelity. The development of photo-based systems will provide real-world imagery since they will be based upon actual photographs. Display technology will also mature, thus enabling both high resolution and wide field-of-view. Moreover, it is expected that these systems will be affordable, thus allowing the implementation of such systems on operational tactical flight simulators. Ongoing R&D will provide answers to the issue of fidelity. Such data will provide the specifications for the minimum requirements for effective training. These data will be of direct benefit to the Simulator System Program Office in their acquisition programs.

To develop the requisite visual systems technology base, AFHRL has driven the industry in the image generation arena and has pursued a host of display technologies. The Advanced Visual Technology System (AVTS) has been developed to provide a flexible Image Generation (IG) R&D tool which is capable of supporting a variety of display system configurations. The Visual System Component Development Program (VSCDP) was also developed, along with AVTS, to demonstrate a Limited-Field-of-View (LFOV) dome capable of supporting helicopter Nap-of-the-Earth (NOE) missions. To provide the considerable LFOV and high acuity for visual displays necessary to simulate weapon systems such as the F-15 and F-16, a Full-Field-Of-View Dome (FFOVD) will be developed. Another approach is taken by the Fiber-Optic Helmet-Mounted Display (FOHMD), which addresses the need for a low-cost, transportable, simulator by developing a head- and eye-tracked, high-resolution, area-of-interest, stereoscopic, high-brightness, infinity display system. Highly cost-effective and visual-system-matched results also appear obtainable using a Variable Acuity Projection System as the technological leverage for the Fighter Lead-In Trainer (FLIT) program.

Both the AVTS and VSCDP programs have completed their development and acceptance cycles; additional work will be system enhancements aimed at providing a more complete or effective R&D tool. The FFOVD system is nearly under contract and should provide an R&D tool in the FY89 time frame. The FOHMD program has already provided a head-tracked-only, interim system to research the salient psychophysical issues. This is being followed by the engineering prototype head- and eye-tracked system scheduled for the fourth quarter of FY88. The FLIT program will soon be under contract and should provide a system by the end of FY88.

In the area of training effectiveness, a number of efforts have been completed and others have been planned and are underway. Completed efforts include: a comparison of tradeoffs between collimated and real imagery; contrasted sensitivity effects at low luminance levels; effects of brightness and contrast on target identification; and the effects of varying levels of scene on approach/landing performance.

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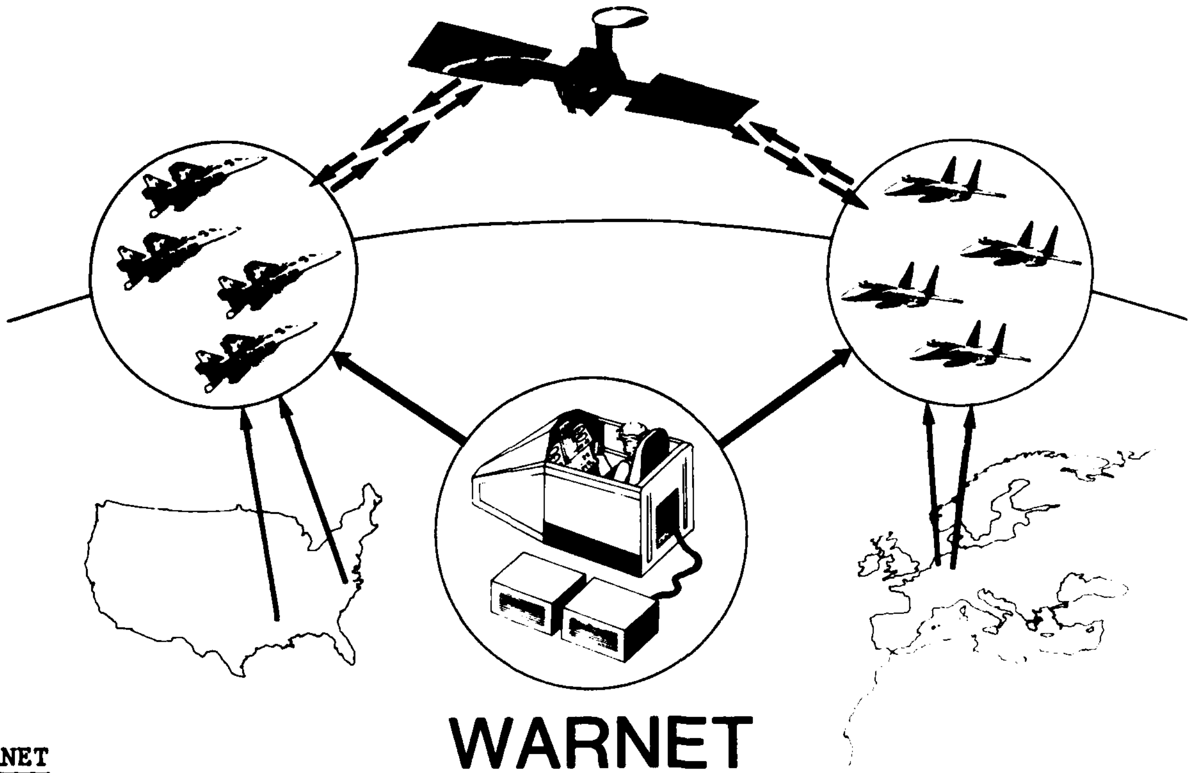

WARNET

WARNET

The objective of the WARNET program is to design and demonstrate an interactive network of low-cost combat simulators to include the F-15 air-to-air mission and the F-16 air-to-ground mission. The benefits of a network of flight simulators would provide a most necessary supplement to those aspects of training not possible in current flying exercises, and allow much more frequent practice of those skills needed to handle peak combat workloads without saturation. The result would be a higher chance of survival in real combat.

Once WARNET is developed, nodes could be established at every Air Force fighter squadron in the world. Each node would contain a four-ship simulator. A nearby node might be challenged for 4 versus 4 combat; or a major area of the network might be activated for large-scale practice. Full-scale air war exercises involving many nodes and one hundred simulators/pilots could be scheduled on a regular basis. In times of potential national emergency, special missions might be flown several times in dress rehearsal with all the players exposed to the expected threats over the battle terrain.

An initial technical feasibility and mission requirements study has started this year and will be concluded in February 1987. Using these results, the Laboratory will launch a three-phased program. Phase I consists of three separate local area networks (LANs) of F-15 and F-16 simulators. One F-16 four-ship and one F-15 four-ship will consist of both high- and medium-fidelity simulations. The third LAN will consist of eight F-16 air-to-air part-task trainers developed in conjunction with the Air National Guard. Adversary consoles will be added to each LAN as required for mission training. This wide range of devices will allow us to address the fidelity versus training question, as well as to conduct research into team/situational awareness training as we transition into Phase II.

Phase II is projected for completion in FY93. In this phase, we will network each of the LANs together for true force-on-force capability. We will also incorporate a command and control node to provide a more realistic wartime environment. Situational awareness research becomes a major effort in this phase as we stress both deep-strike and area defense scenarios.

Phase III is aimed at large-scale wargaming efforts. By expanding the network and providing the logistics and command features, we approach realistic theater-wide combat dynamics. With this tool, we have the ability to investigate all aspects of combat training.

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Aircrew Training Branch

The Aircrew Training Branch (OTA) is primarily responsible for managing, updating, maintaining, and operating the major simulation facilities located at Williams AFB, Arizona. These facilities provide the foundation for research and development on training effectiveness and flight simulator engineering. The simulation systems include dome, dodecahedron, and helmet-mounted visual displays; computer image generation systems; and related R&D equipment. They are capable of simulating F-16A, F-16C, and A-10 aircraft. These simulation systems support all R&D conducted under Project 1123, Flying Training Development, and Project 6114, Flight Simulation Technology, as well as R&D conducted under Program Element 63227F, Advanced Simulator Technology, and thus provide the primary simulation capability for implementing, demonstrating, and testing training technology and simulation hardware advancements.

The major projects supported by the Branch are documented in the previous descriptions for Projects 1123, 2363, 2743, and 6114. However, there are several other noteworthy Branch activities. These activities center around the implementation of new technologies to enhance simulation performance.

One of the Division's primary research systems is the F-16A simulator. This system simulates an F-16A Block 15S using an LFOV Dome display and the AVTS computer image generator. In order to provide a more realistic simulation, several enhancements are being made to this system. First, cell texturing is being added to the AVTS imagery shown in the dome. This will provide a capability for higher-density scene content for use in low-altitude training. Also, the basic side computer system is being upgraded to include a Distributed Microprocessing System (DMS). The DMS will allow us to collocate computer equipment with the cockpit or other research hardware, thus reducing transport delay and providing a more realistic simulation. In addition, it will allow the writing of modular, generic software that can be transported to other systems as needed.

The other major enhancement planned for the Division's simulation systems involves the in-house development of a new Instructor Operator Station (IOS). The IOS is being developed to replace the existing F-16A and A-10 IOS. The new IOS will be low-cost, dual-ship capable, and able to run training missions and collect data for R&D projects. The IOS will be based upon a distributed microprocessing system, thus permitting further evaluation of this technology.

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Combat Mission Trainer

The combat missions of today's Air Force pilots are becoming ever more demanding. This is due to increased weapon system complexity, deadlier threats, and increased speeds. The information that must be processed by the pilot is overwhelming. In order to survive, let alone succeed in this environment, a pilot must perform almost flawlessly. To reach this goal, he must practice, and practice frequently.

Unfortunately, there is no existing way to provide realistic training, with actual threats and valid targets, without imperiling the safety of pilots, on a recurring schedule that will allow maintenance of proficiency.

The objective of the Combat Mission Trainer (CMT) program is to faithfully simulate this tactical combat environment in order to provide valid training without the loss of life or equipment. The CMT will permit our pilots to have the capability to train and rehearse missions in the realistic world of air and ground threats over simulated enemy territory.

In the CMT, the minimum tactical configuration will require the simulation of two-ship missions in the context of a hostile-threat environment. Several flight simulation technologies are being developed and integrated. The aerodynamic characteristics, the cockpit, the offensive and defensive weapon systems, and the supporting sensor systems will be provided for two F-16 aircraft simulators. High-resolution, 360-degree, out-of-cockpit color displays, and their associated visual scenes and sensor imagery (infrared, radar, etc.), will also be provided (see Fiber-Optic Helmet-Mounted Display and Advanced Visual Technology System descriptions above). Communication, command and control functions, hostile threats, and responsive electronic warfare will all be included in this realistic combat simulation. This multicockpit, multisensor simulation will utilize an Instructor Operator Station to keep track of and control the highly complex situations and allow the instructors to remain adequately informed. Finally, networking will allow each simulator to interact with the others.

All of these technologies are being developed either at the Operations Training Division or at other laboratories within the Air Force Systems Command. Planning has been outlined, and implementation has begun. The first ship will be fully operational by the first quarter of 1988. The second ship, with refined and miniaturized components, will be running by the fourth quarter of 1988. The two-ship, interactive simulation will be demonstrated during the first quarter of 1989. Follow-up efforts for more advanced, transportable systems will start in late 1988, with a completion date of the fourth quarter of 1992. The task for the Combat Mission Trainer program is to integrate and package these technologies into an effective training device.

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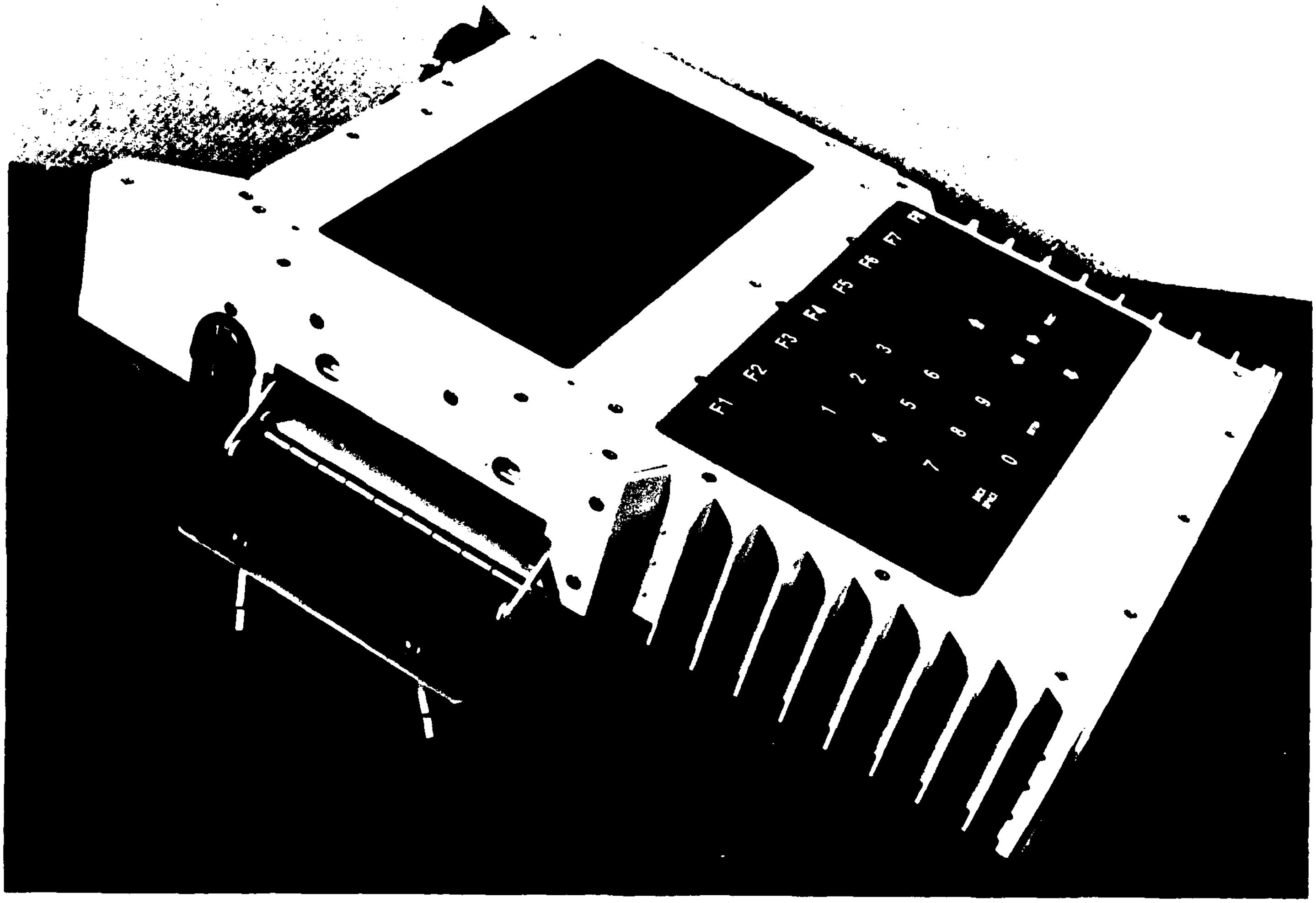
LOGISTICS & HUMAN FACTORS DIVISION



LOGISTICS AND HUMAN FACTORS DIVISION

Colonel Donald C. Tetmeyer
Division Chief

The Logistics and Human Factors Division holds a unique place in the Air Force Laboratory system. As implied by our title, we are developing essential technology for the Air Force infrastructure, as opposed to hardware for weapon systems. We are developing technology to enhance the performance of people doing critical Air Force jobs. Our field of endeavor is information and decision support.

This Division, with its unique mission, is a relative newcomer to the Laboratory system. It was formed in a 1980 internal reorganization of the Air Force Human Resources Laboratory, and did not obtain a funded 6.3 Program Element until 1984. During this short time, it already has had a significant impact on the direction of future Air Force logistics automation. This new organization recognized the rapid growth of computer technology and its applications throughout the Air Force, especially in infrastructure functions such as logistics, command/control, and space operations.

The hardware capabilities to store data are increasing at an exponential rate. However, more data does not necessarily mean more useful information. Too often processes have been automated at considerable cost, only to find that they will then take longer, require more people, and produce results that are less reliable. To be effective and efficient, a system must be designed so people can quickly get just the right information they need for the immediate decision or job, even if they do not always know exactly what that information is. This requires new methods of interfacing computers and neutral exchange among databases; new methods of data structuring, configuration management and control; new methods of decision aiding, modeling and analysis; basic understanding of human and computer processing capabilities to get the best of both; and methods for displaying information

Bertram W. Cream
Technical Director

such that it is most rapidly, easily, and correctly understood. R&D underway covers a spectrum from human information processing to the use of artificial intelligence to organize databases. Much of this cybernetic technology is still in its infancy.

The Logistics and Human Factors Division has a broad program ranging from fundamental research through advanced development, to meet operational needs into the Air Force 2000 environment. The Division staff is interdisciplinary in computer science, human factors, operations research, and engineering. Work is performed by interdisciplinary teams organized to address four critical, automation-sensitive Air Force functional areas: base-level combat maintenance, logistics planning for wartime, command/control, and the systems design and acquisition process. This internal functional organization of the Division recognizes that the results of information and decision sciences must be implemented by people who are already doing these functions and that these people are an enormous resource of expert functional knowledge. Potential users are closely involved from the outset to assure that the technology development stays relevant, and to build the confidence that is so important for eventual successful implementation. Experienced logistics and command/control officers are included in advanced development project teams, and prototypes are tried in the operating environment. The test of any new information/decision support concept is whether it really enables people to do the job better.

Combat Logistics Branch (LRC)

The objective of the R&D in the Branch is to improve the readiness and capability of maintenance and logistics units to sustain the required sorties in any combat environment. There are two major concentrations: improving the technical capability to do maintenance through advanced job aids and diagnostics; and techniques to improve combat maintenance assessment, readiness, and sustainability.

Even in the best of peacetime worlds, the Air Force often has difficulty providing enough highly skilled technicians to maintain the hardware. Experience levels have fallen in some critical skills, aggravating the conflicting time demands of meeting the flying schedule and providing adequate training. Shortages of qualified experienced technicians not only impact the quality of peacetime maintenance but, more importantly, severely impact the readiness of maintenance organizations to produce sorties in the much tougher combat environments of dispersed maintenance sites, austere bases, and mobile maintenance teams. The requirement to perform maintenance tasks under combat conditions imposes additional demands due to chemical warfare, Aircraft Battle Damage Repair (ABDR), and combat stress.

Branch R&D is focused on improving the capability for intermediate- and organizational-level maintenance in various combat environments (especially dispersed basing), including the immediate interfaces with the base-level logistics functions such as supply, cargo handling, fuels, and transportation. The various planning, assessment, training, personnel, management, and technical support processes that impact performance of the base-level maintenance function are of particular interest. This scope includes the development of new hardware and software systems that encompass the whole base-level maintenance function, and yet is narrow enough to permit a concentration on human performance issues that may limit the ability to do tasks that must be accomplished in a combat environment.

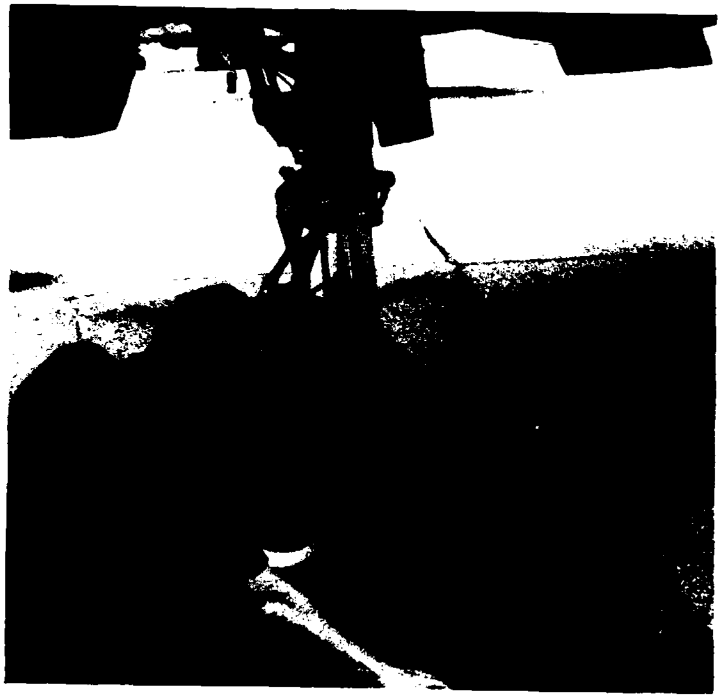
Variables that will be considered and possibly impacted as a result of this R&D include training requirements and training evaluation; job/task requirements, procedures, and evaluation; personnel skills, qualification, and experience; maintenance concepts, management procedures, and systems; design and maintenance of weapon systems and support equipment; personnel utilization and scheduling; organizational structure and management; maintenance policy and planning; technical orders; maintenance prioritization and the decision-making process; maintenance readiness, capability assessment, and sustainability prediction; personnel stress and fatigue; aircraft battle damage repair; and the impact of the chemical/biological warfare environment on organizational performance. Traditional measures of task performance, such as time to perform, type and number of errors made, skills required, and problems encountered will be used to evaluate R&D efforts. In addition, subjective data on attitudes, morale, and preferences will be collected where appropriate. System performance measures will be used during field evaluations. These include sorties scheduled and flown, aborts, cancellations, hours flown, retest OK and cannot duplicate rates, and aircraft status designations.

Advanced information science and computer technology are being used to help "bridge the gap" between the technical skill available and the skill required to maintain today's sophisticated aircraft and the broader skills required of maintenance generalists in the future. The basic approach is to use computer technology to give technicians more thorough, easily followed, and responsive maintenance instructions and troubleshooting aids. These will be developed in a phased, incremental program. The first step was the development of principles for electronic display of job aiding information, and the test of two approaches in Strategic Air Command (SAC) intermediate shops. The second step is a portable computer display system for a Tactical Air Command (TAC) flight line. The third increment will incorporate interactive diagnostics and interface with sensors and computers on board the aircraft. Future increments will provide a single communications link to all base-level maintenance data and artificial intelligence aids.

Integrated Maintenance Information System (IMIS)

Changes in threats, support concepts, and weapon system technology are taking place which will radically alter the way maintenance must be done to generate tactical sorties in future wars. Aircraft must be more dispersed. They must depend less on bulky test equipment and large on-site facilities for off-equipment maintenance. Modular architecture design concepts will make existing maintenance specialties obsolete. Systems will be more complex, more integrated, and require deeper maintenance on the line by fewer technicians who must master a broader range of tasks and skills. Automation will only increase the problem if introduced as a multiplicity of unique and incompatible information "aids." AFHRL is developing a comprehensive information and job aiding system to help technicians generate the needed sorties in this environment.

The IMIS will consist of a portable computer for flight line use, an aircraft interface panel for interacting with aircraft systems, and a workstation for use in the shop when not remotely deployed. The system will provide the technician with direct access to several maintenance information systems and databases including automated technical data, automated maintenance management information, the computer-aided training system, and automated parts information and ordering. IMIS will process, integrate, and display maintenance information to the technician. The system will display graphic, technical instructions, provide intelligent diagnostic advice, provide



Ruggedized Portable Computer
Maintenance Aids System

aircraft battle damage assessment aids, analyze in-flight performance and failure data, analyze aircraft historical data, and access and interrogate onboard built-in test capabilities. It will also provide the technician with easy, efficient methods to receive work orders, report maintenance actions, order parts from supply, and complete computer-aided training lessons and simulations. The portable computer will make it possible to present quality information by taking advantage of the computer's ability to interact with and tailor information to the immediate needs of technicians with varying levels of expertise.

Development is proceeding in three stages, using significant amounts of in-house technology development supplemented by contracts. Stage I, the Computer-based Maintenance Aids System (CMAS), established basic requirements for automated Technical Order (TO) data content, presentation formats, and basic delivery system hardware/software. Stage II, the Portable Computer-based Maintenance Aids System (PCMAS), is designed to examine the TO presentation specified in Stage I on the flight line and demonstrate interactive diagnostics and aircraft battle damage repair assessment. Stage III, Full IMIS Demonstration, will extend the concepts specified in Stages I and II, with an emphasis on information integration throughout the maintenance complex.

In Stage I, a prototype automated technical data system was tested in intermediate-level maintenance. The prototype was used to successfully demonstrate the feasibility and desirability of automated storage and presentation of technical data. The prototype system was well received by technicians, who strongly recommended its application by the Air Force. Draft functional specifications for the system and for the content of technical data to be presented on the system were developed. A major technical advancement has been made with the in-house development of an Authoring and Presentation System (APS) to generate, store, organize, retrieve, and display technical order information. APS uses a relational database to identify and store all the critical data relationships found in a TO. It is format free and machine and application independent. APS will make both present and future electronic TO display systems more flexible, transportable, and powerful. Stage II, the PCMAS, is a follow-on advanced development R&D effort to apply the technology developed in Stage I to the flight line environment. A small, portable, special-purpose computer is being developed for use on the flight line. Field tests with PCMAS will examine problems involved in using a portable computer system on the flight line. The PCMAS will demonstrate several concepts that are key to the successful implementation of IMIS. In addition to presenting technical data for routine maintenance tasks, PCMAS will provide an interactive diagnostics capability.

Portable Computer-Based Maintenance Aids System

The PCMAS device will plug directly into the aircraft system bus, take over as bus controller, interrogate on-board systems for stored fault data, and run manual and built-in tests. Efficient testing procedures will be generated through generic diagnostic software that ensures optimal use of tests based on their run times and fault coverage. The software also examines diagnostic factors such as maximum aircraft downtime and available supplies. Also, the PCMAS will provide specialized technical information to assist in ABDR assessment. This information will allow a single technician to accomplish the assessment task so that specialists in each area (structural, airplane general, and electrical) are not required. In Stage III, the full IMIS capability will be developed and demonstrated. Hardware and software will be developed to integrate the various maintenance information systems with which technicians must interact daily. The technician's primary interface with IMIS will be an extremely portable, battery-powered computer that is rugged enough for flight line use. A library of removable memory cartridges will store all the technical order information and diagnostic aids needed for one weapon system. The portable computer will have the processing power to quickly display complex graphics and provide rapid response to the technician's requests. Interactive troubleshooting routines and artificial-intelligence-based diagnostic aids will provide advice for difficult fault isolation problems.

IMIS will have many benefits. It will optimize the use of the available manpower, enhance technical performance, improve training, and reduce the support equipment and documentation needed for deployment. It will serve as the technician's single, integrated source of all the technical information required to perform modern aircraft maintenance. This will eliminate the need for the technician to learn how to use several different computer systems, thereby reducing training requirements and eliminating confusion. It may also eliminate the need for the Air Force to field several different computer systems; thus reducing the need for unique hardware and software. Significant cost savings will be realized from the reduced training and system acquisition requirements. In addition, the improved diagnostic capabilities will improve the efficiency of technicians to troubleshoot faults, resulting in savings in time to restore malfunctioning equipment to operational status, reduced consumption of spare parts, and improved operational readiness rates. Finally, the ability to collect historical maintenance diagnostics data will allow the identification of common field problems that might indicate flaws in the TO data, incorrect procedures, and/or areas which require additional training for the maintenance personnel.

Progress to date is as follows: Stage I, CMAS, has been completed. The Stage II, PCMAS, has been designed and an initial unit fabricated. The system and software will be tested in 1987. The Stage III, full-scale development of IMIS, will be accomplished under contract, with award planned for late FY87.

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Effects of Chemical Warfare Defense on Airbase Maintenance Operations

The ability of maintenance personnel to perform critical and highly technical tasks in chemical warfare gear has been recognized as a potentially limiting factor in the generation of combat sorties. No systematic, scientific data have been gathered on the effects that chemical protective clothing may have on performing the maintenance tasks that will be required when the aircraft requires troubleshooting and removal/replacement of various systems and components. Until this information is known, the actual degree of limitation imposed by chemical warfare on maintenance tasks cannot be predicted. Consequently, a methodology must be developed and data collected to systematically evaluate the impact chemical warfare gear has on the performance of critical maintenance, diagnostic, and repair tasks in order to assess wartime capability and provide the basis for developing improved equipment and procedures.

AFHRL/LRC is developing this methodology. It can be used by operational personnel as well as R&D personnel. The methodology will be applied to selected critical maintenance tasks on the F-16 to evaluate the impact of the chemical defense gear on the ability of technicians to perform selected critical tasks. The methodology will be used to collect data at a tactical F-16 wing in Europe. The resultant data will be analyzed to develop maintenance workarounds, recommendations for tool redesign, or procedural changes that can reduce the expected negative impact of the chemical gear on task performance. In addition, results from this effort will provide data for use by the Armstrong Aerospace Medical Research Laboratory (AAMRL), which is modeling the impact of chemical warfare on combat operations.

The effort started with an in-house analysis to determine which combat critical tasks should be studied. A thorough review of maintenance data collection records was conducted and appropriate tasks selected. A review of the applicable TO and job guides was also accomplished.

Impacts of Chemical Warfare on Maintenance

Based on these reviews, data recording forms were developed to use in conjunction with video recording to capture the types of problems that arise when maintenance is performed in the chemical ensemble. The methodology was developed and tested at a CONUS base during the 3rd quarter of FY86.

Upon completion, this effort will provide a tested methodology to permit maintenance organizations to evaluate their ability to perform critical combat maintenance tasks while wearing the chemical defense gear. This will provide a basis for them to develop ways to more effectively perform tasks which are severely impacted by the use of the gear. The improved procedures will increase the unit's capability to conduct combat operations under chemical warfare conditions.

The performance measurement and data collection methodologies have been developed and tested at Shaw AFB. In October 1986, these methodologies were applied during data collection for selected critical F-16 maintenance tasks at Hahn AB, Germany.

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AUTOVON 785-3771

Combat Maintenance Capability (CMC)

To ensure that the Air Force has the capability to meet its mission requirements, it is essential to have effective ways to estimate its capability to conduct wartime operations and to sustain these operations. Ways are needed to accurately estimate the capabilities of individual units and to estimate the logistics support required so that the units can accomplish their assigned missions. Extensive work has been accomplished to develop techniques to measure capabilities under peacetime conditions and to estimate logistics requirements for peacetime operations. However, additional work is needed to extend these capabilities to effectively include the unique requirements of wartime operations. The CMC project was undertaken to meet this need.

The CMC project initially used Hahn AB, Germany as an evaluation site and the F-16 aircraft as an analysis vehicle. CMC objectives were to develop methodology, analyze current maintenance processes, identify combat impacts, and recommend improvements. The approach used existing Air Force Logistics Composite Model (LOCM) data sets, war plans, and resource quantities. Surveys were used to capture expected combat impacts and updates to task times and crew sizes. This initial work was followed by a refinement of the methodology and an extensive, highly successful application demonstration at RAF Lakenheath, UK, with the F-111F aircraft.

CMC provides effective analysis of combat issues by employing state-of-the-art models (TSAR, TSARINA, DYNA-Metric or actual spares resources) to evaluate the capabilities of Air Force units to support combat operations. Results are integrated for complete modeling portrayal of base activities. Dynamic conditions such as early combat surge periods and sustained operations can be portrayed. The methodology integrates the combat effects of airbase attacks (e.g., runway damage, facilities damage, resource losses), post-attack delay impacts, aircraft attrition, and aircraft battle damage. This provides simultaneous interaction of combat effects with base activities. CMC results in realistic representations for projecting base combat maintenance capability.

This technology development effort has been completed. CMC assessment via computer simulation modeling has been successfully demonstrated with the F-16 aircraft at Hahn AB, Germany and F-111F aircraft at RAF Lakenheath, UK.

Combat Maintenance Capability

This R&D effort has been successful in developing a capability assessment methodology that considers the synergistic effects of: maintenance and support activities, operational taskings, availability of support assets, enemy airbase attacks, mission aircraft attrition and alternative conditions. An Executive Summary, AFHRL-TR-85-35, is in distribution. Technical reports, "Findings and Computer Simulation Results" and "Methodology," are in final review prior to printing. The technical report for the F-111F phase of the project is in the initial draft stage.

Simulation of 48th TFW combat maintenance has been successfully demonstrated at RAF Lakenheath, UK. Combat maintenance has been assessed and limiting factors identified for scenario conditions and the CMC methodology refined. A follow-on advanced development effort is planned to further refine and test the methodology and to demonstrate its use in conjunction with other advanced technologies to improve combat operations capability.

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Small Unit Maintenance Manpower Analyses (SUMMA)

The current and future emphasis on combat mobility, flexibility, and sustainability of our Tactical Air Forces causes us to redefine the scope and content of maintenance occupations. The prospects of airbase dispersal and small unit operations during periods of conflict imply broadened task training for the maintenance workforce as a key element of logistics support. The SUMMA program is developing technology that can provide a computer-based decision support system useful for:

- projecting and analyzing combat workloads based on deployment scenarios,
- allocating maintenance tasks to new or redefined job specialties,
- evaluating, through integration of logistics performance simulation and force management/policy analysis, the combat effectiveness and feasibility of desired job restructures.

The SUMMA decision support system is being developed using the F-16 for concept prototype application. Key developments during FY86 were the mathematical formulation of a task allocation optimization algorithm and the creation of large F-16 task analysis and supporting personnel and training databases. The data on task learning, task performance, and task time are key inputs to the task allocation and reallocation problem.

Key remaining efforts are the integration of methods and databases and their translation into a microcomputer-based software package that will function as a workstation.

When fully developed, the SUMMA decision support system can be used by analysts working in System Program Offices to help in the definition and redefinition of maintenance occupations for new weapon systems. For managers in the manpower, personnel, and training arenas, SUMMA will allow a fuller analysis of proposed changes in occupational structure and the capability to judge the probable contribution of restructured maintenance specialties to success in the combat environment.

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Logistics Systems Branch (LRL)

The objectives of this Branch are to develop capabilities (a) to analyze Air Force-wide logistics concepts and requirements in terms of their impact on our ability to conduct combat operations and (b) to augment decision-making processes within the logistics support structure.

AFHRL/LRL is conducting R&D to address certain priority objectives outlined in the FUTURE LOOK 85 Logistics Long Range Planning Guide, FY 1988-2002 published by HQ USAF/DCS for Logistics.

Specifically, our R&D is directed toward incorporating advanced technologies and methodologies to meet warfighting capabilities by providing the tools needed (a) to compare and evaluate deployment/employment and support concepts of operations and predict wartime resource requirements and (b) to enhance the capabilities of decision makers within the support structure.

The program is an amalgam of exploratory research and advanced development efforts which will culminate in two significant contributions for the USAF. The first encompasses model and algorithm developments. These will provide the capabilities to evaluate logistics supportability in situations requiring responses to anticipated but difficult-to-quantify events. The second is a series of generic models of decision and information flow processes. These will provide improved automation aids for support personnel within the logistics infrastructure.

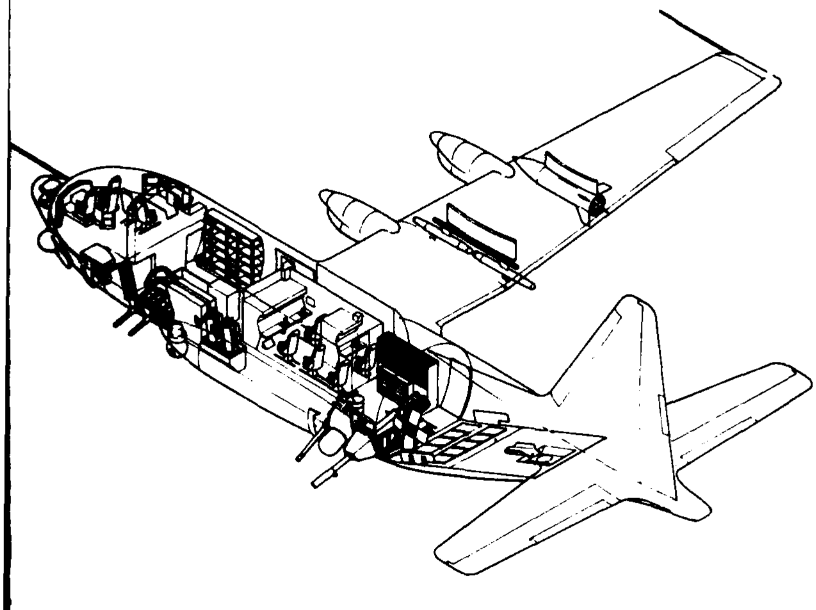
A basic problem exists in most models currently employed for capability assessment. Operations assessment models tend to aggregate (sometimes ignore) logistics and maintenance aspects and impacts. At the same time, logistics support assessment models tend toward minimal operational input. A need exists to provide simulation capabilities that will overcome these and other modeling shortfalls. Specific benefits will include: (a) integration of both current and proposed deployment/employment and support concepts of operations, (b) better quantification of the interactions among these concepts, and (c) more accurate predictions of theater-level resource requirements for consumables, spare parts, support equipment, and personnel to meet the demands of combat flying schedules.

With the onslaught of more and more automated systems and databases, personnel involved with the identification of logistics support requirements need decision support technology to perform their functions effectively and efficiently. The ever-increasing workload and information availability at all levels impact requirements for proper and accurate decision making within the support structure. A need exists to provide decision support systems to alleviate this workload for both experienced and new personnel within the system. Specific benefits will include: (a) accurate representations of documented and "gut feel" decision-making rules, (b) timely forecasts for procurement actions, (c) improved readiness by reducing reprocurement leadtime, (d) reduction in pipeline choke points, and (e) improved surge-handling capabilities to meet combat requirements.

To satisfy these needs, a complex R&D and transition program has been implemented. This program involves internal efforts as well as cooperative work with other Branches, Divisions, Laboratories, and Major Commands. Much initial groundwork has already been covered, with past and ongoing work related to database construction for demand rate estimation, application of existing logistics assessment models, and initial concept analysis methodology. Future efforts will evaluate and address the critical interfaces among development, logistics, and operations systems. These will culminate in tools essential to increase readiness through comparisons of alternative concepts and through provisions for decision support systems. This program has been devised to provide the USAF new capabilities in two major areas of need:

(1) Exploration and advanced R&D efforts are already underway in the areas of predicting wartime resource requirements, developing combat data, and developing support concept analysis methodology. Work performed under the first area is exploratory in preparation for an expanded advanced development effort. In fact, the advanced effort has already begun with the collection of existing, available historical combat data in preparation for the development of systematic methods to forecast wartime resource requirements. Further efforts center on exploratory research related to specific aircraft subsystems for inclusion in advanced R&D to better define the overall methodology. The tools, databases, and models resulting from this process will, in turn, be fundamental to ongoing and future advanced R&D. Current efforts focus on a methodology including an executive program which controls a series of existing computer models to analyze resource requirements by passing information among existing logistics assessment models. We are now beginning to explore the integration of operations, logistics, and other combat assessment models to the end that an integrated system concept methodology will be conceived. Advanced R&D in this area will result in a tool capable not only of realistically estimating resource requirements, but also of depicting the interactions between the employment/deployment and logistics concepts of operations.

(2) The second series of developments involves systematic R&D into the evolution of logistics decision support systems. This involves a three-pronged effort to provide new capabilities to personnel involved with, and working within, the logistics support structure. Decision support systems will be devised, following a thorough systems analysis, for use at various levels within the logistics infrastructure. These systems will be tailored to their intended environment, but will also be generic in nature to allow further *expansion and enhancement.* The intent is to conduct the R&D that will ensure overall system interoperability and compatibility.



Gunship

Gunship Project

Key decisions affecting the life-cycle cost of a weapon system program are made before full-scale engineering development begins. The Air Force currently lacks adequate methodology to analyze supportability issues during the conceptual design phase. At the request of the Aeronautical Systems Division (ASD), AFHRL/LR developed and demonstrated techniques for analysis of the human factors, training, and logistics drivers for future gunship design and employment concepts.

The ability to conduct quantitative analysis of supportability issues in the conceptual design phase will reduce weapon system life-cycle costs and increase supportability, thus improving overall war-fighting capability.

This effort was a baseline supportability analysis of a representative, state-of-the-art technology, near-term, replacement gunship. Emphasis was on quantification of selected resources for a specific weapon system design, and developed missions and scenarios. The intent was to provide a baseline comparison system and accumulate preliminary data for a replacement gunship. A two-pronged approach was taken. A contractor-performed effort used analytical techniques to quantify selected logistics requirements. An in-house effort was also performed using computer simulation techniques to assess sortie generation capability and maintenance manpower requirements.

Both efforts are complete and in the process of being documented. Their application to both the Replacement Gunship Program and Gunship III have been recognized by ASD, who has requested the results be briefed to both the Air Staff and MAC Headquarters. Results have also been presented to the Air Force Logistics Command (AFLC) and the Acquisition Logistics Analysts Conference.

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Mission Reliability Model (MIREM)

MIREM was developed to evaluate the reliability and fault tolerance of new integrated avionics systems and to identify potential design changes to improve reliability during the conceptual stages of design. Traditional models and methods could not evaluate reconfigurable systems. As a new front-end analysis technique, MIREM gives the design engineer and logistics manager the capability to do interactive data entry, to moderate data requirements, and to perform sensitivity analyses. The model will be transitioned to Rome Air Development Center (RADC) for inclusion in a Military Standard and for application to a variety of reliability prediction problems.

Since MIREM is Air Force-owned software, our approach has been to give the model the widest possible exposure. In order to ensure its accuracy, an effort is underway to verify the algorithms used in MIREM. Several enhancements have been added that expand the model's scope to a broad class of fault tolerant reliability problems.

During FY86, several briefings, including a technical seminar, were given to R&D personnel of other Air Force laboratories. The model was well received and is now being used on the Ultra-Reliable Radar (URR) program at the Air Force Wright Aeronautical Laboratories (AFWAL) Avionics Laboratory. Verification of the original release of MIREM (October 1984) has been completed. New features recently added include: quantifying the effects of imperfect testability; innovative repair policies; and graphics. MIREM now has the capability to model cascaded circuits that use more than two levels of redundancy.

The improved version of MIREM was released in March 1986. Draft user and programmer guides have also been prepared and will be published shortly.

With the assistance of RADC, the newest version of MIREM will be verified in the coming year. The model will also be transitioned to RADC in order to provide a permanent home for the software. As the MIREM technology nears maturity, our plan is to pave the way for its widest possible use by the Air Force R&D community. One MIREM application has been in support of the Strategic Defense Initiative Office. MIREM was identified as a technique to assess the ability of various battle management nodes to function under selected scenarios. This application shows the potential of MIREM to serve as an analysis tool beyond modular avionics.

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Unified Life Cycle Engineering (ULCE)

One of the major information and decision science technology development requirements identified during the recent Project Forecast II study was the need to integrate "design for producibility" and "design for supportability" into the weapon system design process along with "design for performance, cost, and schedule." Consideration of these "ilities" (producibility, maintainability, reliability, sustainability, etc.) during the conceptual design phase will reduce weapon system life-cycle costs and increase supportability, thus improving overall war-fighting capability. This requirement was identified based on the study team's judgment that current manual system design and information management techniques for making complex decisions involving trade-offs among competing design requirements are inadequate. The Forecast II team felt that the advances being made in Computer-Aided Design (CAD), Computer-Aided Manufacturing (CAM), and Computer-Aided Engineering (CAE), along with advances being made in integrated networked design information systems, held the promise of allowing truly integrated engineering design development for future weapon systems. The overall objective of this multiple-agency program is to develop, demonstrate, and transfer to application, by 1995, the technologies needed to provide integration of "design for producibility" and "design for supportability" with "design for performance, cost, and schedule."

This program is being conducted by a number of Air Force agencies. These include AFHRL, the AFWAL Materials and Flight Dynamics Laboratories of the ASD, and RADC. The long-term program plan for ULCE is to provide an information/decision support technology base for the next-generation design system. As conceived, this contemplated new capability will allow, through an integrated automated information management system, "cradle to grave" program management. This in turn will significantly reduce design-to-manufacture lead-times and prototyping requirements, and significantly improve supportability. Near-term technology development/demonstration efforts will focus on the development of design tools/models in the Reliability, Availability, and Maintainability in Computer-Aided Design (RAMCAD) domain. The objective of this work is to better define and understand the interaction between these RAMCAD tools/models and CAD/CAM tools/models and to integrate them into a decision support system embedded in the design environment.

Several ongoing AFHRL/LR technology development programs will form the technology core needed to integrate supportability into the CAD process. CREW CHIEF is representative of the type of supportability model that can be incorporated within the ULCE concept. RAMCAD has formed a university/industry consortium to coordinate R&D and speed the transition of R&D products. The Integrated Design Support (IDS) system will provide the basic technology for developing an architecture and information management system capable of integrating the required models and databases in real time.

A new FY87 project will develop a decision support system to aid the design engineer during the trade-off process among competing design requirements. For example, the reliability of a particular part must be compared to its cost, weight, size, and many other measures to obtain an "optimum" design. To determine impacts on system reliability, the reliability of that part must also be compared to the reliability of the other parts with which it interacts.

The ULCE program is now being planned. A Draft Implementation Plan was completed in June 1986. A working group has been formed to complete a detailed technical plan by the first quarter of FY87. In-house and contract work is expected to begin by January 1987.

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Ground Operations Branch (LRG)

The objective of this branch is to improve the combat readiness of battle managers (individuals) and battle staffs (teams) assigned to both centralized and functionally distributed Command and Control (C^2) systems through research, development, test, and application of advanced training and human performance technology. The primary R&D objectives of this program are taken from the Tactical Air Force Interoperability (TAFIS) Master Plan, the 21st Century TAC and Control System Studies (CSS), Tactical Air Control System 2000 (TACS), recommendations of the Defense Sciences Board, and DOD/AF/TAF planning documents. The intent is to develop better ways to organize and train battle staffs and battle managers for wartime C^2 operations; assess the value of these preparations; provide human performance design input during the acquisition cycle for new C^2 systems; and develop methods, specifications, and field demonstrations of how to practice and sustain this combat readiness during peacetime. The approach focuses on the human elements of C^2 systems but considers all other system elements in the approaches followed.

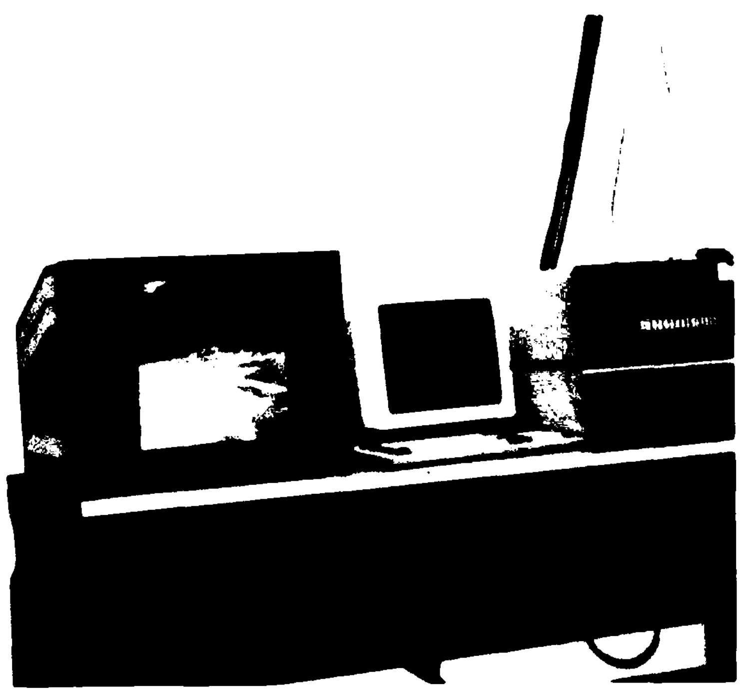
Work being accomplished or planned is directed toward three major goals. All require better understanding of the human and system information and decision processes. The first goal is to develop technology to improve combat readiness training of the individuals and teams assigned to the operational and logistics elements of the theater and force management levels (Tactical Air Forces [TAF] and Tactical Air Control Center [TACC]). The second is to develop practical performance assessment methods for these functions. The third is to develop human performance design guidance for application by the design (RADC) and acquisition (ESD) communities to allow procurement of systems that fully consider the human operators. Past efforts in this area have focused on the TAF/TACC levels. In the future, we will place more emphasis on the generalization of this technology toward additional applications in missile and space systems, with particular emphasis on support for future space C^2 issues.

The number of variables that can potentially impact the operational readiness of battle staffs and battle managers assigned to (or scheduled to be assigned to) tactical C^2 systems is very large. Efforts focus on specific aspects of combat job requirements analysis, system/human interaction modeling, advanced training technology, training/exercising devices and methods, development of internal and external assessment methods, and human performance studies relevant to system operation. These have been prioritized based on the state of technology development, user requirements, resource constraints, and predicted payoff.

Technology development and application programs in this Branch support broad areas of R&D on C^2 training and operations. Work is conducted with/in support of USAFE, RADC, TAC, AAMRL, the Tactical Air Warfare Center (TAWC), the Electronic Systems Division (ESD), the 9th AF, and other DOD agencies. Planning activities are underway to provide technology development and application support to Space Command, the Strategic Defense Initiative Office, and the Strategic Air Command.

Work initiated several years ago to develop a task analysis database technology, to support users such as Blue Flag, continues. A program to train American logistics controllers on NATO procedures was delivered to USAFE. Another Branch program investigates decision making in a simulated Combat Plans Division of a TACC. The purpose of this R&D is to better understand the decision-making processes used in preparing Air Tasking Orders (ATOs).

The Visual Simulation for Tactical Command and Control System (VISTACS) program will provide photogrammetric-based computer image generation for training on mission planning and related activities. Several additional studies are being planned to investigate the required level of imagery realism, among other variables. Fundamental R&D in the areas of human automaticity and multiple resource variables is also underway.



Visual Simulation Equipment for C^2 Research

Other work, to be initiated in FY87, will determine whether artificial intelligence techniques can be adapted to map the knowledge base of C^2 expert decision makers. Results of this work should provide technologies to improve the training of TACC battle staffs. Also in FY87, efforts to investigate the performance effects of various levels of automation within tactical C^2 systems will begin. Simulation modeling tools using artificial intelligence techniques will be developed to allow C^2 system designers to predict the effects on overall system functions (e.g., tasks, skills, training) resulting from the introduction of automation.

Command and Control R&D Capability Enhancements

US Air Force C^2 battle managers and their supporting staffs are faced with increasing amounts of information to review while having less time in which to make critical decisions. Many of the projected combat scenarios, coupled with the capabilities of current and planned operations, intelligence, and communications support systems, allow only a brief period of time in which a correct decision must be made to achieve a combat objective. As an additional complicating factor, many of the future C^2 systems will allow functionally distributed and physically dispersed operation of C^2 nodes to increase their survivability. If certain nodes of a C^2 system become nonoperational, other nodes will have to assume some functions previously allocated elsewhere. Accordingly, the complexity of battle management will grow. With this growth comes an increasing requirement to provide realistic combat training opportunities to prepare our C^2 battle managers, their staffs, and supporting agencies.

Providing Air Force C^2 battle managers/staffs with advanced training technology to allow realistic learning and practice of combat tasks is essential to increasing the probability of successful combat performance. In order to achieve this objective, we must have a better understanding of the combat decision maker's mental model (i.e., his information processing strategies, decision approaches, etc.) of the situation(s) and the associated decision processes. Because little R&D on decision making has been aimed at complex, nonproceduralized, time-critical, and often stressful situations, not much is known about the battle manager's mental model. The payoff of this work will be not only more realistic combat preparation for the operational forces but also design information on human performance capabilities relevant to new system technology development and acquisition agencies (e.g., RADC and ESD).

During 1985-86, work was initiated to upgrade the current AFHRL/LRG In-House Team Performance R&D Facility to a secure operating environment. Detailed plans were prepared to design a facility with adaptable and reconfigurable workstations to enable several nodes of a given C^2 system to be simultaneously emulated. This adaptability will allow the facility to support in-house and contractually supported R&D on a variety of systems and programs (e.g., tactical and strategic C^2, space ground control, Strategic Defense Initiative). In addition to the computer hardware requirements and physical layout, considerable work was done to identify existing simulation software to support needed simulations to use as baselines for expanding and testing new combat training exercise programs. Also, the feasibility of providing a satellite and/or ground link to other facilities, such as the RADC Battle Management Research Facility, AAMRL C^3 Operator Performance Engineering Facility, and the AFHRL Operations Training Division, is being investigated as part of a contemplated networking to allow joint studies of distributed C^2 decision making.

The basic physical facility modifications have been completed and the plan to achieve this significant R&D capability enhancement was completed in September 1986. Current hardware configuration includes DEC VAX systems, symbolic processors, graphic systems, and various user terminals and workstations. Additional renovations are planned in FY87 in order to complete the facility. Some hardware, such as LISP machines, was purchased, and the design of the facility was initiated. It is anticipated that R&D to support a variety of users will be conducted in 1987 while facility renovation is underway.

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Computerized Training and Design Tools for Tactical Command and Control

Traditional task analysis techniques are not well suited for describing activities in a complex C^2 system such as TACS. These techniques rely on the ability of an observer to capture the process under scrutiny by observing and recording the active system in a structured manner. The geographical dispersion, individual decision making, and frequent small group interactions characteristic of a TACC make observations difficult. A second problem is that detailed and current data on actual TACS organizational structure and assignment of functions to individual organizations often do not exist. Data which do exist are outdated and/or do not provide the required level of detail. This constrains the design process for new tactical C^2 systems. Whenever a new system is being designed or retrofit of a new capability to an existing system is contemplated, data must first be collected on current systems and configurations, thus slowing the design process. A third problem is the need for highly trained analysts working one-on-one with C^2 personnel to collect data at the job site. This type of data collection is difficult due to the widely dispersed CONUS and overseas locations, the requirement not to interfere with job duties, and the extensive time required.

To address these problems, an in-house program is underway to design and develop a computerized task analysis system that will allow operational personnel to input task analysis data themselves, at their job site, whenever they have spare time. The contemplated data collection system will then perform an analysis of the data to generate both a database which contains a model of the system (to the positional level) and an error report which lists inconsistent and missing data. This system will provide the Air Force with a capability to collect accurate data from C^2 system operators in a more expedient and less costly manner. Additionally, the database generated will provide the design community with accurate and detailed knowledge about C^2 functional nodes and operations prior to the start of a design effort. Software is being developed to automate task analysis data collection from Subject-Matter Experts (SME). This software, which runs on standard Air Force microcomputers, guides the SMEs through a data collection session by asking questions and recording responses. The data files generated are then analyzed by a second program, which builds a model of the system under evaluation and generates an error report. The model of the system is then loaded into a relational database. The error report generated allows the analyst to address the problems encountered. After in-house testing, field tests will be conducted to assess the system and if validated, the software will be made available to relevant DOD agencies for their use. AFHRL/LRG will use the data collected to build a data library. These new data may then be merged with already existing data on other systems to provide the C^2 community with a current database with multiple applications.

Software that will allow SMEs to input data was developed and debugged during FY86. In FY87, software to analyze the collected data will be developed and debugged. A field test of the prototype system is planned during the last quarter of FY87.

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Acquisition Logistics Branch (LRA)

The objective of the Branch is to provide the technological components of structured engineering information support and automated management processes for acquiring more supportable and sustainable systems. Key programs address the exploitation of computer technology for designed-in supportability and the integration of automated technical information.

The future predicted by Air Force 2000 requires more dispersed and mobile operations that can be achieved only if the new weapon systems are designed for increased availability, supportability, and sustainability. Similarly, the Strategic Defense Initiative will require very high levels of reliability at much lower cost. DOD Directive 5000.39, the Acquisition Improvement Program, the Air Force Reliability and Maintainability (R&M) 2000 Program, and AF 2000 call for increasing readiness through R&D and policy changes. At the same time, the prospect of limited budgets and increasing Soviet weapon system sophistication requires that we develop more supportable systems faster and at substantially lower cost. The need to employ computer technology to develop more supportable weapon systems faster and cheaper has been identified more recently by the Office of the Secretary of Defense (OSD) and the Institute for Defense Analysis (IDA) through two joint studies. The R&M study and the Computer-Aided Logistics Support (CALS) Study structured policy initiatives which were affirmed in a 1985 Memorandum by Deputy Secretary of Defense William H. Taft IV. This Memorandum requires the Services to implement CALS concepts by the year 1990. AFHRL/LRA is the primary Air Force R&D agency responsible for developing the automation and system integration technology to enable CALS.

The acquisition logistics R&D program will aid in overcoming technical deficiencies and hence, achieve the Air Force objective of improved supportability and sustainability. This R&D program forms a nucleus for the Air Force response to the CALS initiative and also provides a strategy to resolve technical deficiencies. Each individual program will contribute to the achievement of higher weapon system availability and supportability through the integration and automation of a large portion of the acquisition and support process. As a benefit of this automation, weapon system funding can be redirected from costly redesign and maintenance to the acquisition of additional systems.

The scope of this area of work includes the technological components of engineering information support. These components are applicable to the entire weapon system acquisition process from early conceptual studies through analysis, design, planning, and support of fielded systems. Technical emphasis is on computer applications, mathematical algorithms, structured information flow processes, and development of technology transition strategies.

Significant components of the process include CALS, Automated Technical Information (ATI), R&M analysis, Logistics Support Analysis and Records (LSA/LSAR), engineering configuration management and life-cycle cost, and ergonomic Manpower, Personnel, and Training (MPT) factors involved in design and unified life-cycle engineering. Weapon system emphasis will be upon aeronautic systems; however, the technological R&D products will be applicable to other defense systems. Specific examples of these technological components will occur in three areas: design analysis models (e.g., CREW CHIEF) and their application in computer-aided design (RAMCAD); logistics support analysis (Unified Database for Acquisition Logistics) database automation; and information support (Integrated Design Support Systems and Automated Information Technology).

The planned R&D will influence a number of variables within the acquisition cycle. These variables are classified into four categories: acquisition management, planning, design and analysis, and data and information management.

Each of these variables is comprised of a number of important components. Acquisition management includes contract requirements, specifications and standards, management control procedures, Defense Systems Acquisition Review Council/Air Force Systems Acquisition Review Council criteria and content, and major system documentation such as the Air Force Program Objectives Memorandum, the Decision Coordinating Paper and the Integrated Logistics Support Plan. Planning includes elements such as forecasting models, maintenance and logistics concepts, unit manning structures, and training program requirements. The design and analysis variables include specific elements such as mathematical CAD techniques, design goals and criteria, trade-off parameters and procedures, and design review objectives and procedures. The data and information management variables includes structured analysis of data content and systems, data timeliness and information availability, data exchange specifications and standards, data flow processes, and storage and retrieval mechanisms.

Reliability, Availability, and Maintainability in Computer-Aided Design (RAMCAD)

In order to meet the operational objectives as described in Air Force 2000, significant improvements in the supportability of Air Force weapon systems are required. R&M must be designed into weapon systems early in the design process. The objective of RAMCAD is to develop technology to accomplish this through the use of Computer-Aided Engineering (CAE).

Use of advanced information processing and display technology applied to CAE models and data will result in more reliable and maintainable weapon systems. Improved R&M will significantly lower system life-cycle costs and result in higher states of combat readiness. Other direct benefits include: a more efficient design process, more explicit trade-offs in the design, and better R&M analysis techniques which can be implemented throughout the design phase of weapon system acquisition.

There are three major activities which will be accomplished under this effort: (1) technology demonstrations; (2) development of a RAMCAD consortium of leading industrial, academic and DOD agencies; and (3) establishing a methodology for communication and information transfer among the diverse and numerous agencies involved in RAMCAD relevant technology development and application programs. Each of these activities is discussed below.

Demonstrations: A series of technology demonstrations have already been accomplished, and others are planned, to show the benefit of using CAE to address R&M problems on existing weapon systems. One demonstration was completed in FY85 as part of the redesign of the Ground Launched Cruise Missile (GLCM) turbine engine. The GLCM demonstration resulted in an estimated 8% improvement in the availability of the turbine. In another demonstration, a computer graphics model of an F-15E is being created along with a model of a TAB-VEE shelter and the appropriate support equipment. This graphic model will then be exercised to simulate several reconfiguration scenarios, with the F-15E loaded with different weapons and support stores. The intent is to graphically analyze loading requirements, shelter clearances, and support equipment positioning to ensure they are sufficient to allow quick turnaround within the limited space and time constraints presented by a wartime environment.

RAMCAD Advisory Group: The RAMCAD consortium includes organizations from industry, Government, and academia, all working toward acceleration of technology development, demonstration, and use of RAMCAD tools and techniques for DOD applications. Originally conceived by the Joint Logistics Commanders' Subpanel on RAMCAD, the consortium has three tasks: (a) integrate R&M analyses into commercially available CAE; (b) conduct long-term R&D into computer science and R&M analyses as they apply to next-generation RAMCAD; and (c) develop engineering curricula that include RAMCAD as an integral part of academic training. This joint effort is being directed by a tri-Service committee with technical participation, direction/guidance, and funding from the Air Force and Army. This technology development and integration/demonstration forms the foundation for our Unified Life-Cycle Engineering work (Project Forecast II, PT-32) described on page 30.

Communication and Information Transition: Interagency communication activities are of two types: technical interchange meetings being held at the Institute for Defense Analysis (IDA) and a newsletter published under the auspices of the Joint Logistics Commanders' Subpanel on RAMCAD.

During FY86, the National Security Industrial Association (NSIA) Maintenance and Logistics Factors in Computer-Aided Design (MLCAD) project was completed, the first part of the F-15E demonstration was continued, the RAMCAD consortium was started, the first IDA Technical Interchange Meeting (TIM) was held, and two RAMCAD Bulletins (Newsletters) were published and distributed.

Looking to FY87, the F-15E demonstration should reach completion, the RAMCAD Bulletin will continue publication on an approximate quarterly basis, and the RAMCAD Consortium project will be awarded by 1 April 1987. Additionally the IDA will be held semiannually.

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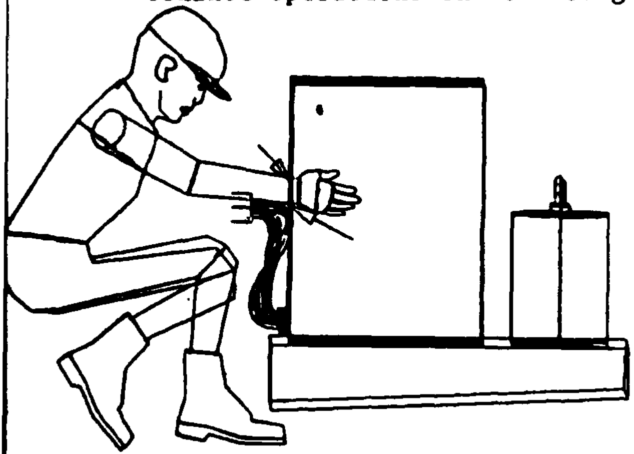
CREW CHIEF (Computer Model of an Aircraft Technician)

Budget constraints, coupled with the increasing cost of advanced weapon systems, make clear the need to bring acquisition and maintenance costs under control. Both of these actions must occur while sustaining and/or increasing combat availability of the weapon system. These objectives are consistent with and support Air Force 2000, which emphasizes increased Reliability and Maintainability goals for tomorrow's systems. To achieve these goals, significant additional tools must be developed for use during system design. These design tools must emphasize enhancing the capability to design for increased maintainability. New design tools which consider all aspects of weapon system maintainability can significantly reduce the amount of avoidable design-involved maintainability problems currently found now during actual system fielding and employment and consequently, reduce overall system life cycle-costs.

CREW CHIEF is a computer-based, anthropometric computer graphics design and analysis tool. It puts "people" into computers. It can be used by designers to actually portray and simulate maintenance operations on new designs during early stages of the design cycle. CREW CHIEF gives the design engineer the on-line capability to analyze the design for maintainability for new weapon systems or to analyze changes to equipment or procedures for existing systems. This significant technology is being developed in cooperation with AAMRL and will allow early identification of potential or actual design-induced maintainability problems so that corrective actions are taken before mockup, fabrication, or production. The ability to do on-line interactive maintainability and accessibility design trade-offs without the need for a hard mockup is a major advance over current design methods. CREW CHIEF holds the clear potential not only to reduce developmental engineering costs but to provide the opportunity to reduce acquisition time, maintenance time, and life-cycle costs while increasing system availability for the Air Force.



AUTOMATED ACCESSIBILITY ANALYSIS POINTS TO INTERFERENCE

The specific technology development/integration objective of CREW CHIEF is to develop three-dimensional computer graphics models for aircraft maintenance technicians (male/female from the 5th to 95th percentiles). These models will interface with state-of-the-art CAD/CAM packages to allow on-line analyses of design for maintenance. Extensive experimental research is being conducted to collect ergonomic data to populate the database. This database is unique to CREW CHIEF since minimal ergonomics data on human capabilities related to maintenance activities previously existed. When fully developed, these models and supporting databases will include quantitative metrics on human capabilities (such as range of body size, strength, reach, vision, and lifting abilities). It will also contain library programs on common handtools, task analysis, manual material handling analysis, interference analysis, visual field analysis, and encumbrance of clothing (fatigue jacket, Arctic gear, chemical defense).

CREW CHIEF

During FY86, a number of CREW CHIEF functional capabilities were achieved. These included: (a) 12 different maintenance postures; (b) 1st to 99th percentile male/female anthropometric dimensions; (c) enfleshment for fatigue, cold weather, and chemical defense clothing; (d) visibility analysis; and (e) interference analysis.

During FY87, we plan to complete and validate the remaining database and validate a fully capable model. Release of the database and analysis models is expected to occur during the second quarter of FY88.

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Unified Data Base (UDB) for Acquisition Logistics

Modern weapon systems are combinations of complex hardware and software subsystems. Full design and operational data on a weapon system are inherently complex, voluminous, and rarely used or stored in one physical location. Data communication gaps, in the form of inconsistent or inaccessible data, can prevent the timely dissemination of accurate data needed to make valid supportability planning decisions during the system acquisition and fielding process.

Successful completion of this effort will produce a data information and decision support system which will enable logisticians and engineers to rapidly and efficiently document, retrieve, and query a central database on-line via a computer terminal. The ability to perform on-line data access will have the following significant impacts on the the supportability planning process: (a) enhance the validity of integrated logistics support analysis data; (b) increase the productivity of logisticians involved in the systems acquisition process; (c) improve the quality of logistics data items used for planning training, support equipment, spares, etc.; and (d) reduce the cost and time required to prepare and integrate data generated by physically separated logisticians and engineers.

The UDB is a Logistics Support Analysis database system designed to improve the documentation and accessibility of acquisition logistics support data. UDB conforms to MIL-STD-1388-2A and automates all the data elements of the standard, through the addition of data elements supplemental to the military standard. The system may also be used to automate common acquisition data items.

The software was essentially completed in 1986. Final documentation, validation by the Army Materiel Readiness and Support Activity, and internal verification and validation by AFHRL is planned for 1987, with full transition in early 1988.

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Integrated Information Systems Engineering Methodology

Aerospace contractors and the Air Force currently rely on ever-increasing amounts of computerized data to perform their respective functions during system design, acquisition, and deployment. Specifically, these computerized data are critical to R&D, design, procurement, management, maintenance, logistics support, and operations life-cycle activities of Air Force weapon systems. At this time, access to these data is through multiple and typically, dissimilar computer systems. These data storage and processing systems are usually developed based on existing policy, available funding, current technology, and individual user requirements, without an overall integrating or systems engineering methodology. This has resulted in a multiplicity of unique systems without common specifications or standards for computer hardware, software, communications, or data. This ensures that these systems cannot share information or data. Current information systems design methodology and technology are divided functionally into vertical segments such as information, hardware, software, and communications engineering. A methodology encompassing all these functional areas is needed for design, production, operation, and support of large-scale, distributed, heterogeneous information systems.

Successful completion of this effort will produce a support system environment for integrated information systems development. The support system environment will consist of the methodology, techniques (methods/practices), and tools (mechanisms): (a) to ensure the success of integrated information systems development, (b) to increase the productivity of the project teams involved in systems development, (c) to improve the quality of the life-cycle products of the development team, and (d) to reduce the cost and time required for integrated information system development.

Establishment of a complete system development methodology is a complex system development effort in itself. The key is to develop a common core of methods which are modular and which interlock in a consistent fashion to cover the entire life cycle of the system being developed. Surrounding this core there must be a set of techniques for dealing with the viewpoint of a particular problem area or application technology. This effort will analyze the experience base in integrated information system engineering projects to capitalize on the discoveries of current practitioners of existing system development methodologies. Deficiencies and workaround techniques will be identified, and a baseline model of system development activities and information will be established. From this baseline and the experience base, the methodological needs will be identified and critical R&D areas established. This will serve as the foundation for development of the final integrated information systems engineering methodology.

Work will begin in late 1986, and results will be transitioned to the IDS advanced development program, a joint undertaking led by the AFWAL Flight Dynamics Laboratory.

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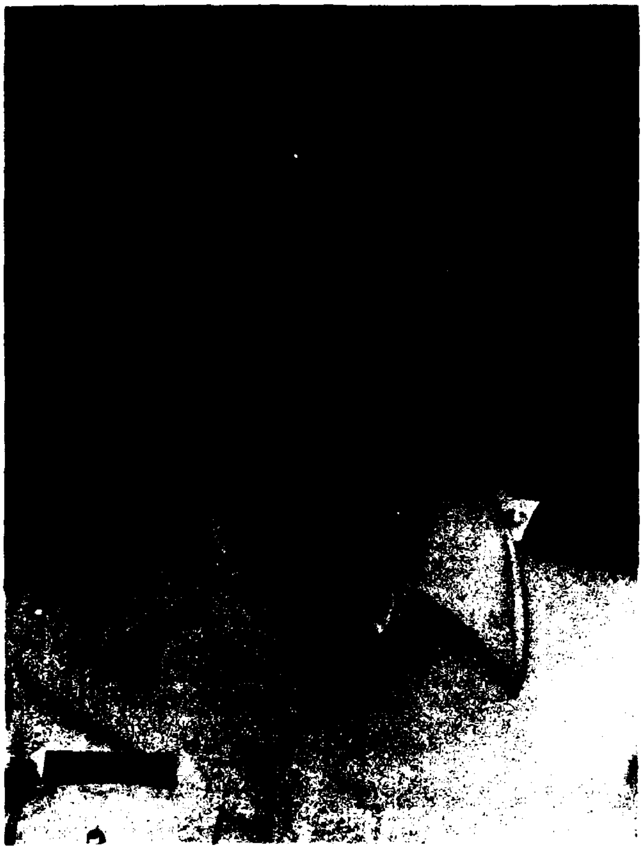
TRAINING SYSTEMS DIVISION

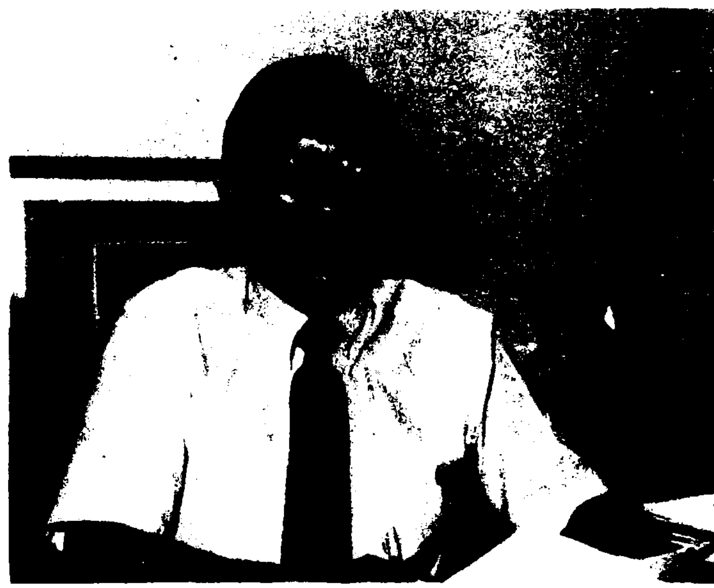


Colonel Gene A. Berry
Division Chief

TRAINING SYSTEMS DIVISION

The Training Systems Division has completed a move from Lowry AFB, Colorado to Brooks AFB, Texas. At the close of calendar year 1986, all Division personnel are located either at Brooks AFB or at the remaining operating location at Bergstrom AFB near Austin, Texas. The primary objective of the Training Systems Division is to perform Research and Development (R&D) to enhance Air Force skill development and job performance through improved training methods, devices, management and assessment. In addition, the Division has been designated the Laboratory center for artificial intelligence R&D and, in particular, its applications to Air Force training.

To better accomplish its mission, the Division has been reorganized as four branches, each named for its R&D thrust: the Training Technology Branch, Skills Development Branch, Intelligent Systems Branch, and On-the-Job Training Branch.



Dr. Hendrick W. Ruck
Technical Advisor

The Division's R&D efforts are currently focused on five major projects or thrusts. The major focus of each branch is as follows:

Branch	Projects
Training Technology	Instructional Support System
Skills Development	Job Performance Measurement Training Decisions System
Intelligent Systems	Applications of Artificial Intelligence to Training
On-the-Job Training	Advanced On-the-Job Training System

Training Technology Branch

The mission of the Training Technology Branch is to perform R&D on methods and techniques for improving the training effectiveness of the Air Force. At present, the branch is rebuilding its staff while continuing to work in the area of computer-based training. The major ongoing effort is the Instructional Support System (ISS).

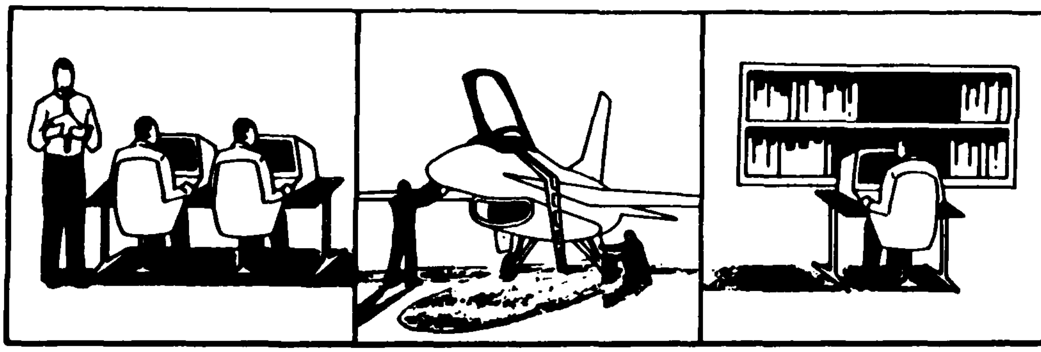
Instructional Support System (ISS)

Efforts to check out and properly "field" the ISS for broad Air Force-wide use comprised most of the action of the new Training Technology Branch. Early Training Systems Division R&D efforts in Computer-Based Training (CBT) in the 1970s produced the Advanced Instructional System (AIS). The AIS was designed to train and manage a large number of students using a mainframe computer; consequently, its implementation resulted in costly hardware and software dependency.

In the early 1980s, multiple non-standard CBT systems emerged along with microcomputers. The ISS was developed to meet these new challenges, and it ultimately became the successor to AIS. The ISS consists of two major components: Computer-Assisted Instruction (CAI) and Computer-Managed Instruction (CMI). ISS is Government-owned and is written in Ada, the standard DOD programming language. The use of Ada enables ISS to be rehosted to a variety of machines, ranging from mainframes to microcomputers. ISS's modular construction makes it possible to load the entire system simultaneously or in portions, depending on the user's need.

The Air Force accepted ISS as a prototype on the VAX 11/780 minicomputer in October 1985. This year, the Strategic Air Command (SAC) at Dyess AFB, Texas has served as the Operational Test and Evaluation (OT&E) site, using ISS to develop, deliver, and manage aircrew training for the B-1B.

INSTRUCTIONAL SUPPORT SYSTEM
FOR
AIR FORCE COMPUTER BASED TRAINING



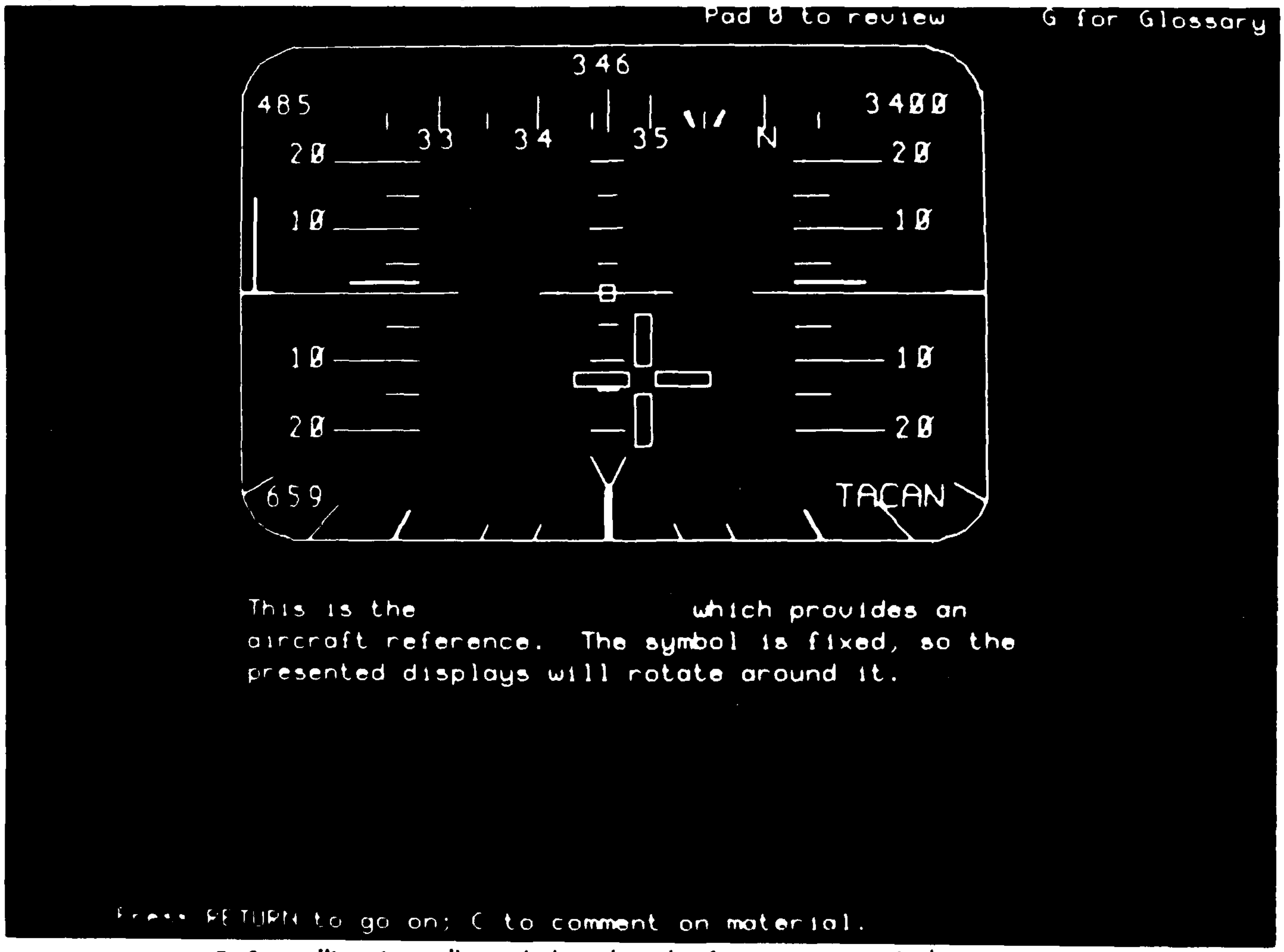
ACADEMIC/TECHNICAL TRAINING	JOB SITE TRAINING	PROFESSIONAL TRAINING

REDUCED COSTS	FORCE-WIDE APPLICATIONS
GOVERNMENT OWNED	SHARED COURSE MATERIALS
ADA-BASED	EXPORTABLE TRAINING
MACHINE INDEPENDENT	MINI OR MICRO COMPUTERS
MODULAR	TRAINING DELIVERY & MANAGEMENT
POTENTIAL FOR AIR FORCE STANDARD	UNIT LEVEL DEVELOPMENT SUPPORT

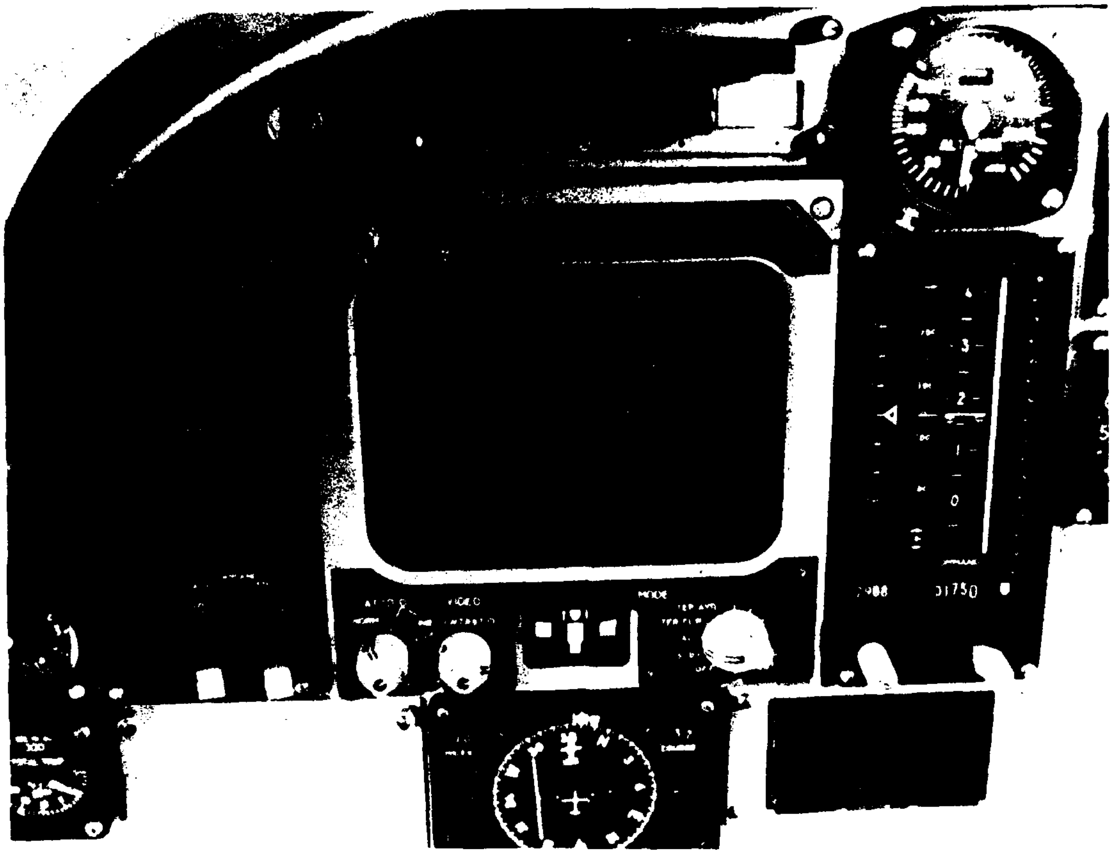
ISS was rehosted from an early Ada compiler version to a validated Ada compiler in September 1986, making it a more stable and maintainable product. In addition, a number of software problems were corrected, several CMI enhancements were added, and a training package was developed in-house that provides on-line instruction for using the system to develop CAI courseware.

Efforts are underway to develop an online training package for designing and managing curricula using the CMI component. In addition, the application software is being documented to aid in transitioning the software to a long-term support agency. A state-of-the-art videodisc interface will be developed soon. Also, a CMI component is being developed which will be compact enough to run on a microcomputer, yet powerful enough to track student progress and preserve the data required to evaluate instructional effectiveness. Rehosting ISS to the Zenith 248 and micro VAX II have been initiated. If the Zenith 248 venture is successful, ISS could then provide the basic architecture for a standard Air Force-wide CBT system.

The demand for ISS is extensive. ISS will be the CBT core for both the Advanced Training System (ATS) for Air Training Command's (ATC) Technical Training Centers and the Advanced On-the-job Training System (AOTS). In addition, it is being used as the basic software for the General Imagery



Before "hands on" training in simulators or cockpit mock-ups, B-1B aircrew students train on the ISS.



Pilot's Vertical Display in B-1B aircraft presents attitude, altitude, airspeed, and navigation data.

Intelligence Training System (GIITS) at the Electronic Systems Division at Hanscom AFB. Also using ISS, the ATC at Lowry AFB developed 20 hours of Electronics Principles instruction; the 6575th School Squadron at Brooks AFB is using the ISS to demonstrate the feasibility of CBT in its Computer Resources Acquisition Course; and SAC is expanding its B-1B instruction to its main operating bases, using ISS on the Micro VAX II.

Many other Air Force training managers have expressed an interest in ISS, and this demand highlights the need for a permanent agency to maintain and support ISS. Progress is being made in identifying such an agency.

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Skills Development Branch

The Skills Development Branch conducts exploratory and advanced R&D programs to improve the acquisition and maintenance of job-related skills. Presently, these programs include the Training Decisions System (TDS), a computerized database and resource allocation model designed to help training managers make training program and budget decisions, and the Job Performance Measurement System, a methodology for collecting accurate and reliable performance information to determine the extent of skills acquisition and training program effectiveness. Future programs will include other technologies to improve the efficiency and effectiveness of Air Force training programs.

Training Decisions System (TDS)

A basic problem in developing overall training programs and policies for Air Force career ladders is deciding what to train (training content decisions), where to train (appropriate settings), and when to train (at various points throughout an airman's career). Due to the scope and complexity of Air Force training, many decisions with major impacts on training must be made independently by management without the benefit of coordination and relevant data.

The TDS is being developed to provide a more unified and integrated approach to solving training problems. TDS integrates job tasks, manpower, and cost considerations into a single comprehensive model. Specifically, TDS uses information obtained about job tasks performed by airmen, combined with personnel assignment information, to evaluate the training capacities of Air Force settings to determine what cost-saving training and utilization options are available.

TDS is a multiyear, multimillion-dollar R&D effort consisting of four research components. The Task Characteristics component is designed to develop computerized task-clustering techniques based on Occupational Survey report data. The Field Utilization component will compare and contrast present and alternative personnel utilization and assignment patterns and the impact of each on training. The Resource/Cost component will address available resources, assess training capacity, and determine cost tradeoffs associated with training in various settings. The Integration/Optimization component will integrate the three individual components into a computerized decision support system.

A four-year exploratory development contract that began in September 1983 is addressing a representative sample of Air Force specialties: (Avionic Inertial and Radar Navigation Systems, Security/Law Enforcement, Aircraft Environmental Systems, Electronic Computer and Switching Systems). A portable computerized demonstrator is being used to allow potential users at Air Staff, HQ Air Training Command, and Major Command training offices to review and validate design concepts. A computerized, statistically generated, task clustering procedure has been created to generate modules with tasks which are to be trained together based upon their co-performance in accomplishing a job. An advanced development contract will consider additional specialties and provide for the transition of the TDS to an Air Force operational unit.

The TDS will save training time and reduce costs by increasing efficiencies in the structure of the Air Force personnel and training system. By providing better training, the mission readiness of the Air Force will be improved. The TDS database will also be an invaluable asset for updating or initially determining contingency plans by having available a wealth of current information from which accurate decisions can be made. Finally, TDS will provide up-to-date information to Air Force managers and provide a modeling capability to address "what if" training questions.

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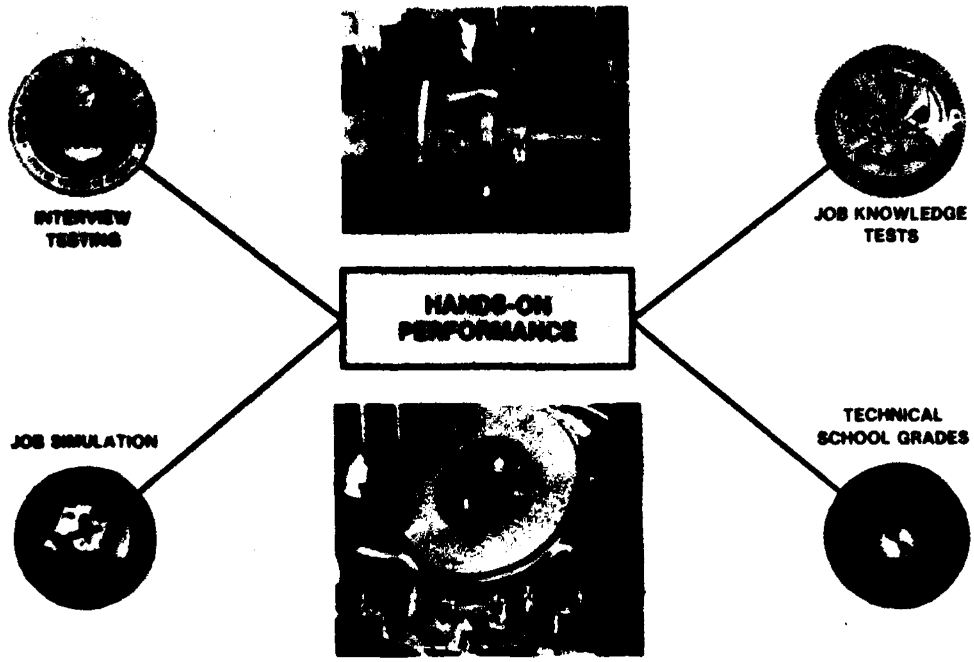
Job Performance Measurement

The objective of Air Force job performance measurement R&D is to develop a technology for accurately measuring job performance. Such a technology will be used to enhance the prediction of job success for improving Air Force selection and training programs.

JOINT-SERVICE
JOB PERFORMANCE MEASUREMENT PROJECT STRATEGY



Historically, enlistment standards and selection/classification decisions have been linked to training outcomes. Similarly, other career point decisions have been based on highly subjective supervisory ratings, rather than against actual on-the-job performance. Linking enlistment standards and other personnel actions directly to measures of job performance would result in more for our manpower dollars by selecting the best-qualified applicants and assigning them to jobs in which they are likely to succeed.

The job performance measurement project should have widespread benefits for the Air Force. This impact is clear in three areas:

- First, selection of recruits will improve after establishing a positive link between selection tests and performance on the job. This improvement takes the form of greater accuracy in selection and classification of personnel. By improving the accuracy of recruiting and classification, it will ensure the selection of the best-qualified applicants for jobs where their skills can be fully utilized. Air Force members are then more likely to succeed and re-enlist.

- Second, training programs will also benefit from the performance measurement technology. Program designers will be able to use actual job performance as a basis for comprehensive training analysis, thereby improving the evaluation and development of training programs. This strategy can apply to both on-the-job and technical training.

- Third, such system improvements will result in more productive and satisfied personnel; higher reenlistment rates; and lower selection, training, and personnel replacement costs. By improving the performance of the most important part of the Air Force - its people - this technology will improve Air Force readiness.

Current Air Force efforts involve the development of a Job Performance Measurement System (JPMS) for eight Air Force specialties (AFSs). The JPMS consists of a hands-on work sample testing technique and a variety of substitute job performance measures. The most detailed, task-oriented Air Force measurement technique being developed for the JPMS is called Walk-Through Performance Testing (WTPT). This technique combines observation of hands-on performance and incumbent interview testing procedures for a set of representative tasks. Critical specialty and job-specific tasks are identified for the WTPT from occupational survey data. Subject-Matter Experts (SMEs) aid developers in categorizing tasks into those for which performance can be economically observed, and those which can be more efficiently measured by interview. Job experts then develop procedures for observing task performance and specifying performance standards for scoring incumbent responses. Because observation of actual hands-on performance is expensive and time-consuming, this procedure will be used as a benchmark against which less expensive, easier-to-administer "surrogate" job performance measures are developed.

The Air Force has developed specialized expertise in the following surrogate measurement procedures: interview testing and rating forms. Rating forms reflect supervisor, peer, and self evaluations of an incumbent's proficiency. Rating forms also vary in specificity, ranging from ratings of task proficiency to more global measures of technical and social/ interpersonal competence on the job. Interview testing takes place in the work setting and assesses an incumbent's proficiency by allowing the incumbent to demonstrate task-based knowledge and procedural strengths and weaknesses. The incumbent does this by providing a combination of verbal responses, gestures, and demonstrations in a "show and tell" approach.

The Air Force has completed data collection and preliminary data analysis for the first enlisted AFS, Jet Engine Mechanic. For this specialty, the interview, and the supervisor and peer ratings, all showed promise as potential surrogates for hands-on testing. Also, incumbent time in service, training school grades, and mechanical aptitude showed positive, significant relationships with hands-on test performance. Other major FY86 accomplishments included:

- Data collection was completed for the Air Traffic Control Operator, Avionic Communications Specialist, and Information Systems Radio Operator Specialist. Up to 300 airmen were tested in each career field, at a total of 45 bases.

- Job requirements were defined for the final four joint-Service Job Performance Measurement Project AFSs. These are: Aircrew Life Support Specialist, Personnel Specialist, Precision Measuring Equipment Specialist, and Aerospace Ground Equipment Specialist.

- The Air Force will develop all the Services' surrogates on two AFSs (one cross-Service specialty, and one Air Force-unique specialty). This will allow each Service to gather additional performance information at significant cost savings and further enhance the overall joint-Service job performance measurement R&D effort.

To summarize, the Air Force is developing hands-on job performance tests along with less expensive substitute tests to provide personnel and training managers with cost-effective job performance measurement procedures. Ultimately this technology will be used to collect performance information for setting enlistment (classification) standards, developing and evaluating training, and improving force quality.

This technology will help ensure that Air Force commanders and supervisors are provided with personnel who have the knowledge and skills required to accomplish their mission.

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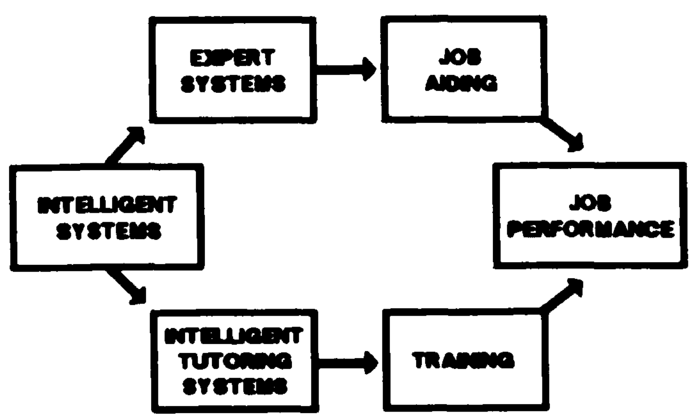
Intelligent Systems Branch

The objective of the Intelligent Systems Branch is to continue R&D in Intelligent Tutorial Systems (ITS) for training efficiency and effectiveness. The branch also pursues basic research in Artificial Intelligence (AI) for better understanding of computer-based training applications. The Intelligent Systems Branch takes a multidisciplinary approach to artificial intelligence R&D and considers this stance a major factor for producing a solid technology base. The approach is to build an artificial intelligence team including computer scientists who build the software, engineers who build the hardware, linguists who work with natural human language processing for computer understanding, and educational psychologists who design training and evaluate each system's efficiency and effectiveness.

Projects are built on a national network of researchers in DOD, academia, and industry. One cornerstone effort is the joint-Service project for a knowledge acquisition system and intelligent authoring aid. The purpose of this effort is to develop an ITS shell in joint-Service domains. Also, the intelligent authoring aids will allow an instructor, without computer experience, to develop a course of instruction in an automated tutoring situation. Intelligent instructional gaming environments are also underway for embedding motivational experiences into ITS, a methodology believed capable of benefit to Air Force classrooms. An Associate Training Instructional Environment (ATIE) is the generic testbed for in-house R&D as the branch looks toward the development of multiple-domain intelligent training systems. For example, an in-house R&D effort on orbital mechanics is being developed for the Undergraduate Space Training School at Lowry AFB, Colorado. Major interest in such a project comes from HQ Space Command and HQ Air Training Command. For the long term, a four-year project called Intelligent Computer-Assisted Training Testbeds includes more applied expert systems and ITS R&D projects. The long-term goals are to build the best in ITS for the Air Force 2000's complex, high tech jobs.

INTELLIGENT SYSTEMS FOR HUMAN RESOURCES



Artificial Intelligence R&D Will Enhance Training and Instruction

For the branch, a major role is seen for implementing knowledge-based systems R&D. In fact, General Skantze, AFSC Commander, initiated Project Forecast II meetings over a six-month period to determine the next 20 years of R&D relative to preparation for Air Force 2000 technological advances. One such R&D issue is "Knowledge-Based Systems," in which AI technologies for Air Force training are demonstrated - new reasoning algorithms and machine learning to be specific. General Skantze indicated "loud and clear" that artificial intelligence payoffs should be demonstrated.

Knowledge Acquisition/Intelligent Authoring Aids

The goals are to design and develop intelligent computer-assisted instructional tools and techniques for system users (instructors and students). This effort involves Army, Navy, and Air Force cooperation in a common-goal R&D project. All services will benefit in their R&D objectives for more efficient and effective training. The project is in the second year of a four-year R&D effort. Interface designs are completed and specifications on the knowledge acquisition system are underway. Probable domains include space operations and explosive ordnance disposal.

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Multiple Forms of Knowledge Representation

The objective of this R&D effort is tc design a methodology for multiple knowledge representation. The goals are to determine whether different types of knowledge can be represented differently within a single system, and whether the output from one system's representational memory can be used as input to the working memory of another system. This effort will provide support to intelligent tutorial systems and expert systems R&D. A prototype Nosocomial Expert System Testbed for Original Research (NESTOR) was developed for use in the medical diagnosis area and its capabilities are to be extended in the Phase II follow-on.

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AI Development Languages

The object of this R&D was to design two expert systems using LISP and PROLOG languages and then determine advantages and disadvantages of each. This effort helps establish an AFHRL technology base for further R&D in AI. The project has been completed. A prototype Expert Patient-Ventilator Manager (EPVM) system was developed and is being tested.

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Research Planning Forum For Intelligent Tutoring Systems (ITS)

This forum was developed to give guidance to the AFHRL investment strategy for ITS and provide the foundation for AI R&D initiatives. This effort has provided the Air Force with a set of tools for efficiently developing ITS and has identified important Air Force training tasks and settings for which implementation would be appropriate. The forum was held in San Antonio, Texas, in September 1986.

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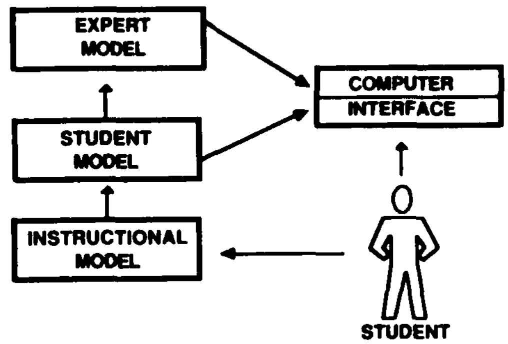
ANATOMY OF AN INTELLIGENT TUTORING SYSTEM



On-the-Job Training Branch

The On-the-Job Training Branch is located at Bergstrom AFB, Texas, under the Tactical Air Command. Its mission is to develop a prototype system that can be used in the field to enable commanders and supervisors to conduct, manage, and provide on-the-job training in support of mission effectiveness. The branch is located at Bergstrom AFB so that the prototype system can be developed and tested in the field.

The Advanced On-the-job Training System (AOTS)

The project objective is to design, develop, demonstrate, test, and evaluate a prototype Advanced On-the-job Training System (AOTS) for Air Force on-the-job training (OJT). AOTS is the Air Force Human Resources Laboratory's advanced development effort to build a prototype state-of-the-art training system that integrates and effectively manages, evaluates, and automates job site training to make OJT more responsive to mission requirements.

A well-trained enlisted corps is critical to Air Force mission accomplishment. The majority of that needed training is provided by the Air Force's OJT program. Data show that over 70 percent of technical training requirements that support unit missions are met through OJT. The scope of the Air Force's OJT program is vast. For example, more than 80,000 personnel are in OJT upgrade training at any given time; approximately 400 Air Force specialties are trained through OJT; and OJT is conducted at all Air Force locations worldwide, including the Air Force Reserve and Air National Guard. While singular responsibility for training policy exists at the Air Staff level (HQ USAF/DPPT), OJT encompasses all functional areas and functional managers play a key role in training. Qualification training conducted in conjunction with OJT at the job site includes more than 90 percent of the enlisted corps. In addition to the vast scope of the Air Force OJT program, influences such as the following impact unit training: shortages of skilled technicians; increasing mission production demands; new and upgraded weapon systems; force structure management tactics and strategies; and increases in both the number of personnel routed directly into OJT and the number of tasks to be trained by OJT, due to increasing resident training costs. In short, the Air Force OJT program must be made to work in this vast and dynamic operational environment to produce the trained personnel required for mission accomplishment.

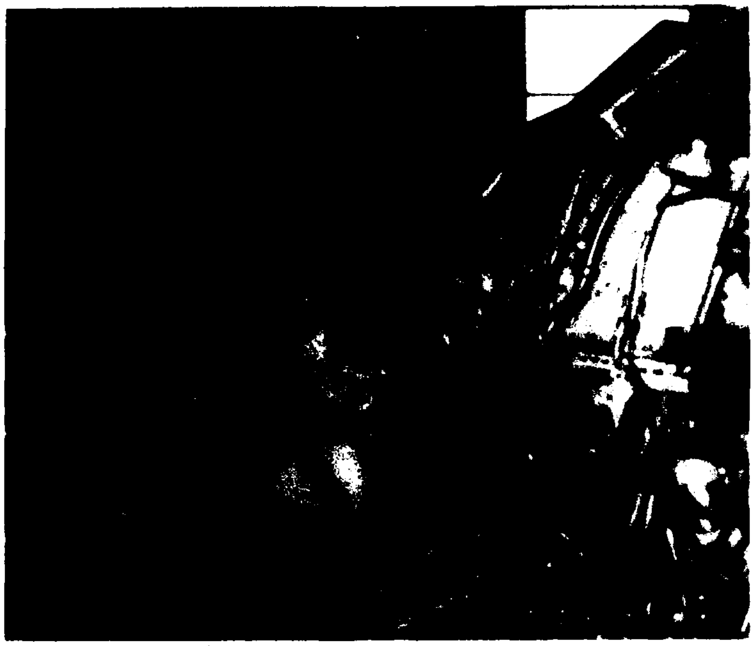
In the mid-70's, functional management inspections, senior management reviews, and OJT studies and analyses have identified numerous operational deficiencies of job site training. While a number of problem areas were identified, the major deficiencies may be summarized as follows: inadequate definition of task training requirements; inadequate evaluation of task performance; a burdened, labor-intensive process; insufficient training management/cost/capacity data; and inadequate use of automation technology. While diligent effort has produced some improvement in OJT, the kinds of factors previously identified have combined to tax OJT capability, resulting in minimally effective job site training. Consequently, the Air Staff directed an R&D effort to develop a prototype state-of-the-art Air Force OJT system.

The AOTS prototype consists of five major interrelated subsystems that integrate Air Force training management, evaluation, training development and delivery, computer support, and personnel and logistics subsystems. The management subsystem improves OJT management tools and procedures at all levels of the OJT process. Its major components provide an integrated, computer-based OJT management system which helps supervisors define job/task training requirements, manages airman training progress towards position qualification, and identifies and allocates base-level resources. The evaluation subsystem provides evaluation materials, quality control procedures, and data for assessing OJT capacity and effectiveness. This subsystem provides the instrumentation and enhanced capability to evaluate airman task performance. In addition, the evaluation

Security Police On-the-Job Training

subsystem's training management information system provides data tailored for all levels of management (i.e., unit, base, major command, and Air Staff) to track training quality, relevance, and effectiveness. The training development and delivery subsystem provides AOTS with the additional capability to develop instructional materials and manage their delivery at the OJT job site. This subsystem provides the capability to develop computerized instructional materials. The computer support subsystem applies state-of-the-art computer technology to support the management and evaluation of job site training. This subsystem identifies, designs, develops, and integrates the hardware and software requirements to support AOTS. The personnel and support subsystem specifies the qualitative and quantitative personnel requirements of an operational AOTS, as well as the requirements associated with maintenance, reliability, logistics, and transition of the system. This subsystem provides the necessary documentation for AOTS implementation, operation, and expansion. The goal is to provide for smooth transition of AOTS.

The AOTS prototype is a joint Air Force and contractor effort and is undergoing development in the operational environment at Bergstrom AFB, Texas. Prototype execution is a four-year, three-phased effort. The design phase fully details AOTS specifications and provides the design documents for the development phase. Phase II, the development phase, is the time during which AOTS will be built. The final phase, Operational Test and Evaluation (OT&E), is 12 months in duration, allowing the Air Staff and major commands to assess AOTS in the operational environment. State-of-the-art technol-



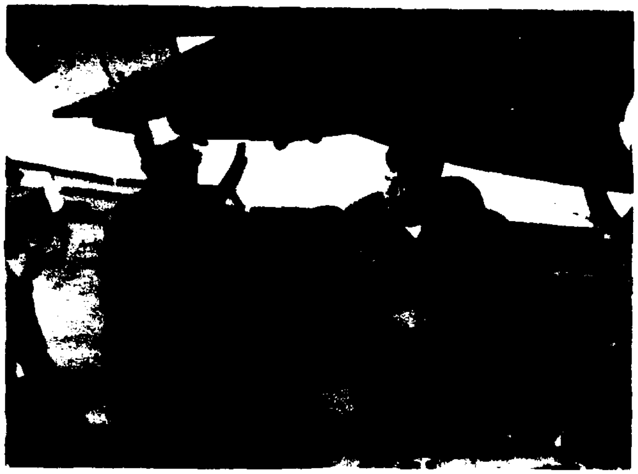
Jet Engine Mechanic On-the-Job Training

ogy will be systematically applied to OJT conducted in designated work centers of TAC's 67th Tactical Reconnaissance Wing, the 147th Fighter Interception Group of the Texas Air National Guard (Ellington ANGB), and the 924th Tactical Fighter Group of the Air Force Reserve. The enlisted job specialties used to develop the prototype system include: 426X2, Jet Engine Mechanic; 732X0, Personnel; 431X2C, Tactical Aircraft Maintenance; and 811XX, Security Police. AFHRL has 20 NCOs assigned to the project on site at Bergstrom AFB to assist in the development of instructional and evaluation materials and to ensure the AOTS will work in the operational environment. In addition to the evaluation data resulting from OT&E, the evaluation plan calls for a side-by-side comparison of AOTS and current OJT system work centers. The AOTS execution schedule is a challenging one, requiring concurrent parallel development of the major AOTS subsystems.

A fully coordinated and signed technology transition plan is available for AOTS. Three levels of transition are required. AOTS has been designed to provide and emphasize the transition of incremental products, payoffs, and implementation as the work unfolds. Examples of initial products include: training requirements definition processes/lists, task proficiency evaluation procedures, training resources identification/scheduling procedures, and automated training records. Incremental products will be provided to the Air Staff for evaluation and implementation Air Force-wide. The model AOTS at Bergstrom AFB, Texas, is to be transitioned to the Tactical Air Command upon completion of the project. Finally, AOTS transition and implementation plans are to be provided to the Air Staff for deployment of AOTS Air Force-wide.

The AOTS effort is currently underway and all start-up and support activities have been completed. The site was established and manned, support agreements were worked out, and personnel have been trained. The AOTS development contract was awarded 1 August 85 to McDonnell Douglas Corporation, initiating the design phase. The design

Personnel On-the-Job Training



Aircraft Maintenance On-the-Job Training

phase was completed in May 86, and the project is currently in the development stage.

AOTS will provide the Air Force with a state-of-the-art OJT system that will meet the following objectives: define task training requirements for the operational environment; quality control OJT performance evaluation; simplify OJT administration; automate training management and evaluation; provide a training management information system; and interface OJT with other emerging and existing computer systems.

As the Air Force approaches the 1990s, the Air Force needs to improve the methods for conducting OJT. New weapon systems, skills compression and shortages of skilled technicians all indicate a greater need for a system that is automated and capable of handling the Air Force's OJT needs. AOTS is the answer to this challenge.

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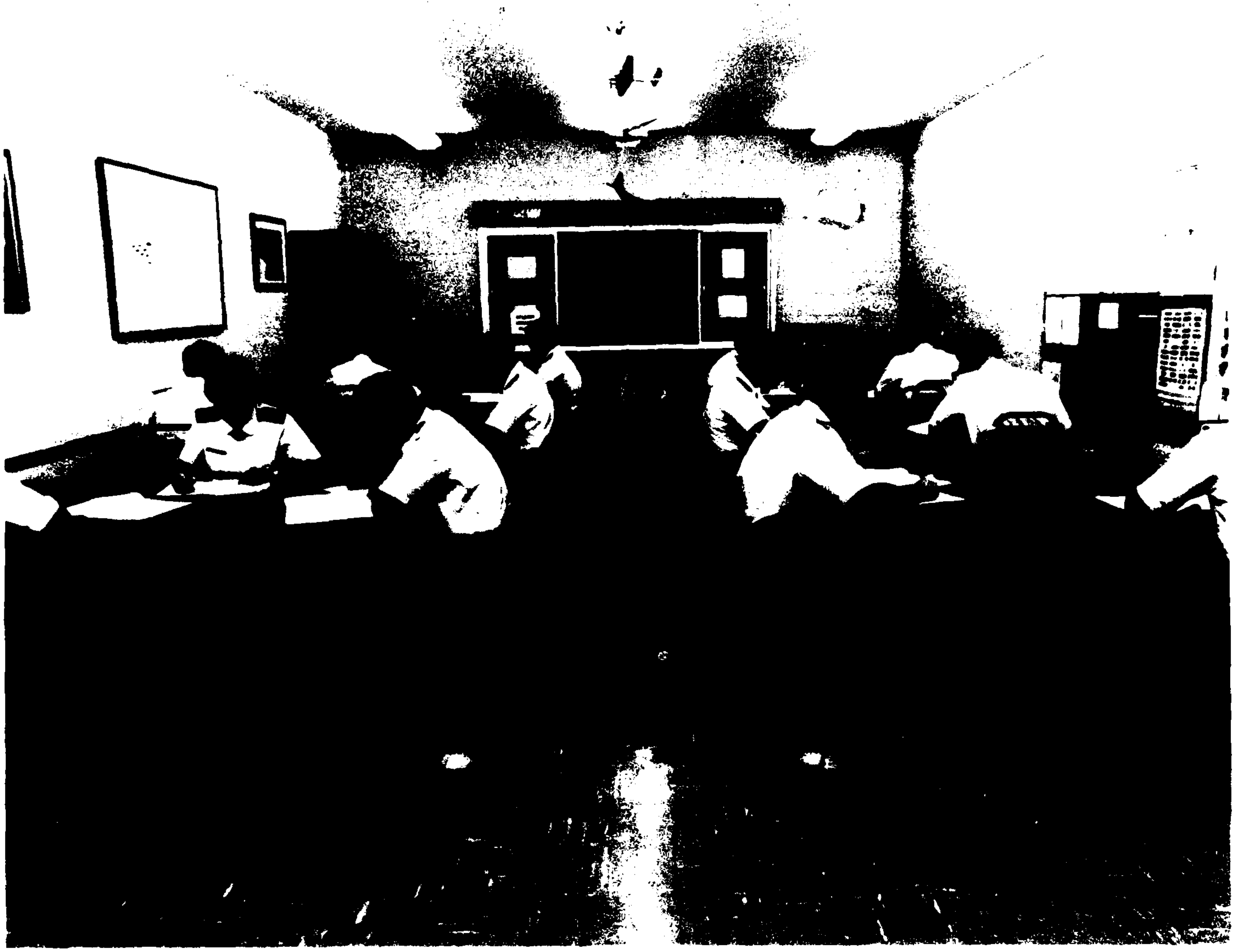
MANPOWER & PERSONNEL DIVISION



MANPOWER AND PERSONNEL DIVISION

Selecting the most qualified applicants and placing them in the right jobs are essential to maintaining a combat-ready Air Force. To sustain an enlisted strength of over 488,000 and an officer corps of 108,000, the Air Force must recruit a large number of relatively untrained individuals. In fact, some 65,000 new airmen are brought into the Air Force each year and matched with jobs in 245 career fields. To keep the officer force fully manned requires some 9,000 new officers yearly for jobs in 235 career fields. Matching people and jobs continues beyond initial accession since each year over 10,000 enlisted members change career fields.

Colonel Ronald L. Kerchner
Division Chief

To be an effective fighting force, not only must the newly accessed members be trained in their jobs, but also, the entire force must continue to train to stay proficient. Each year 125,000 enlisted members attend formal training and many more participate in on-the-job training to retain and increase job skills and abilities. Initial and subsequent training of officers also comprises a significant portion of officer force management. For rated officers alone, 1,600 new pilots and 750 new navigators are trained each year. Of the 30,000 experienced rated officers, virtually all who are performing flying duties participate in some form of training each year. Costs of this training are substantial. For example, training an FB-111 pilot costs over $1.3 million and the navigator training for the same weapon system costs over $700,000.

Personnel selection, classification, and training are all part of a force management strategy which optimizes performance, retention, and overall combat readiness. At nearly $20 billion yearly, Air Force military personnel costs are a major budget item requiring effective management to ensure the Air Force gets the most for its investment.

Dr. William E. Alley
Scientific Advisor

The Manpower and Personnel Division directs a comprehensive and long-term R&D program to develop the tools, procedures, and associated technologies to ensure more effective use of personnel resources. Specific R&D programs are organized into two major thrusts:

1. Personnel qualification testing which includes development of new cognitive tests as well as updating of the Armed Services Vocational Aptitude Battery (ASVAB) and Air Force Officer Qualifying Test (AFOQT).

2. Manpower, personnel, and training integration which includes Person-Job Match algorithms, determination of job requirements for existing and future weapon systems, and manpower forecasting technologies.

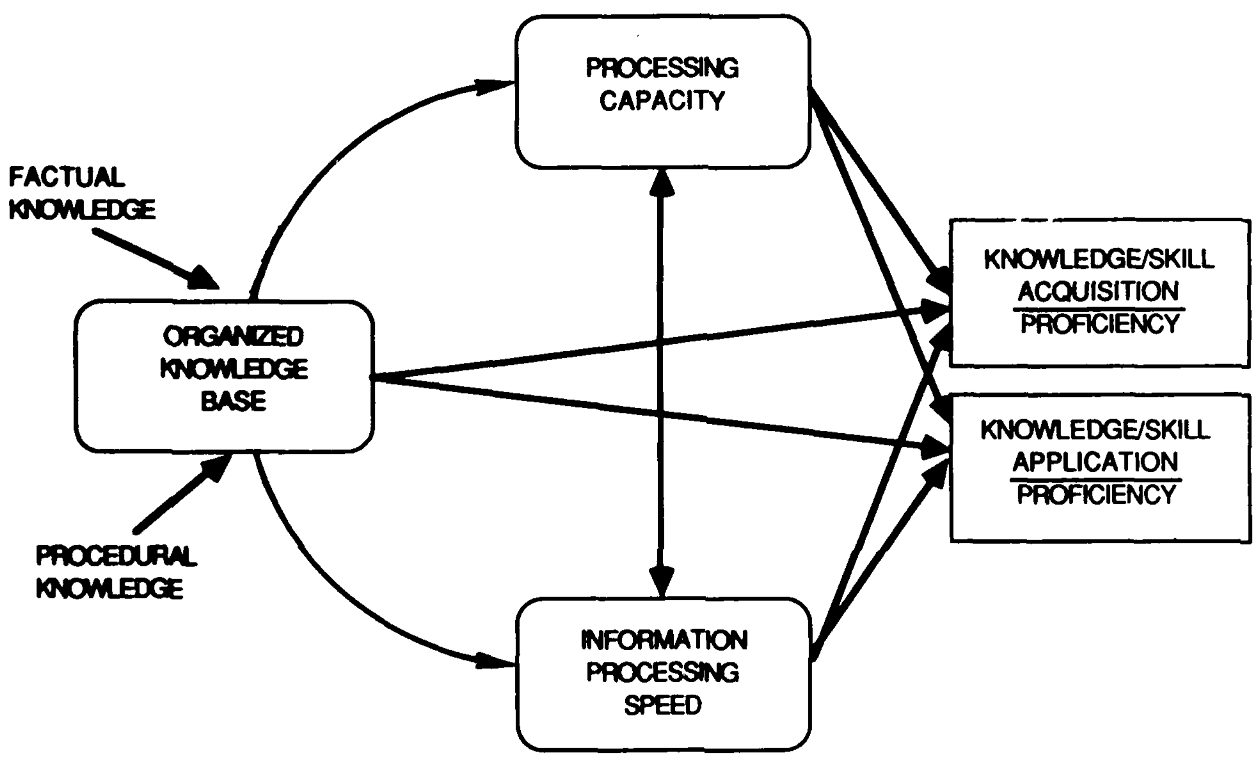
Personnel Qualification Testing

Learning Abilities Measurement Program (LAMP)

LAMP is a major research effort in ability research that is jointly sponsored by the Air Force Office of Scientific Research (AFOSR) and AFHRL. It utilizes a laboratory at Lackland AFB which houses 30 microcomputer-equipped testing stations. Approximately 300 airmen in Basic Military Training are available as subjects each week, and over 40,000 have participated in testing conducted to date.

There are two major objectives for the LAMP effort: first, to identify the basic components of human cognition,

INTERACTIVE MODEL OF LEARNING AND PERFORMANCE



and second, to determine the interactive power of cognitive components in predicting complex learning and performance behaviors. The AFOSR has established a special grant program to provide support, testing facilities, and Air Force subjects to university scientists who wish to help us in our search for cognitive components. A new laboratory is being established to support the second goal of measuring learning and performance behaviors.

The LAMP effort capitalizes on the availability of microcomputers to measure abilities not easily evaluated with paper-and-pencil tests, and it leans heavily on cognitive science to provide a theoretical basis for the research effort. It is hypothesized that individual learning and performance can be accounted for by knowledge, processing speed, and processing capacity factors. Much of the research conducted to date has related to information processing speed which encompasses encoding, comparing, choosing, retrieving from memory, memory searches, and *attention shifting*. Results indicate that measures of elementary processing speed are not likely to replace conventional ability tests, but they may be important in predicting the performance of individuals working in high information flow environments. Current research emphasis is on information processing capacity, with an attempt to understand its role in accounting for memory failures, processing errors, and information overload.

Although this program is devoted to basic research, usable outcomes are anticipated. For example, a major goal is to develop new ability measures for inclusion in future personnel selection and classification programs. As in any basic research program, however, it will be a number of years before the contribution of LAMP is fully known. But the results of early studies and the vision of ultimate success have already generated a feeling of excitement among the scientists working in the program.

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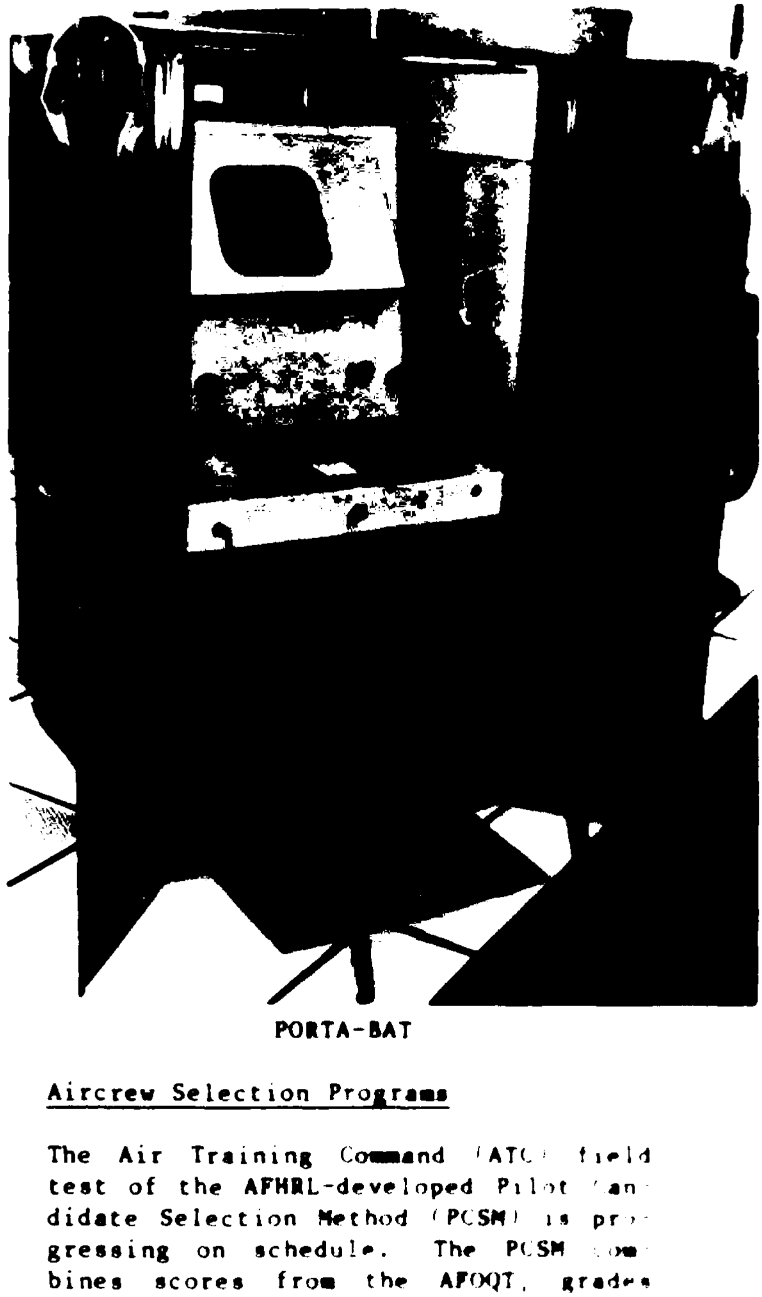

PORTA-BAT

<u>Aircrew Selection Programs</u>

The Air Training Command (ATC) field test of the AFHRL-developed Pilot Candidate Selection Method (PCSM) is progressing on schedule. The PCSM combines scores from the AFOQT, grades from the last four sorties of the Flight Screening Program (FSP), biographical information, and scores from a psychomotor (eye-hand coordination) test into a final score highly predictive of success in pilot training. The psychomotor test is given by the AFHRL developed Portable Basic Attributes Test (PORTA-BAT) system. Planning with ATC is underway to establish the operational use of the PCSM. A slightly modified version of the PCSM (without the FSP grades) is being considered for use by the Air National Guard (ANG) for selection of their pilot training candidates. The ANG and AFHRL are working towards their operational use of PCSM starting in late 1986.

The PORTA-BAT also gives a battery of information processing and personality tests referred to as the Basic Attributes Test (BAT). The BAT and PORTA-BAT are being used by allied air forces in two major international R&D programs. The Royal Australian Air Force began a cooperative testing program with AFHRL in June 1986. Two PORTA-BAT systems were sent to Australia and will be used to test pilot applicants, helicopter pilots from the Australian Army and Navy, and combat crew members from operational squadrons. The goals of this program are to independently validate the BAT as a screening/classification instrument for pilot selection and classification, examine the utility of the BAT for selecting helicopter pilots and other aircrew positions, and suggest possible tests or improvements from Australian R&D programs.

A second international R&D program is being conducted as part of AFHRL's support of the EURO-NATO Aircrew Selection Working Group. In this program, the PORTA-BAT is being used in Germany, Great Britain, Denmark, the Netherlands, Norway, Belgium, Italy, and Portugal as part of an effort to improve the selection of fighter pilots for entry into the EURO-NATO Joint Jet Pilot Training (ENJJPT) program. This project is designed to select pilots who will succeed in becoming "fighter pilots" as opposed to the universally assignable pilot produced by the USAF Undergraduate Pilot Training (UPT) program. The aim of the Working Group is to increase the success rate of ENJJPT candidates and establish a standard NATO selection system. Each participating nation will have the use of PORTA-BAT to test applicants during some portion of 1986 and 1987. Data will be shared between the individual nations and AFHRL who will analyze the aggregate performance of all entrants in a combined sample.

Installation of a fighter pilot performance measurement system in the Air Combat Maneuvering Instrumentation (ACMI) range at Luke AFB is scheduled for completion in late 1986. Data gathered from "real-world" airborne performance on the range will help establish criteria for selection into the fighter training track within the Specialized Undergraduate Pilot Training program. A related project to develop pilot performance measures for reconnaissance missions is scheduled to begin in October at Bergstrom AFB, Texas.

Analysis continues of the performance of USAF ENJJPT graduates versus USAF UPT graduates in Lead-In Fighter Training (LIFT). The project is designed to investigate the effects of their different training syllabi on common performance elements in follow-on fighter training programs.

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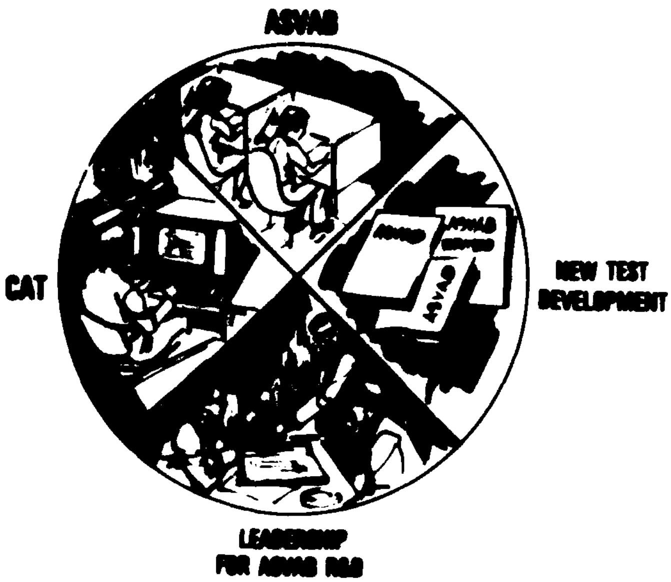
Armed Services Vocational Aptitude Battery (ASVAB)

The ASVAB is used as the primary enlistment selection and classification test for the United States Armed Services. The ASVAB is administered to approximately one million applicants for the US military in the operational testing program as well as another one million high school students in the DOD Student Testing Program. The Laboratory is the lead service personnel R&D



organization supporting the joint Service and DOD programs. AFHRL not only develops the ASVABs for both programs, but provides R&D work necessary to support each testing system. This year, AFHRL completed the Initial Operational Test and Evaluation of the recently implemented ASVAB Forms 11, 12, and 13. The Laboratory also produced final normative conversion tables for these ASVABs using a representative sample of 1980 American youth. Deliberate failure keys were also developed and given to the US Military Enlistment Processing Command (US MEPCOM) to be used to detect malingering in the event of national mobilization.

Development and publication of the ASVAB <u>Technical Supplement to the Counselor's Manual</u> was accomplished this fiscal year in support of the DOD Student Testing Program. Candidate follow-on ASVAB Forms 15, 16, and 17 were constructed and tested as overlength operational tests at the Services' Recruit Training Centers. The design of an equating effort for the operational calibration of candidate ASVABs was completed and testing began for the interim calibration of the new forms. New, overlength ASVABs were also constructed as follow-on forms for ASVAB 14, used in the DOD Student Testing Program. Work was also completed on the development of various indices of "appropriateness." These indices employed state-of-the-art psychometric advances and show promise for use in detecting deliberate failures and test compromise. Work was also completed on a project to determine estimates of the alternate forms reliability of the ASVAB. A number of analytic projects were completed for the Air Staff. These efforts generally examined the projected impact of the new normative conversion tables on Air Force accessions. The Laboratory also revised the Vocational Interest for Career Enhancement Inventory and, in conjunction with the Air Force Military Personnel Center and US MEPCOM, designed a strategy to try out this interest inventory for use in refining recruit classification.

Work was begun on a project to examine the effects of multidimensional test items on the estimation of test item parameters in computer-administered adaptive tests. The Laboratory also hosted a conference to provide a forum for test theorists and practitioners to discuss future concepts in test validity.

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<u>Air Force Officer Qualifying Test (AFOQT)</u>

AFHRL is responsible for developing tests used in officer selection and classification decisions. R&D is conducted on a continuing basis to maintain and improve the AFOQT, which is the Air Force's principal aptitude test for officers. A major project underway has the objective of developing a large pool of new test items for use in subsequent forms of the AFOQT. Items have been written in aptitude areas tested by the current form (Form O). Additional items are still under development. Also, item types to assess new content areas are being identified, and a pool of items will be developed to cover selected new content areas which may be used in future tests. Nearly 12,000 items will be written and tried out to determine their acceptability for use in operational forms of the test.

Two new versions of the battery will be implemented in January 1987. These two versions were developed from the early items produced under the large-scale item writing effort. In order to meet the January 1987 implementation deadline, 4,500 experimental items were pretested at Lackland AFB. The pretesting resulted in two proposed parallel versions of the AFOQT. These two versions were then administered along with the current form to a sample of 602 Officer Training School (OTS) cadets, 2,027 Reserve Officer Training Corps (ROTC) cadets, and 781 basic trainees to ensure all three tests are parallel. Careful analyses of these data are in progress to assure that the two new forms (P1 and P2) are properly equated to Form O.

The major product will be a more up-to-date AFOQT. Production of parallel versions will reduce the possibility for test compromise and will facilitate retesting of examinees with alternate forms. New item types have potential for increasing the validity of the test. In recent years, AFOQT test results have been used annually in a prescreening process to identify from 5,000 to 8,000 low-ability, high-risk applicants with a poor probability of success in officer training and in subsequent career assignments. Although the dollar savings associated with officer aptitude testing are indeterminate, each high-risk applicant screened out represents a potential savings of $10,000 or more in commissioning training program costs alone.

Work is continuing in the development of item pools to be used in subsequent forms of the AFOQT. Support materials for AFOQT Forms P1 and P2 have been developed. Validity evaluations are continuing on the AFOQT; analyses are ongoing using the AFOQT subtests to predict aircrew and non-aircrew criteria. AFOQT Quick Scores, which are used by Air Force recruiters, have also been evaluated. Validation of the OTS and ROTC selection systems is nearing completion. As a part of that effort, OTS student graduate/eliminee performance profiles were generated.

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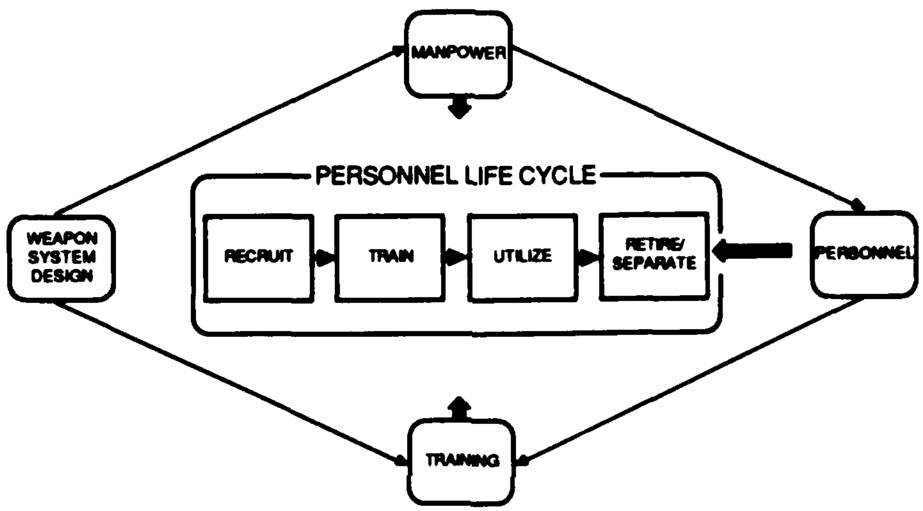
Testing Program Additional Notes

During 1986, development of English Language Tests (both elementary and intermediate versions) was completed, and these new tests were implemented at overseas bases for use in selecting foreign nationals for employment at the base. These new versions represent a great improvement over their predecessors.

In the officer test area, new content areas for the AFOQT are under active investigation. Ten new cognitive item types are being developed for validation and evaluation in terms of contribution to the existing battery content. In addition, plans are being formulated for careful exploration of possible measures of leadership and management ability as contributors to effective officer selection.

A number of efforts exploring various aspects of the validity of the ASVABs are planned, as well as a comparison of the ASVAB to the General Aptitude Test Battery (another widely used multiple aptitude battery). The Laboratory will also begin development of an ASVAB Archives. The Archives will contain all published and unpublished material related to the development of the joint-Service and student testing programs, as well as all extant data sets of ASVAB test scores.

We continue to explore Item Response Theory (IRT) and possible applications of it to practical problems in operational testing programs. Methods of detecting deliberate failure on the AFOQT would be needed in the event of a national mobilization. Appropriateness indices may find useful application in the detection of true and deliberate failures, and the Laboratory is sponsoring the operational tryout of some of these indices in the near future. Also planned for future development and tryout are statistical methods for estimation of frequencies in censored samples—useful in norming and validity estimation.



Schematic Representation of the Personnel Life Cycle

Manpower, Personnel, and Training Integration Research Planning

Manpower, Personnel, and Training Integration Research Planning

Significant manpower authorization shortages and increasing industry competition for personnel with high technical skills, at a time when emerging weapon systems are requiring more highly skilled personnel, mandate that MPT requirements be evaluated early as part of new weapon system design tradeoff decisions. At the present time, MPT requirements have little impact on design decisions. If these MPT requirements are to impact design decisions, they must be available during concept development in the acquisition process. There is currently no adequate technology for forecasting MPT requirements during the concept development stage. Further, there is no technology for integrating forecasted requirements for a new or modified system with other emerging and existing systems to forecast total force impact and assess life cycle MPT supportability. Another problem is that fielding of new or modified weapon systems is suboptimal because the acquisition process does not provide detailed information sufficiently early to permit the personnel and training pipelines to be properly established before delivery. This delays assimilation of the new weapon systems into the operational force. There is significant evidence of this suboptimal fielding of new weapon systems. For example, staffing of the new systems usually takes sufficient experienced personnel from existing weapon systems to create critical experience shortages in the existing systems. Further, in the early years after deployment, extensive changes in the new weapon system's Air Force Specialty Codes (AFSCs) and pipeline training normally occur, creating turbulence in the personnel and training systems. Finally, for existing weapon systems there are insufficient database and software mechanisms for MPT managers to consider total system impact when making specific decisions in their spheres of influence. For example, decisions to change the minimum aptitude requirements of a specialty do not fully consider associated changes in training time and resource requirements. Hence, the ability of the training community to support such aptitude requirement changes has not been fully considered at the time an AFSC's aptitude standards are changed. In addition, databases and models are not adequate to fully consider the ability of the market place to supply recruits who meet the new standards or to see if raising aptitude standards in one AFSC will create talent voids in another AFSC.

The MPT Integration Research Project will develop technologies to solve each of the problems stated above. Specifically, weapon system acquisition or modification program managers will be provided procedures, databases, and software necessary (a) to set supportable MPT goals for an emerging weapon system, (b) to forecast the MPT requirements associated with design options, and (c) to evaluate the total force impact of the selected options. These capabilities should ensure that the operational systems will not exceed MPT supportability constraints. Also, detailed task-level information will be available to the training community for input into the Instructional Systems Development (ISD) process, and training requirements will be specified for timely insertion into the budget process. This will permit development of a stable and effective training pipeline well in advance of weapon system deployment. In addition, the detailed task-level information will permit personnel managers to establish efficient specialty structures, set entry standards, establish effective retraining policies, and set recruiting goals well before deployment. The training and personnel managers' involvement in supporting the new weapon system will become proactive rather than reactive and will both enhance deployment and shorten the time between delivery and full mission capability. Finally, integration of MPT decision processes for existing weapon systems will create an environment where MPT decisions can be mutually interactive, rather than isolated decisions which meet one manager's needs but perhaps create a more critical problem for another manager.

Although the MPT integration R&D project is a newly identified effort, it involves restructuring, integrating, and shifting priorities for existing, ongoing job requirements and modeling R&D efforts rather than starting totally new efforts. Both in-house and contract R&D will be used to develop new MPT forecasting and integrating technologies. Specifically, extensive occupational analysis, task benchmarking, aptitude and training requirement forecasting, and job and force modeling technologies will be modified or developed to fill identified technology gaps. With the technologies to build databases, new forecasting procedures will feed increasingly larger models until the ultimate model, Force Impact Model, is complete. Interim products will be transitioned to MPT users for implementation as they are completed. Technologies now nearing completion will aid the integration of MPT decisions for existing weapon systems. R&D efforts to be initiated in FY87 and FY88 will be directed toward enhancing the fielding of new weapon systems. FY89 and FY90 R&D initiatives will be directed toward developing technologies for forecasting the MPT requirements of new weapon system design options and providing a total force view of MPT resources and constraints to determine supportability.

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Civilian and Military Availability R&D

For some years there has been a growing concern among military MPT planners that not enough attention was being given to MPT issues in the acquisition of new weapon systems. Succinctly stated, the problem is that weapon systems are being planned for and procured which will be difficult to operate and maintain, given the military services' current ability to attract and retain qualified personnel. This problem is of key concern to the Air Force as it moves toward the use of even more technologically advanced weapon systems. Several recent thrusts—most notably the Navy's HARDMAN project and Army's MANPRINT project--have attempted to ensure that proper consideration is given to MPT concerns in the weapon systems acquisition process.

One of the key parts of the Air Force's manpower and personnel-oriented R&D program in this area will be the matching of personnel available to operate and maintain weapon systems with the demand for such personnel. This particular R&D program will focus on developing models of the future availability of not only military personnel but civilian personnel as well. Estimates of future civilian mental and physical qualifications and interest in entering military service are required for effective MPT planning.

This R&D program is composed of two parts. The first part will continue previous AFHRL work in modeling retention and reenlistment decisions by Air Force occupational specialty. The Air Force Reenlistment Analysis Package (AFRAP) will be enhanced with the inclusion of validated reenlistment estimation equations. The validation work will consist of using reenlistment estimation equations developed on reenlistment decisions made through 1982 to predict reenlistment decisions made since that time. Where necessary, new equations, by AFS, will be reestimated and included in the AFRAP software package. This package permits the user to evaluate the impact on reenlistment rates by AFS of changes in economic and demographic factors and incorporate these impacts on a length-of-service force profile. The software package is designed to be very user-friendly and operates on a personal computer. The second part of the R&D effort is the design of a civilian availability model. The model will be based on an extensive analysis of existing civilian availability data such as ASVAB high school testing program data, data on individuals interested in Air Force service, and Bureau of Labor Statistics and Census Bureau population projections. Particular emphasis will be given to determining what Air Force Recruiting Service and other services do to estimate the availability and interest of civilian personnel in military service. Another facet of this R&D project will be an examination of the suitability of various forecasting techniques to estimate the long-range (5-15 year) availability of civilians. This time frame is necessary because of the length of time required for weapon system acquisition. A demonstration model will be designed and tested with selected data and forecasting techniques.

The development of a model to estimate the future availability of military and civilian personnel for military service will be of great benefit to MPT planners. The ability to determine where and when potential future shortfalls of critical personnel can happen will be of significant value. Through the use of a civilian availability model and a military retention prediction model, an MPT analyst will be able to estimate the compensation, training and other policy incentives necessary to attract sufficient numbers and types of nonprior-service personnel to join the Air Force, as well as to retain current active duty individuals in key military jobs and/or those individuals capable of being retrained to operate and maintain new weapon systems.

Work is underway to validate the estimating equations in the AFRAP software. The model will be enhanced with the revalidated equations along with several changes suggested by interested potential users. The civilian availability R&D effort is scheduled to begin in early FY87. Both should be completed by the end of calendar year 1987.

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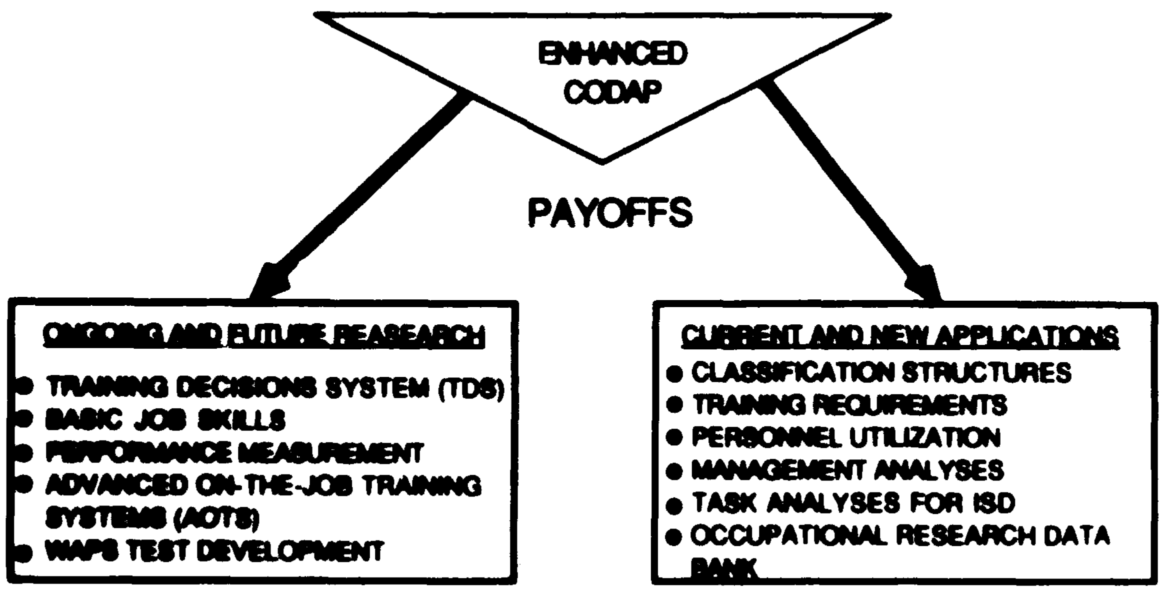
OCCUPATIONAL MEASUREMENT TECHNOLOGY



<u>Comprehensive Occupational Data Analysis Programs (CODAP)</u>

The principal occupational analysis technology in the Air Force is the Comprehensive Occupational Data Analysis Programs (CODAP) software system, which has supported a major occupational R&D program within the Laboratory and a major operational analysis program within the Air Force Occupational Measurement Center (AFOMC) since 1967. CODAP-generated products have had significant impacts on the development of Air Force technical training, in the evaluation and revision of Air Force enlisted classification structures, and in the establishment of a scientifically sound basis for realigning entry-level aptitude requirements across Air Force enlisted career fields. Over the last 15 years, the

CODAP system has grown in size and complexity as a direct result of significant hardware improvements to the AFHRL Sperry System and due to major enhancements to the basic structure of the CODAP software itself.

Increasing sophistication in the methods and procedures required by Air Force occupational researchers and analysts, and a wider range of users and applications, forced the somewhat unsystematic expansion of the system. Over time, the programs became difficult to maintain, modify, or augment without extensive programmer training and experience. It became increasingly urgent that a major system redesign effort be launched to consolidate and use to better advantage the many additions and modifications that had been incorporated into CODAP over the years and to create new technology and software to meet the current and anticipated methodological and applications requirements of CODAP users.

The products of the redesign effort will provide CODAP programmers and computer technicians with software that is easier to execute, maintain, and modify. Occupational analysts will have available more effective analytic tools for performing job analysis in operational settings, and occupational researchers will be provided with state-of-the-art R&D tools necessary for addressing their ongoing and future occupational measurement needs. Other users such as industry, academia, allied forces, Army, Navy, and various Government users who have adopted CODAP will now find it much easier to incorporate software updates.

The goal of this multiyear project is to develop a prototypal occupational measurement software system which will integrate historical changes to the CODAP system with newly developed capabilities. By the end of FY86, three major project objectives had been achieved. First, operational efficiency of the system has been increased. Fewer runs are now required to accomplish a standard analysis, and run setups have been simplified. The development of a computer-based training package, along with better internal and supporting documentation, enables technicians to learn the system faster and with less supervision. Redundant programs have been eliminated, and core requirements for many programs have been reduced, resulting in much faster turnaround times. Second, system maintainability has been improved. Consistent documentation throughout the system permits programmers and programming technicians to operate and debug the system without excessive expenditure of time and money. Formalized test and acceptance procedures ensure that the new and modified software is working properly for all types of CODAP data sets. Finally, analytic capabilities of the system have been expanded. The improved American Standard Code for Information Interchange (ASCII) Fortran version of the CODAP system accepts up to 20,000 cases, 3,000 task items per case, and 2,000 background variables. Hierarchical clustering can be performed on 7,000 cases or 3,000 tasks. Along with increased system limits, new capabilities have been explored including the areas of profile analysis, nonhierarchical clustering, two-way clustering (cases x tasks), module technology, and automated job typing. Final products are more readable, and users are given greater flexibility in their use of free text and in formatting reports. Non-CODAP software (correlation and regression, factor analysis, statistical packages such as Statistical Package for the Social Sciences (SPSS) and Biomedical Program (BMDP)) are now accessible through interfaces with the AFHRL Sperry.

Like its predecessor, ASCII CODAP will continue to support AFOMC's occupational analysis program in establishing classification and training criteria for the Air Force. Major new Air Force MPT programs which will require use of occupational survey data will benefit from the system's advanced capabilities as will Air Force operational managers and decision makers. An example of such an operational application would be in the use of CODAP-based occupational survey data to help establish test outline "testing importance" specifications for the development of enlisted promotion tests.

As in recent years, the new system will be made available for transfer to other US Armed Services and to our allied military services; to Federal and state agencies, county-level governments, and universities; and to commercial and industrial firms. AFHRL currently is involved with the personnel department of the city of Fort Worth, Texas, which is analyzing occupational data on clerical workers to evaluate the adequacy of their present job classification structure, to develop job descriptions, and to assess training needs in their clerical occupations.

In the next year, we will continue to upgrade the computer-based training course, not only for ASCII CODAP technicians but for programmers and analysts as well. Advanced development and operational testing of the new CODAP system will go on, as will exploration of new, more sophisticated analytic techniques such as semantic analysis, nonhierarchical clustering and automated job-type selection. Transition of the new system to the Occupational Measurement Center will progress, with a fully operational system expected by early 1988.

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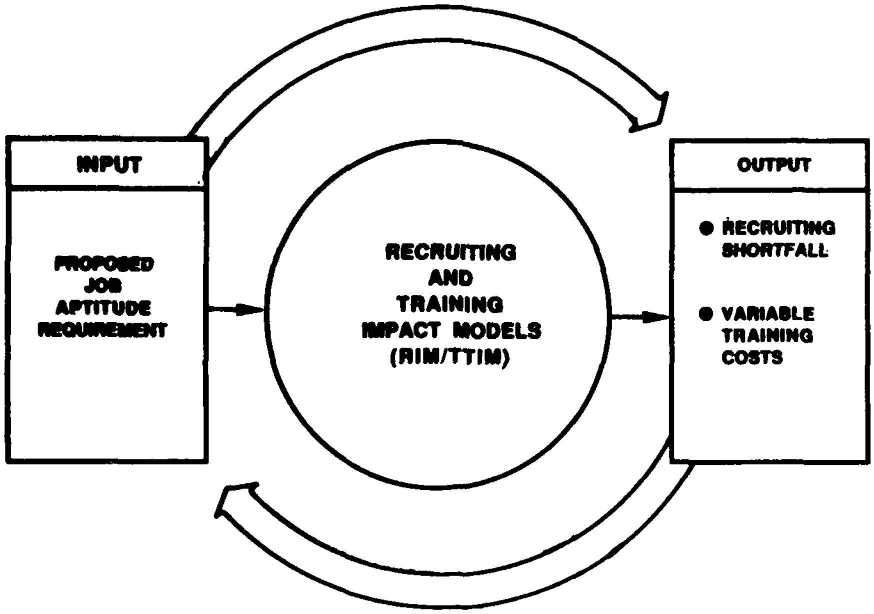
Recruiting and Technical Training Impact Models

Effective personnel and training management requires knowledge of the impact of adjustments in a bewildering array of factors. Although experienced managers can estimate the probable impact of adjustments in a single factor, it is nearly impossible to accurately estimate the impact of simultaneous adjustments in several factors. Computerized decision aids can easily accommodate the complexity of multiple factors and provide a means of evaluating management alternatives prior to final decision and implementation. Dual forecasting systems, known as the Recruiting Impact Model (RIM) and the Technical Training Impact Model (TTIM), are under development to provide tools for personnel and training management. These tools are designed to provide estimates of recruiting and training outcomes likely to result from proposed management actions. For example, a proposed aptitude requirement minimum for a given job specialty would be evaluated on the basis of projected recruiting shortfalls, given the constraint on recruiting imposed by the aptitude requirement. Also, the proposed aptitude requirement would be evaluated on the basis of the variable training costs that are projected as necessary to produce skilled technicians. If unacceptable recruiting or training outcomes were projected for the proposed aptitude requirement minimum, alternatives could be evaluated by way of an iterative planning loop. More effective management of recruiting and training resources would issue from the use of computerized decision aids which allow anticipation and avoidance of adverse recruiting and training outcomes.

The R&D consists of the development of two computer models which will operate sequentially to simulate the personnel and training pipeline. For the Recruiting Impact Model, R&D consists of the development of a computer program which can be used to project, on a specialty-by-specialty basis, recruiting shortfalls and the aptitude distribution of assigned personnel. For each job specialty, the estimated aptitude distribution would be combined



with other personnel attributes and several course factors to form the input for the TTIM. Training impact R&D consists of the development of a covariance structure model of initial skills training and involves specification of the magnitude of the effects of student and course factors on training outcomes such as number of remediation hours, student elimination rates, and variable training costs.

A computer program designed to project recruiting outcomes is nearing completion. Regression equations designed to forecast technical training outcomes have been developed and are being validated. Work in support of the development of the computer program for the TTIM has commenced. The RIM and TTIM should be available for operational use by the end of FY87.

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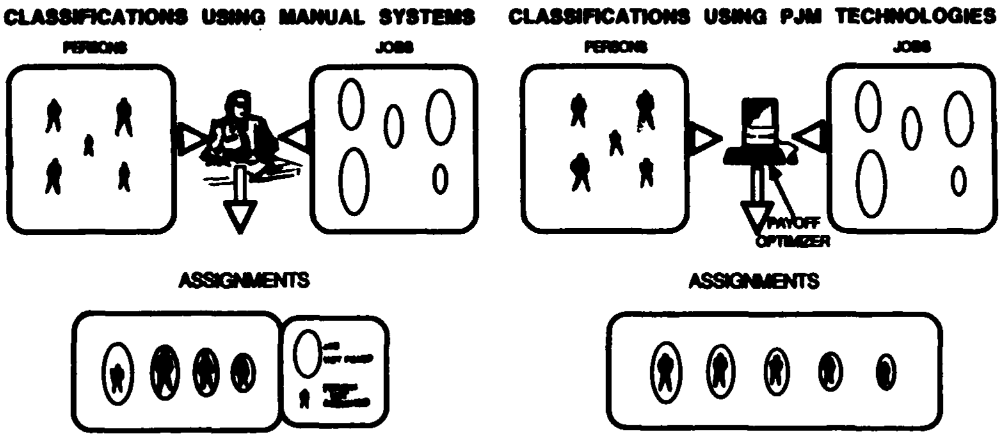
Expansion of Person-Job Match Technology

The Procurement Management Information System (PROMIS) selects and classifies nonprior-service enlisted personnel into specific Air Force Specialties (AFSs) or into an Air Force aptitude area (Mechanical (M), Administrative (A), General (G), or Electronics (E)). Personnel classified into an area are called Aptitude Index (AI) enlistments. The Processing and Classification of Enlistees (PACE) system classifies the AI personnel classified by PROMIS into specific AFSs during basic training. In the retraining area, over 10,000 airmen are selected each year for training into new specialties. Decisions as to which specialties they enter are based on a first-in, first-approved procedure, with little regard to selecting the better-qualified applicants. This procedure contributes to non-optimal reclassification of airmen for retraining. This could lead to higher attrition from technical training and to lower job satisfaction for those who begin working in the new fields. The R&D efforts in support of PROMIS, PACE, and retraining are designed to improve the selection and classification of airmen at different points in their careers. These R&D efforts will improve the personnel systems by using state-of-the-art assignment algorithms and the latest results of personnel R&D. Since the PROMIS, PACE, and retraining systems efforts are at different stages in their development, they will be addressed as separate but similar efforts.

CLASSIFICATION OF AIR FORCE NONPRIOR SERVICE AND RETRAINING PERSONNEL



PROMIS was developed in 1975/76 and took advantage of the classification and personnel R&D of that time. PROMIS is a classification algorithm that assigns personnel sequentially (one person at a time) based on the "worth or payoff" of that person in an AFS combined with the prediction of future accessions for the AFS. The R&D efforts to enhance PROMIS that will be started or completed in FY86 and FY87 are: (a) to include additional information to use in evaluating the worth of a person on a job, (b) to consider alternative sequential classification algorithms, (c) to include the Vocational Interest for Career Enhancement inventory, (d) to implement improved regression equations to predict technical school success, and (e) to consider new methods to predict future accessions.

The present PACE classification system does not take advantage of personnel R&D results or mathematical algorithms to make its classifications. R&D in progress will upgrade PACE so that it will take advantage of past Person-Job Match (PJM) R&D and will use state-of-the-art linear programming techniques. R&D initiated in September 1985 developed a PACE classification policy. As in PROMIS, the policy will be used to compute the worth of classifying a person to an AFS. PACE R&D efforts to be started or completed in FY86 and FY87 are: (a) development of the PACE classification policy, (b) implementation of algorithms to optimally classify personnel, (c) designing of data files needed by the PACE operational prototype, (d) development of the PACE prototype, (e) testing and evaluation of the prototype by running both the existing and new PACE classification systems in parallel, and (f) delivery of the prototype and policy-generating programs to Air Training Command for operational use.

The primary objective of the current retraining classification R&D is to develop a methodology that will optimally reclassify enlisted personnel for retraining according to a predefined Air Force policy. The new retraining system will utilize PJM selection and classification methodology already developed in the PROMIS and PACE systems. Usable variables from PROMIS and PACE and new variables will be integrated into the retraining system. A working group composed of retraining program managers and AFHRL scientists first met in May 1986. The group will identify variables and develop a retraining policy using policy-specifying techniques. System development will include the definition of an algorithm to optimally assign personnel based on Air Force requirements and available talent. The retraining policy is expected to be completed by January 1987. A prototype will then be developed for small-scale testing. In addition to making optimal retraining assignments, the new retraining system will make work easier for system managers. There will be fewer requirements for waiver determination, quicker and more accurate decisions on applications, and reduced requirements for selective retraining of nonvolunteers.

The outcome of this R&D effort will result in three systems which will classify personnel in a similar and optimal manner. By using AFHRL personnel R&D results and operations R&D techniques, classifications should result in: (a) the meeting of PROMIS, PACE, and retraining classification goals; (b) increased retention; (c) less attrition cost; (d) less cost due to casual time (the waiting time between graduation from basic military training and beginning of technical school); (e) improved matching of abilities with the difficulty of the AFS; (f) increased job satisfaction and motivation through considering personal interests; and (g) improved success in the Air Force.

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Basic Job Skills Research Program

Modern Air Force work centers reflect the technological advances that have established the Air Force as a "technological pacesetter" in today's world. That role carries with it the need to define the intellectual demands that complex systems levy on workers so that training can be advanced to keep pace with rapidly developing hardware technologies. In response to this need, a large-scale R&D effort--the Basic Job Skills (BJS) Research Program--has been initiated. The overall goal is twofold: (a) to examine 125 Air Force occupations in order to define high-tech competence in terms of the skills that are shared across domains (basic job skills), and (b) to develop adaptive training based on the skill commonalities. Basic job skills are defined as the core knowledge and thinking processes; that is, the unobservable mental events that underlie expert performance on the Air Force's most technically demanding tasks. They can be considered the components of scientific literacy needed for performance in today's high-tech work environments. For example, a technician's "mental model" or internalized conception of how an automated electronic test station works is considered a basic job skill.

Precise definitions of shared skills such as these can produce answers to questions about the optimal knowledge humans should have in work centers saturated by "smart machines." Further, the focus on the unobservable mental events that account for technical expertise makes it possible to accurately represent and train the skills that are demanded in the high information flow environments created by complex technological systems. Training will be able to focus on the <u>thinking</u> required for modern Air Force work centers, with the goal of fostering in apprentices "performance with understanding." Payoffs will also be derived from centralizing the instruction for thousands of apprentices in a streamlined and potent instructional system that takes advantage of AFS commonalities.

A three-stage R&D approach has been implemented to produce task analysis, diagnostic test, and training outcomes. First, cognitive task analysis methods to capture the unobservable mental events of technical expertise have been developed and tested in five Air Force occupations. The events are analyzed for content and process similarities and then fed into the second R&D stage. At this stage, problem-oriented tests are developed to diagnose trainees' deficits in the skill areas. In the third stage, results from cognitive analyses provide the basis for a series of problem-oriented training systems designed to cover more and more skills and occupations. The initial instructional systems will present trainees simulated troubleshooting environments (intelligent practice environments) using intelligent tutor computer systems. The tutors provide support, advice, and criticism as trainees practice making diagnoses of increasingly complex systems.

The following major accomplishments highlighted the BJS Program in FY86:

1. Field-test stage of the application of cognitive task analysis methods to 125 AFSs was completed.

Workshops were held at three operational sites (Langley AFB, VA; Cheyenne Mt. Complex, CO; and Nellis AFB, NV). Over 20 Air Force technical experts and 20 apprentice airmen participated in each 10-day workshop event.

Prototype task analysis methods were developed based on workshop experiences.

2. Large-scale testing of a pervasive basic job skill identified during FY84 feasibility work (i.e., the skill of determining logic gate input/output values in tracing digital circuitry in electronics) was accomplished on 119 airmen in three organizations at Nellis AFB, NV.

Design specifications were completed for the first training system to be developed as part of this R&D program. An intelligent tutoring system delivering 30 to 50 hours of instruction to integrated avionics technicians has been designed as a demonstration trainer for this effort.

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Value of Air Force Experience

In this period of increased emphasis on reducing costs and accomplishing the defense mission with fewer resources, the Air Force is often required to address the impact of different compensation and policy alternatives on the composition and experience mix of the enlisted and officer forces. Cost comparisons must be made between having a more experienced but more costly force and a less experienced but less costly force. Closely associated with this problem is the demand placed on the Air Force to answer DOD and Congressional inquiries about the impact of losing experienced personnel and the cost of replacing such individuals in critical job specialties. Air Force manpower and personnel planners need a logically defensible and scientifically sound method to be able to respond to these questions. Such a methodology will enable the Air Staff user to quantify in dollar terms the value of Air Force job experience, training, length of service, and other key variables across critical enlisted and officer specialties, occupational and demographic groupings, and the total force.

This R&D will center on providing new and creative solutions to the problem of costing (valuing) Air Force experience. It will not be limited solely to determining replacement costs or training costs, but will result in a model that reflects the entire life cycle and future worth of experienced personnel in critical Air Force occupations. The work will consist of three phases. Phase 1 will see an extensive review of relevant human resource accounting and human capital models and previous work. The goal in this phase is to integrate the various approaches where possible and to suggest areas where new technological break-throughs need to be made. Primary emphasis will be on tailoring the techniques or devising modifications to existing approaches which will make them suitable for the unique characteristics of the Air Force and military environment. Phase 2 will select one of the approaches, a modified approach or new concept from Phase 1, and develop a design for a model of the value of Air Force experience. Phase 3 will develop the model to the extent that an operational evaluation of the model using actual Air Force occupations, training types, and service groups can be made.

The primary benefit of this R&D will be to provide Air Force manpower and personnel planners and managers with an analytical tool to assess the value of Air Force experience. The supporting methodology will aid in establishing the relative value of different kinds of Air Force personnel and, thereby, help determine the cost of losing and replacing such experienced airmen or officers. Better-informed decisions on force structure and force management should help the Air Force to accomplish its defense goals within the stringent boundaries of limited fiscal and personnel resources. As the era of dwindling manpower pools approaches, knowing the cost tradeoffs necessary to obtain or retain certain kinds of specialized, costly to train, or difficult to retain personnel is [illegible] important. Increased emphasis [illegible] sophisticated weapon systems [illegible] demand a more technically capable [illegible] Being able to accurately assess [illegible] of experienced personnel will [illegible] in acquiring and main[illegible] a force. The cost of los[illegible] experienced individual such as [illegible] technician is high, but knowing just how expensive can aid in fashioning cost-effective force structure and retention policies.

At the end of FY86, this project will be in the early stages of contract procurement. A Program Research & Development Announcement (PRDA) was selected as the avenue for soliciting proposals. Two firms have been identified for contract award and purchase requests are being prepared. Under the PRDA arrangement, these two firms will each provide new and creative solutions to the problem but each will suggest a different approach. Once the 18-month efforts are completed (scheduled for January 1987 starts), AFHRL will select one of the approaches for further development.

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Reevaluation of the Weighted Airman Promotion System (WAPS)

Each year the Air Force promotes approximately 45,000 airmen to the grades of staff sergeant (E-5), technical sergeant (E-6), and master sergeant (E-7) from a pool of over 240,000 eligibles. The enlisted promotion system used to select these promotees is the WAPS. Basic components of WAPS consist of six promotion selection factors and corresponding weights that are used to compute a total weighted factors promotion score for each airman considered for promotion. The six selection factors involve two test scores, two seniority measures, decorations, and job performance ratings. For each grade, eligible airmen within each AFS are aligned in order by their total weighted factors score. A promotion quota is then applied, and those airmen with the highest scores in each AFS are promoted. The system has been fully operational since 1970; however, to

Weighted Airman Promotion System: Provides Equitable/Visible Promotions

keep WAPS running smoothly and up to date, it must be periodically reevaluated.

Working in close coordination with the Military Personnel Center and the Air Staff, the Manpower and Personnel Division initiated a project in 1985 to reevaluate the current WAPS. The main objective was to compare a newly developed weighted formula for each grade with the operational system to identify significant changes, if any. Other objectives addressed included the following: (a) determine if separate weighted formulas are required for each of the three grades, (b) consider the completion of Command Noncommissioned Officer Academy as an additional selection factor for promotion to E-7, (c) evaluate various weighting strategies for the Airman Performance Report (APR) factor, (d) investigate the use of standardized scores for the test factors, and (e) analyze the establishment of a separate weighted formula for those AFSs which have no Specialty Knowledge Test (SKT). In June 1985, a carefully selected group of six colonels and six chief master sergeants convened at AFHRL to form an experimental promotion policy board. Each board member independently examined a large sample of specially constructed airman records taken from the most recent promotion cycle and provided promotion evaluations. The promotion decisions furnished by the experimental board provided the necessary information for the analysis phase of the project. The mathematical methodology known as policy capturing was used to model the promotion decision policy of the experimental board. All experimental systems which were developed during the analysis phase were evaluated in terms of their similarity to the current system and their impact on women and minorities.

The WAPS provides the Air Force with an enlisted promotion system that is both "equitable and visible", i.e., promotion opportunities are equal across AFSs, procedures are easily understood and accepted by airmen within the system, and individual feedback is provided to all eligibles. R&D results from this reevaluation effort will provide enlisted promotion policy makers with a current, scientifically defensible basis for making improvements to the operational WAPS. This, in turn, will assure that the best and most deserving enlisted personnel are promoted to the important midlevel grades and will impact positively on retention rates, quality of performance, and morale.

The WAPS reevaluation effort was completed and the results and conclusions have been presented through the chain of command to the Air Staff. Policy makers at the Air Staff level are now evaluating and considering the final outcomes.

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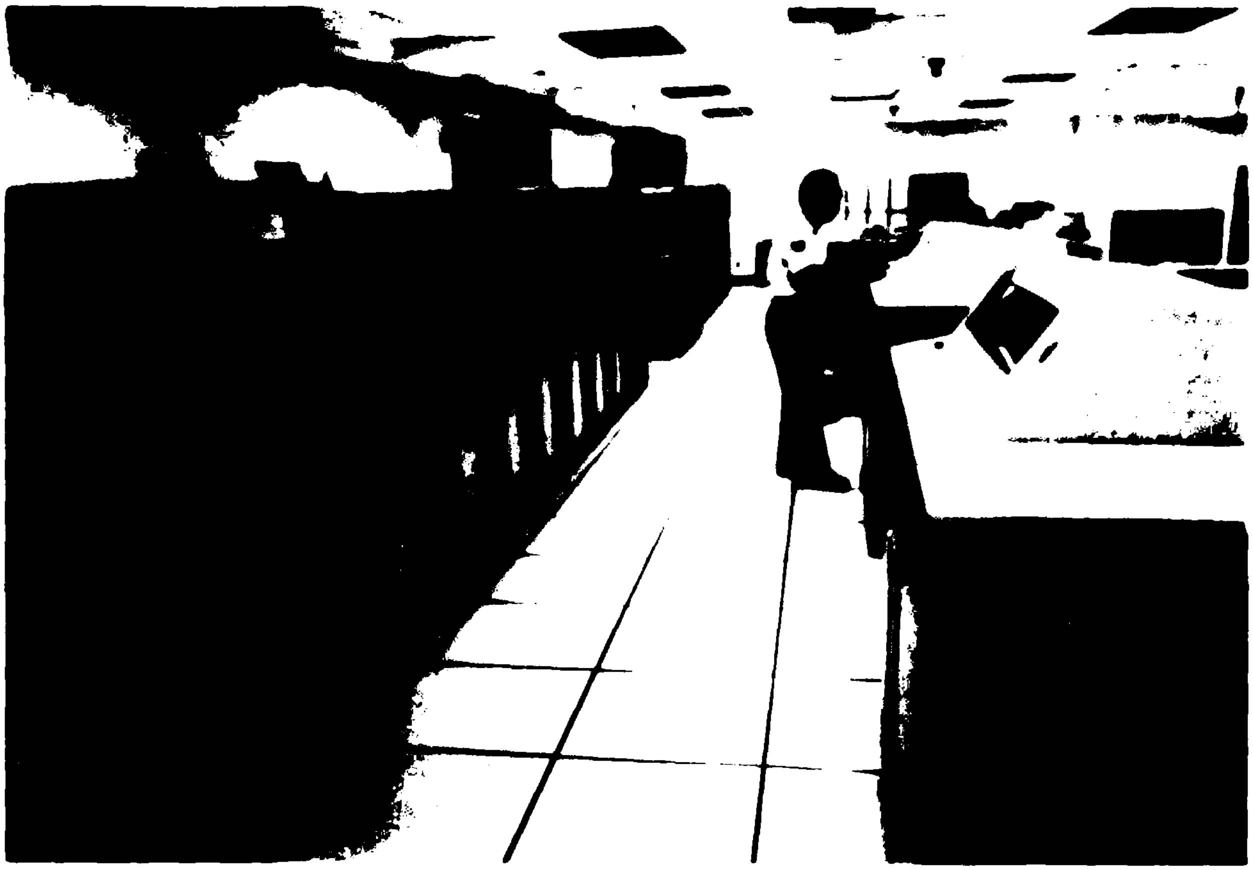
TECHNICAL SERVICES DIVISION



TECHNICAL SERVICES DIVISION

The Technical Services Division, located at Brooks AFB, Texas, provides support to the AFHRL Headquarters and the four R&D Divisions. This support includes management and operation of the scientific data-processing center of AFHRL. Office automation services are also provided by the Division. Management information is maintained on a computer system. The Division develops, maintains, and updates automated personnel and training R&D databases. The Division also provides consultative and programming support in the formulation of R&D efforts and the application of statistical techniques in support of other Laboratory Divisions and other Air Force offices. The major organizational elements within the Division are the Computer Programming Branch and the Computer Operations Branch. The Division also includes the Information Resources Management Office and the Scientific and Technical Information Office.

Dr. Robert A. Bottenberg
Division Chief

COMPUTER PROGRAMMING BRANCH

The Computer Programming Branch provides three services:

1. Software Development.
2. Database Management.
3. Research Processing.

Software Development. The Computer Programming Branch develops, maintains, documents, and provides training in the use of general-purpose computer software. This software includes the broad categories of (a) language translators, such as precompilers and interpreters; (b) utility programs, such as sort/merge and report writers; (c) applications programs, such as correlation-regression analysis and multidimensional frequency distributions; and (d) subroutine libraries containing common computing algorithms. The Computer Programming Branch is responsible for more than 460 general-purpose and statistical analysis programs and 3,080 pages of user guides to those programs.

Database Maintenance

Database Management. The analysis of relationships between personal characteristics and performance during an Air Force career requires the extensive use of data. Experimental tests and performance measurement devices are administered in a research setting, and these results are ordinarily correlated with information about experimental cases using other information developed on the same cases at a distant point in time, either earlier or later than the experimental data. Similarly, studies of career progression and factors related to successful completion and to attrition require the analyst to correlate information on the same individuals across a time span of several years. The major operational commands, where background and performance data on military personnel are initially acquired, retain these data for only a limited period--ordinarily less than 1 year. In order to facilitate R&D on the Air Force personnel and training systems by AFHRL researchers, automated data are obtained from the major operating commands on a recurring basis. These data are then converted for use in the AFHRL Computer Center. Based on experience with specific analyses and studies over a period for years by AFHRL researchers, data in these master files are then reorganized in a manner calculated to eliminate as much of the overhead as possible in the context of specific studies. Experience has also indicated the desirability of combining information from two or more master file sources to establish ready-to-use master files with a common set of data for each case in the file. The availability of these R&D master files makes it possible for researchers to effectively carry out comprehensive R&D efforts related to the personnel and training systems without having to initiate arrangements for data collection on a case-by-case and study-by-study basis with field locations in major operating commands.

Personnel Tape Library

The AFHRL R&D master files contain data that reflect the personal characteristics of officer and enlisted personnel at time of entry to active duty, performance outcomes during flying or technical training, career status at periodic intervals, and information related to reenlistment or separation. Special files are created to meet long-term study requirements, and longitudinal files have been constructed to facilitate studies in career development. Work is underway to build dynamic officer and enlisted database systems capable of providing responses to operational and research investigators. These database systems will eliminate the requirements for many small, fragmented databases and further reduce the startup time and cost of many personnel R&D efforts.

Major master personnel files are maintained historically on Air Force enlisted and officer personnel and include enlisted strength files from 1964, officer strength files from 1960, officer effectiveness report files from 1956, flying training files from 1964, Air National Guard Reserve files from 1970, separated officer files from 1963, enlisted separation files from 1956, Basic Military Training files from 1956, Officer Training School files from 1973, and ROTC participant files from 1970. These files are received from various Air Force agencies, such as the Air Force Military Personnel Center, Air Training Command, Air University, and Air Reserve Personnel Center. Special longitudinal files, such as the Airman Gain/Loss and Officer Gain/Loss, are developed in-house from these databases and significantly reduce data processing requirements in many personnel and training R&D efforts.

In order to understand the code structures used in the development of the personnel files, an additional database was developed and is maintained by AFHRL. This database is the File Item

Data Organiser (FIDO). It consists of selected data elements and code definitions from Air Force Regulation 700-20, Air Force Data Dictionary, and earlier code systems. It has on-line retrieval capability for current and historical code values with definitions for each data element that appears in a data file. The database currently contains over 1,100 Air Force and DOD-defined data elements, enabling a researcher to obtain English-language meanings for each code value in effect for any particular historical file. FIDO has proven to be a valuable tool for improving database accuracy, both at AFHRL and other agencies.

Technical Services Division Personnel Perform R&D Data Analyzis

Research Processing. The complexity of comprehensive R&D efforts performed by AFHRL researchers frequently leads to an extensive series of data-processing steps and use of AFHRL computer resources. The design and conduct of these data-processing steps in many cases requires the use of technical experts, who select and assemble utility, general-purpose, and statistical programs. Some efforts also require the development of unique software. In many cases the use of one or more technical experts who have a working knowledge of the R&D master files is critical. The Computer Programming Branch maintains a staff of programmer and database experts who support the analysis requirements of researchers. These services are performed in response to approved work requests initiated by all AFHRL divisions. These same services are available to approved agencies outside AFHRL. Work requests are initiated on behalf of the outside customers and then processed in the same manner as those for the AFHRL divisions. In addition to processing these work requests, the Branch performs a quality review of all work performed, to ensure complete and accurate results. Annually, the Branch services over 200 R&D data-processing requests.

COMPUTER OPERATIONS BRANCH

The Computer Operations Branch manages and operates a computer center which includes a large-scale, general-purpose Sperry 1100 computer system to support R&D programs of AFHRL and the Aerospace Medical Division (AMD) at Brooks AFB, and the Occupational Measurement Center (OMC) and the Air Force Military Personnel Center (AFMPC) at Randolph AFB. A Digital Equipment Corporation VAX 8600 is operated by the Branch to provide specialized support to the Training Systems Division for the Instructional Support System (ISS) and the Advanced On-the-job Training System (AOTS) applications. A Digital Equipment Corporation VAX 11/780 computer system provides automated management information systems in support of R&D projects within AFHRL and also provides an interface with the Defense Data Network (DDN). A Wang Laboratories VS-100 computer system provides office automation support within AFHRL.

The computer center includes a magnetic tape library which houses 15,000 active tape reels. These tapes contain historical data from Air Force personnel files, which include master files, working files created in the conduct of data-processing work requests, and system and application software.

Over 300 authorized users access the Sperry 1100 system via dial-up telephone lines, dedicated telephone lines (servicing Williams AFB and Randolph AFB), and direct connected terminals at AFHRL, Brooks. Sperry 1100 users include AFHRL and AMD scientists and contractors, as well as survey analysts from OMC and AFMPC.

The Wang VS-100 computer system provides office automation support within AFHRL. This system provides local automated word processing capability and electronic mail service to the remote AFHRL divisions and HQ AFSC. The Wang terminals and printers located throughout AFHRL (building 578) allow users to create, edit, reuse, and print research reports, correspondence, etc. and to store documents on magnetic disks for later retrieval as needed. The electronic mail function allows transmission of correspondence, research reports, etc. to all AFHRL divisions and HQ AFSC.

Airman Developing Graphics
by Computer

INFORMATION RESOURCES MANAGEMENT OFFICE

Audio and Visual Conferencing Graphics

The remote divisions of AFHRL and headquarters are equipped with a visual/graphics teleconferencing system. This system simultaneously links all the AFHRL sites. This linkage makes it possible to conduct a presentation at any of the AFHRL sites, with participation at each of the other sites. The Advanced Teleconferencing Multi-media Communication (ATMC) equipment is the heart of the visual conferencing capability. One ATMC is located at each of the remote sites, and one system, together with a backup, is located at AFHRL headquarters. Each ATMC is capable of creating, storing, and retrieving digital color imagery consisting of text, graphs, and/or photographs and subsequently displaying these images locally on large-screen display systems or on color monitors. Using this system, full-scale visual and color video conferences can be conducted, augmented by voice communication channels through a specially designed bridge located at AFHRL headquarters. The function of the bridge is to balance voice signals, making it possible for the audio conferencing operator to monitor the conference passively. The Office can provide various types of color output, such as textual slides, pie charts, bar graphs, and line graphs, suitable for viewgraph and 35mm projection.

Management Information System

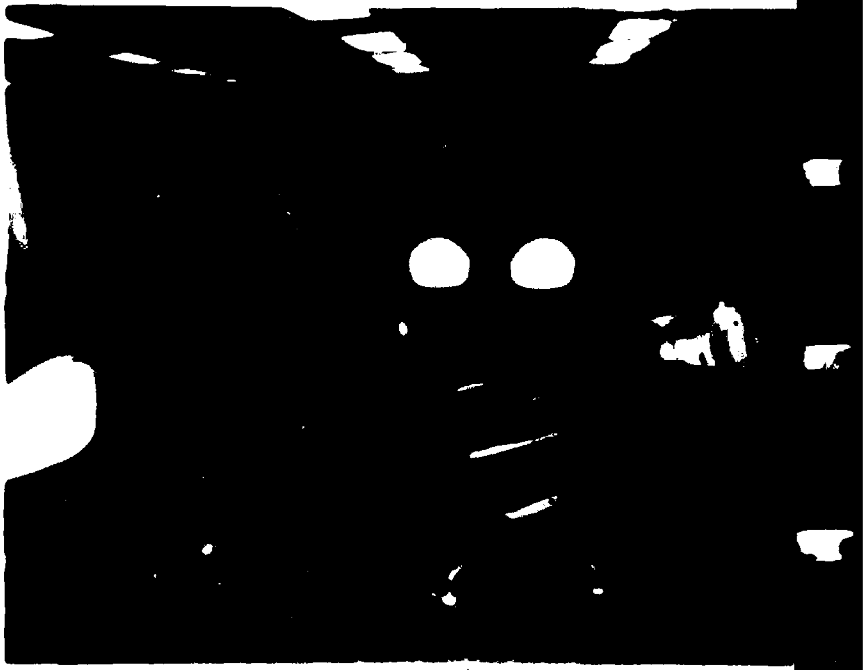
The Information Resources Management Office is also the focal point for collecting and displaying data used in the management of the AFHRL technical program. The software for input of data at the source has been completed. All laboratory divisions are on line to input and retrieve work unit and Job Order Cost Accounting System (JOCAS) products. Automated data transfer is being done for data to support Air Force, Department of Defense, and Defense Technical Information Center (DTIC) databases. Personnel throughout AFHRL retrieve data and produce reports using the AFHRL database and the Oracle database management system.

SCIENTIFIC AND TECHNICAL INFORMATION OFFICE

The Scientific and Technical Information (STINFO) Office plans and directs the STINFO program, including the technical library, to meet the information needs of Laboratory scientists and technicians in managing, monitoring, and conducting R&D. STINFO personnel identify the information and publicity needs of the Laboratory and develop news articles, newsletters, reports, brochures, and displays to meet those needs. The Office also publishes the AFHRL Annual Report. The Office's technical editing function reviews, processes, and publishes results of R&D projects in the form of technical reports, journal articles, special reports, professional papers, and other documents. Technical editing personnel provide guidance to authors and contract monitors to ensure that publications comply with Government regulations and professional standards. They also monitor distribution of AFHRL publications and maintain records for responding to informational requests from the user and scientific communities. The Office provides liaison services between the AMD Public Affairs Office and the Laboratory. The Office obtains clearance of information for public release; arranges for visits and services of reporters, photographers, and audiovisual specialists; and performs special public relations and information assignments as required. Finally, the Office maintains the AFHRL historical archives, answers historical inquiries, and provides information for the AMD History.

<u>Technical Library</u>

The services provided by the AFHRL library include the acquisition of books, journals, and other library materials.



AFHRL Technical Library

Services are provided for the command staff offices and the divisions on Brooks AFB, as well as for divisions and offices located in other geographical areas. The library has on-line access to the Dialog Information Services, Inc., at Palo Alto, California; the Defense Technical Information Center's Defense RDT&E On-Line System, at Alexandria, Virginia; and the OCLC, a national library network, through the AMIGOS Bibliographic Council, Inc., Dallas, Texas.

During the fiscal year, the Library staff accomplished 129 on-line literature searches. Library holdings at the end of FY86 were 12,535 books and bound volumes of journals, 10,976 technical reports, and 454 journal subscriptions.

FY86 ACCOMPLISHMENTS

Major upgrades to the Sperry computer system were completed. New disk storage equipment was installed, providing faster access and a 130% increase in disk storage. A new tape subsystem was installed to replace older equipment. Twelve new tape drives process data at

6,250 characters per inch, compared with 1,600 characters per inch for the older equipment. The new drives operate with significantly improved reliability, and lessen the delay experienced by interactive users of the Sperry system. A second Sperry Central Processing Unit and a front-end processor were also installed. The net effect of the Sperry system upgrades has been to provide users of the system with improved turnaround and the ability to maintain and use more files interactively. A Digital Equipment Corporation VAX 8600 system was installed and placed in operation to support the scientific data-processing requirements of Training Systems Division personnel. Ada, FORTRAN, and PASCAL compilers are available. The system will be used initially to support further development of the Instructional Support System software, and to support extensive data-processing requirements for the Advanced On-the-job Training System effort being carried out at the Bergstrom AFB operating location. Additional disk storage and tape drive equipment were installed in the Digital Equipment Corporation VAX 11/780 to support increasing requirements for financial and project management data.

Twelve workstations and four printers were added to the Wang office automation system at Brooks AFB. This brings the total to 40 workstations and 19 printers, and provides ready access to office automation by an increasing number of professional and technical employees. Increased processing speed and additional ports were made available for workstations and printers through the upgrading of the VS-90 CPU to a VS-100. Increasing disk storage to the systems enables all files to be backed up daily and minimizes the loss of documents previously experienced when backup operations were less frequent. Hardware installation and modification permitted the optical mark reader to detect identification information on answer blanks used in ASVAB testing.

A project to convert hard-copy documentation on inactive data-processing work request studies to microfiche was completed during FY86. Eight tons of converted hard-copy documentation were salvaged. Equipment has been procured and procedures installed to convert new inactive study documentation annually.

Quarterly processing of Officer Effectiveness Report summary data was completed in FY86. This processing support has been provided continuously to AFMPC since 1975.

The technical library installed an Online Computer Library Center (OCLC) M-300 terminal. This equipment significantly increases the speed of on-line literature searches by making it possible for the operator to view and select information displayed on a screen. It provides the means for establishing and maintaining an on-line serials controlled database, which supersedes the previous manual method for logging the receipt of journals. The M-300 also significantly reduces the time required for on-line cataloging and interlibrary loan transactions.

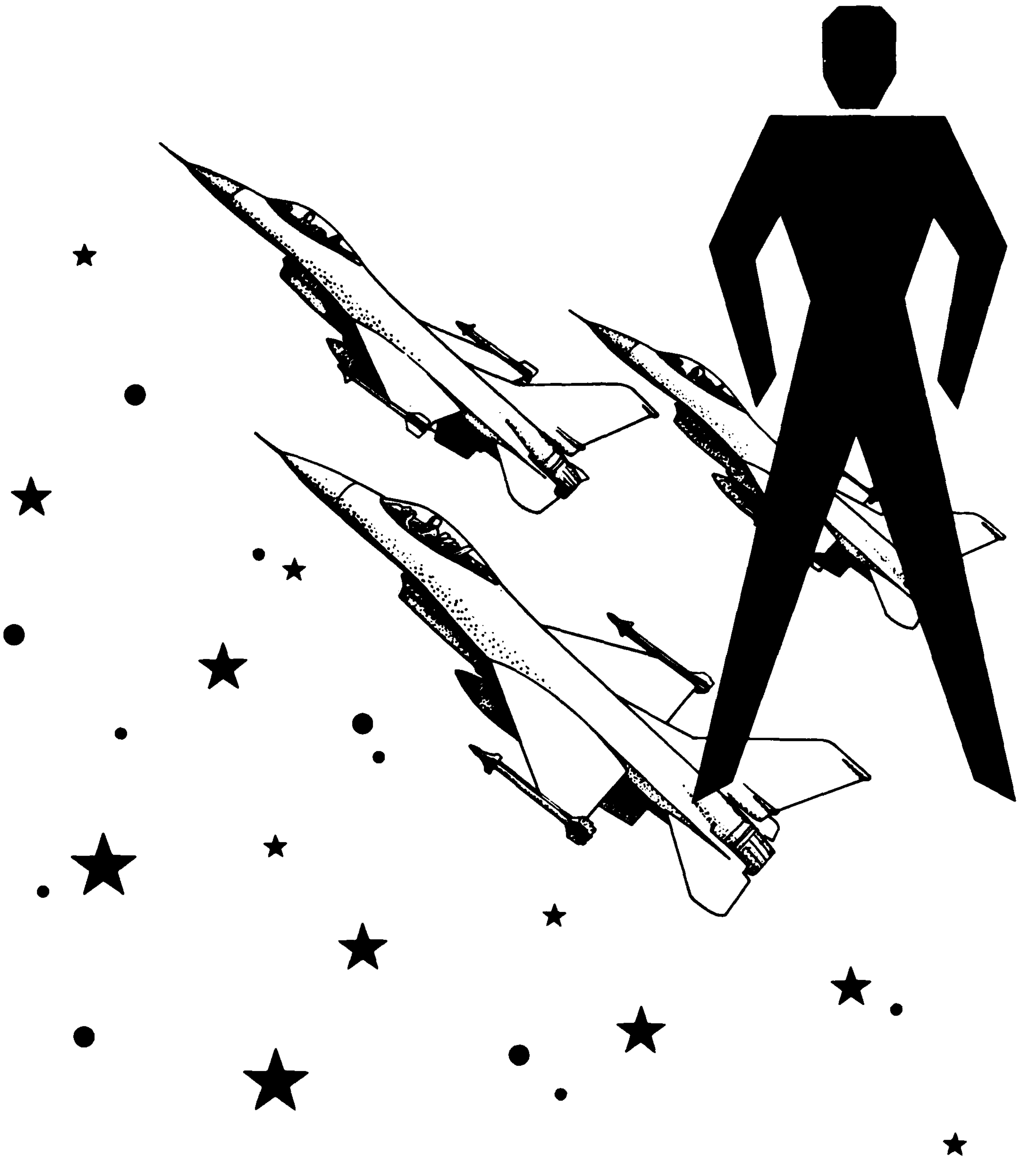
Pictorial Display of
Laboratory R&D

A pictorial display portraying contemporary R&D was prepared and installed in the second floor lobby of AFHRL at Brooks AFB. A folding upright portable display was obtained and equipped with photographs portraying laboratory programs and operations. Displayed near the Command section in the headquarters building, it can be easily dismantled and shipped to conference sites. The AFHRL FY85 Annual Report was published in December 1985 to publicize the work of the Laboratory and its achievements.

Thirty-two Laboratory personnel were provided in-house training in the use of the Z-100 microcomputers. The Author System for Education and Training (ASET), computer-assisted instruction containing 16 programming courses, was used as the basis for training 37 users.

During FY86, work was completed on 303 studies carried out in support of data-processing work requests. Major requesters included the research divisions and staff offices within the Laboratory, the Occupational Measurement Center of Air Training Command, the Rand Corporation, the USAF School of Aerospace Medicine, the Air Force Military Personnel Center, and the U.S. Department of Justice.

SPECIAL EVENTS



AFHRL SIGNS AGREEMENT WITH UTSA

Col Jarvi and Dr. Wagener Sign Agreement

On 24 February 1986, Col Jarvi, Commander of AFHRL, and Dr. Wagener, President of the University of Texas at San Antonio (UTSA), signed a Memorandum of Agreement (MOA). The major provision of the MOA is to allow UTSA faculty and students to use AFHRL research facilities at Brooks Air Force Base. The use of these facilities and equipment will be in support of the AFHRL mission. The Laboratory benefits from the agreement through the addition of technical expertise to its R&D program; likewise, the University benefits through experience gained by its faculty and students in supporting AFHRL R&D goals. Strengthening DOD and University ties is a national priority and a specific Air Force goal. This MOA is a first step in achieving that goal.

Dr. Philip Olivier, a professor of engineering at the University of Texas at San Antonio, has already realized the benefits of the MOA. He has utilized the equipment and expertise of the Training Systems Division to research control systems and control design in artificial intelligence. Dr. Olivier is in the process of designing and implementing an Intelligent Tutoring System to teach the interpretation of circuit design using problem-solving strategies developed by the mathematician Polya.

DIVISION ADVISORY GROUP VISIT

On 1-2 May 1986, the Aerospace Medical Division Advisory Group (DAG) visited the AFHRL facility at Williams AFB, AZ. The first day of the visit began with an executive session led by Maj Gen Fredric Doppelt (HQ AMD/CC), which was followed by a welcome/introduction from Lt Col Kilgore (AFHRL/OTD), who spoke on simulation and training effectiveness R&D issues. The visitors were then given an extensive tour of the facility. During the tour, briefings and demonstrations were presented on all the major efforts currently in progress. These included the Fiber-Optic Helmet-Mounted Display, Part-Task Training, LANTIRN, Advanced Visual Technology System, Fighter Lead-In Training R&D, Electronic Combat Training R&D, Simulation and Training Effectiveness, Dome Technologies, Visual and Sensor Issues, Combat Mission Trainer, and Simulator Instructional Technology. A presentation by Dr. Elizabeth Martin (AFHRL/OTE) on basic research efforts was also included in the tour. Future projects such as Aircrew Combat Mission Enhancement and Artificial Intelligence were also presented.

The second day began with a briefing by Col John Wolcott (Deputy Commander/Director for Research, Development and Acquisition, AMD) on Forecast II - Impact and Strategy Implications for the Aerospace Medical Division. The rest of the day involved a discussion of report writing assignments by the DAG, an executive session by Gen Doppelt, and a final discussion/conclusions session.

Major General Fredric Doppelt and Lieutenant General George Sylvester (retired, USAF) watch as Captain Karl Towle demonstrates project.

ARTIFICIAL INTELLIGENCE: NEW FRONTIERS

On 3-4 September, the state of the art of Intelligent Tutoring Systems (ITS) and the most recent research findings in Artificial Intelligence (AI) were discussed at the "1986 Air Force Human Resources Laboratory Research Planning Forum for Intelligent Tutoring Systems." The symposium was an event of historical importance for the field of artificial intelligence.

World-renowned educators, psychologists, and computer scientists met to discuss the results of their past research efforts and to formulate new directions for future artificial intelligence for this Laboratory. The forum was composed of some of the most notable proponents of AI, persons who have essentially built its foundation.


Col. Dennis W. Jarvi
AFHRL/CC


Lt Col Hugh L. Burns
AFHRL/IDI


Dr. Jeffrey Richardson
Univ. CO, Boulder


Dr. John Anderson
Carnegie-Mellon

Photographs by Capt Jeffrey Moore


Dr. Pamela Fink
Southwest Research Inst.


Gunter Hotel


Dr. Beverly Woolf
Univ. of MA, Amherst


Dr. James Greeno
Univ. of CA, Berkeley


Dr. Elliot Soloway
Yale Univ.


Dr. Henry Halff
Halff Resources, Inc.


Dr. Kathleen Swigger
North Texas State Univ.


Dr. [illegible]
[illegible]


Dr. David Merrill
Univ. of Southern CA


Dr. William Johnson
Search Tech. Inc.


Dr. James Mi[illegible]
Microelectronics [illegible]

AD-A181 732 AFHRL (AIR FORCE HUMAN RESOURCES LABORATORY) FY 86 2/2
ANNUAL REPORT(U) AIR FORCE HUMAN RESOURCES LAB BROOKS
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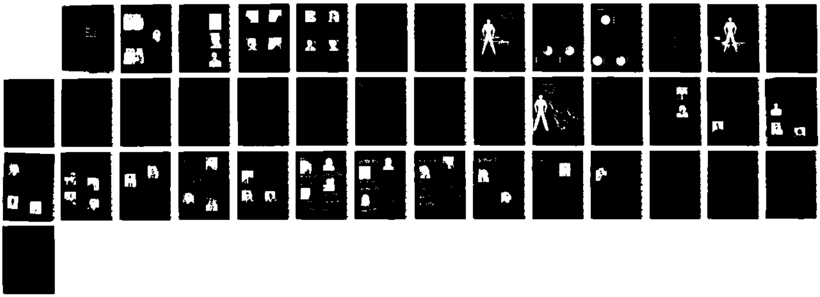
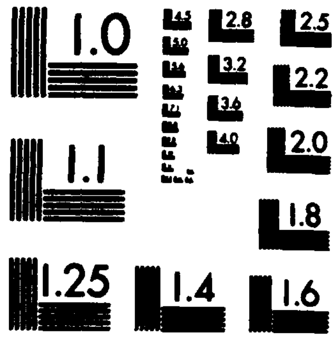




MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

Dr. Jeffrey E. Kantor
Winner of the Donald B. Haines Award

The 1985 Donald B. Haines Award was presented to Dr. Jeffrey E. Kantor for his outstanding work in the selection and classification of Air Force pilots and navigators. Dr. Kantor and his research team developed a battery of 15 computer-administered tests designed to measure abilities relevant to pilot performance that are not measured in conventional tests. His efforts have resulted in R&D programs being adopted by NATO and the Royal Australian Air Force.

Mr. Ray Martinez
Winner of the AFHRL Management Award

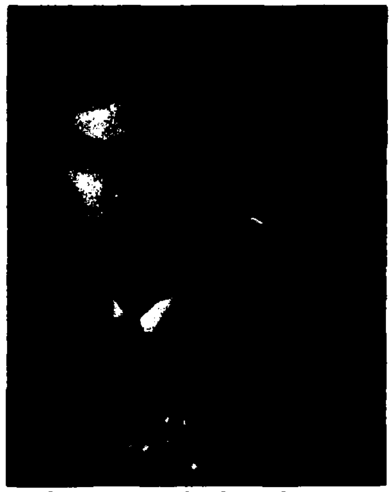
The AFHRL Management Award for 1986 was presented to Mr. Ray Martinez on 30 July 1986. During 1985, Mr. Martinez managed projects involving the procurement, installation, and operation of scientific computers, management information computers, and office automation systems. He was also instrumental in the analysis of requirements for the acquisition of a large-scale computer system to support the research mission of the Training Systems Division as it relocated to Brooks AFB from Lowry AFB.

Mr. Richard E. Lamb
DOD Handicapped Employee of the Year

Mr. Richard E. Lamb of the Human Resources Laboratory at Wright-Patterson AFB attended ceremonies at the Pentagon on 7 October 1986, in honor of his selection as the DOD Handicapped Employee of the Year. Mr. Lamb was recognized for developing and implementing a plan to verify and validate the Mission Reliability Model, which will be used to assess the reliability of integrated communications, navigation, and avionics circuits of future Air Force weapon systems. Blind since birth, Mr. Lamb uses a reading device which converts standard print into braille to help him in his daily work with statistics, data analysis, and computer simulation.

AFHRL AIRMEN AMONG AIR FORCE SYSTEMS COMMAND OUTSTANDING AIRMEN OF THE YEAR

MSgt Joseph Singleton is an Instructional Systems Training Manager in the Training Systems Division. He has contributed a great deal to the Advanced On-the-job Training System (AOTS) project. He developed clear and comprehensive AOTS briefings, as well as duty titles and position descriptions for the Instructional Systems Team cadre. MSgt Singleton also co-developed the AOTS Personnel and Support Subsystem, which identifies HQ Air Force to base-level personnel requirements and responsibilities for management of Air Force on-the-job training under AOTS.



MSgt Joseph Singleton

TSgt Robert Swindell provided an extensive computer background and experience in the Airman Personnel Data System of the Advanced On-the-job Training System project as an Instructional Systems Supervisor in the Training Systems Division. His interaction with local work centers in the preliminary design of AOTS was vital to the project. His inputs to the contractor in the preliminary design and development of Computer-Assisted Instruction and Computer-Managed Instruction were invaluable.

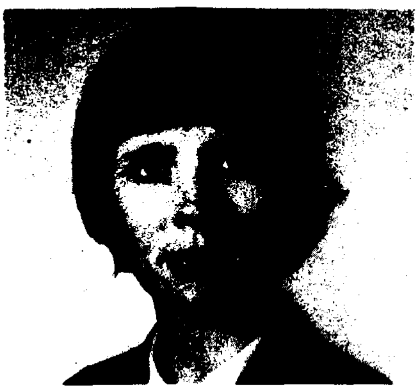
TSgt Robert Swindell

SrA David LeBrun was recognized for his timely and accurate completion of large-scale, complex statistical analyses in support of manpower, personnel, and training R&D. He is a Computer Programmer/Analyst in the Technical Services Division. SrA LeBrun completed 15 studies in the past year, with several of them supporting R&D on the Armed Services Vocational Aptitude Battery (ASVAB) directed by the Joint Services Selection and Classification Working Group.

SrA David LeBrun

Capt Antoinette Wegner

The 1985 Brooks AFB Outstanding Woman of the Year Award in the Officer category went to Capt Antoinette Wegner, a Behavioral Scientist in the Manpower and Personnel Division. She identified and solved interpretation problems in a major joint-Service test, planned and executed contract efforts totaling over $1,000,000, and analyzed the impact of personnel testing at the Air Staff and DOD levels for technical and policy level decisions.

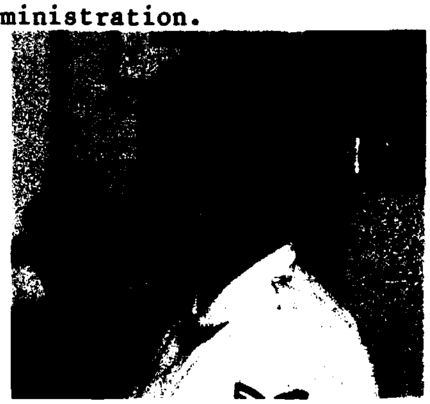


1st Lt Amy E. Potts

1st Lt Amy E. Potts was selected as the AMD 1985 Company Grade Officer of the Year. As the Program Control Officer in the Advanced On-the-job Training System project, she isolated factors that could lead to contractual cost, schedule, and performance problems. As a direct result, the Air Force initiated actions to correct contractor management of this critical, multimillion-dollar AOTS effort.

MSgt Leeroy Burrell

MSgt Leeroy Burrell of the Logistics and Human Factors Division was selected as the AMD Senior Enlisted Administrator - Unit Administration - of FY85. He was also nominated as the 1985 AFSC Senior Enlisted Administrator - Administrative Management. Although Sergeant Burrell was not selected as the Command nominee for this category, he was awarded an HQ AFSC Certificate of Recognition for his expertise, professionalism, and dedication in the field of administration.



TSgt Joanna Nixon

TSgt Joanna Nixon, a Computer Programmer in the Logistics and Human Factors Division, won the ASD Black Employment Program Achievement Award for Community and Youth Service. She has devoted much of her time to young people, conducting children's activities for the Noncommissioned Officers Association Bike-a-Thon and raising over $500 to provide toys for underprivileged youth, volunteering her time to telethons, and serving as a foster parent.

Jimmy D. Souter
Professional Civilian of the Year

Mr. Souter, former Chief of the Computer Programming Branch, Technical Services Division, contributed a great deal to the R&D of AFHRL through his skill and expertise. A few of his accomplishments include the analysis of data on enlisted and officer promotion trends, the development of master files for research and development, and participation in a study involving the relocation of computer support from the Training Systems Division at Lowry to Brooks AFB.

Harriet K. Renick
Clerical Civilian of the Year

Ms. Renick serves as Personal Administrative Assistant/Secretary to the Chief of the Technical Services Division. A truly deserving recipient, Ms. Renick has developed a detailed handbook of office policies and procedures, as well as a computerized system to monitor Civilian Policy Board information. She is considered an expert on office automation equipment and is often called upon to demonstrate complex functions.

James L. Friemann
Technical Civilian of the Year

Mr. Friemann, a Supervisory Computer Systems Analyst in the Technical Services Division, is responsible for the computer design and programming of data analysis projects. His achievements include the analysis of item responses on 265,000 ASVAB tests, a labor management survey to identify or resolve problems in civilian labor management, and WAPS revalidation data. This award recognizes the high productivity and impact of his data processing function.

Joyce K. Wilson
Air Force Administrator of the Year

Ms. Wilson is a Management Assistant in the AFHRL Plans and Operations Office. She serves as the management focal point for Air Force R&D requirements, such as Requests for Personnel Research, Technology Needs, and Logistics Needs. She is quite an asset to AFHRL by virtue of her expertise in using the word processing system, her exceptional leadership skills, and her effective oversight of AFHRL Memoranda of Agreement.

SUMMER FACULTY RESEARCH PROGRAM

The USAF Summer Faculty Research Program, sponsored by the Air Force Office of Scientific Research, provides opportunities for qualified faculty members of U.S. educational institutions to conduct research in areas such as computer science, industrial and experimental psychology, and engineering. Researchers are able to pursue an area of interest for a 10-week period during the summer at one of 21 USAF laboratories across the U.S. Follow-on research opportunities are also available under the Research Initiation Program, which allows a maximum of $20,000 to pursue further a particular area of interest.

The objectives of this program are: (a) to enhance the research interests and capabilities of scientific and engineering educators in areas of interest to the Air Force, (b) to stimulate continuing relations among faculty members and their professional peers in the Air Force, and (c) to allow the Air Force to continue research of interest at the faculty member's institution.

The following researchers were participants in the 1986 Summer Faculty Research Program

Logistics and Human Factors Division

Patricia T. Boggs: Decision-Making Paradigms in the Design and Implementation of Adaptive Decision-Making Aids, Wright State University.

Raghava G. Gowda: Structured Techniques for IMIS Software Development, University of India.

Stephen L. Loy: Visual Problem-Structuring and Hemispheric Processes of the Human Brain, Iowa State University.

Shreenivas Moorthy: Human Factors Analysis of Microcomputer-Based Maintenance Systems for Advanced Combat Aircraft, Texas A&I University.

Manpower and Personnel Division

Dr. Phil Tomporoski: Individual Differences in Vigilance Behavior of Military Personnel, University of Alabama.

Dr. Jorge Mendoza: Methods of Correcting Validity Coefficients for Effects Due to Range Restrictions, Texas A&M University.

Dr. Richard Cox: Studies to Improve Prediction of Pilot Success Based on Two-Hand and Complex Coordination Psychomotor Tests, Kansas State University.

Operations Training Division

Dr. Marylou Cheal: Visual Attention, University of Dayton.

Dr. Garvin Chastain: Visual Attention, Boise State University.

Dr. A. Hariman: Germ Warfare, Oklahoma State University.

Dr. Bill Wooten: Color Vision, Brown University.

Dr. Ed Hass: Mental Rotation, Franklin and Marshall.

Susan Abrahms: Form Perception, University of Illinois.

Laura Sewall: Color Perception, Brown University.

Dr. Bill Shontz: Contrast Sensitivity, Montana State University.

Training Systems Division

Dr. Doris Walker-Dalhouse: Reading Comprehension and Discourse Analysis, Jackson State University.

Dr. Doris Ginn: English and Sociolinguistics, Jackson State Universiy.

Dr. Phil Olivier: Control Systems/ Design, Artificial Intelligence, Computer-Aided Instruction, University of Texas at San Antonio.

Dr. Kathleen Swigger: Computer-Based Education, Artificial Intelligence, North Texas State University.

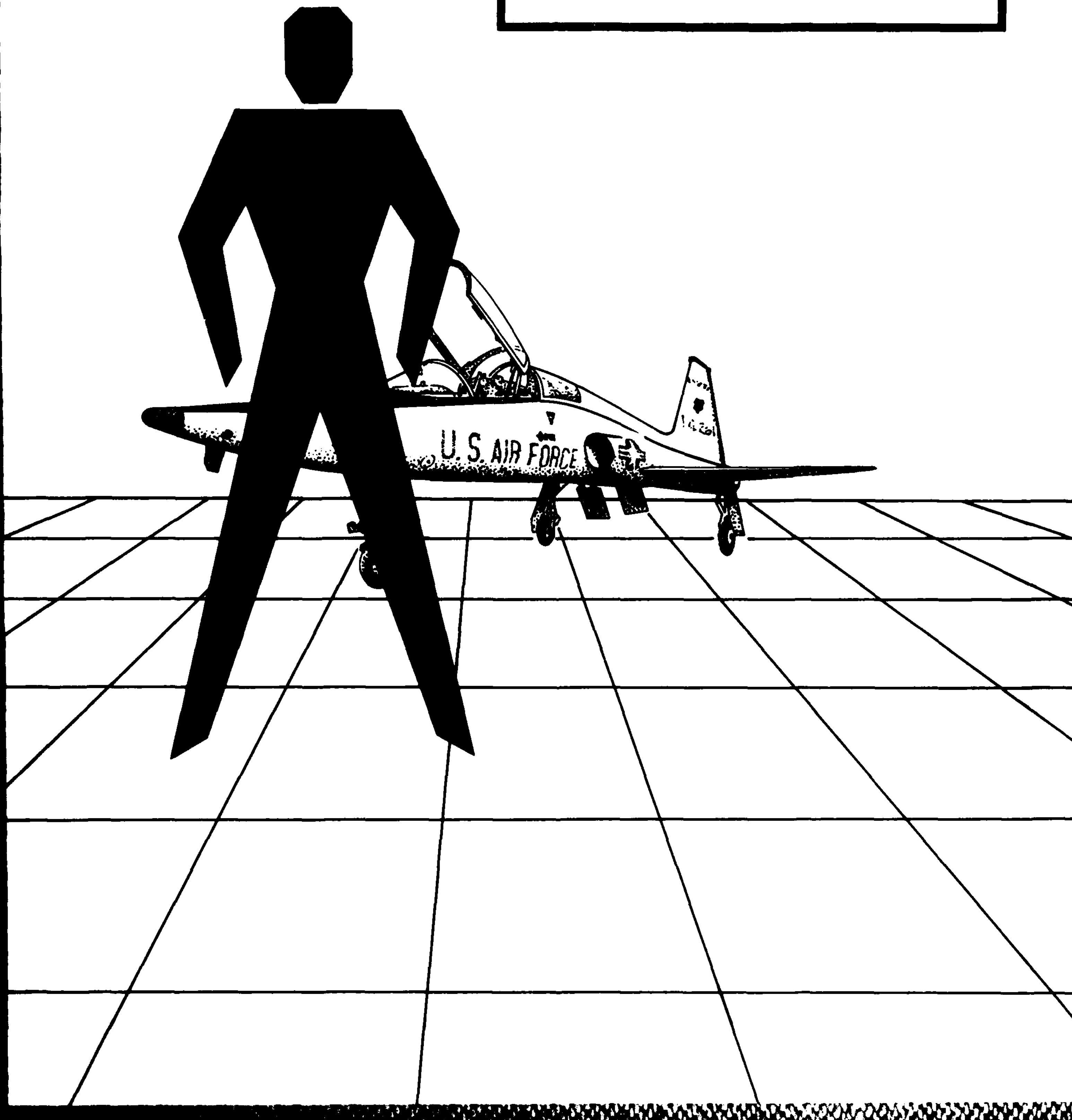
FORTY-FIVE YEARS OF EXCELLENCE

The Air Force Human Resources Laboratory's 45th Anniversary, celebrated on 9-10 October 1986, did indeed mark 45 years of excellence. What began as a single Psychological Research Unit established on 15 November 1941 at Kelly Field, San Antonio, Texas has evolved into a vital element of the Air Force dedicated to strengthening its human resources. Other predecessor organizations of AFHRL include the Human Resources Research Center (HRRC), the Air Force Personnel and Training Research Center (AFPTRC), and the Personnel Research Laboratory. HRRC was activated in July 1949, with the 3309th R&D Squadron incorporated as the Personnel Research Directorate. AFPTRC replaced HRRC on 1 February 1954 and continued until 1962. During its heyday, AFPTRC had almost 1,400 employees. Subsequently, it was diminished in size and redesignated as Detachment Number 1, Wright Air Development Center (WADC). Later the 6570th Personnel Research Laboratory was established as an element of the Aerospace Medical Division on 1 January 1962. It continued until July 1968. The entire contingent of AFHRL was moved to Brooks AFB in 1977 and was assigned to Air Force Systems Command. In 1983 AFHRL was again assigned to the Aerospace Medical Division.

Although AFHRL was established in 1968, its research areas span over four decades. Some of AFHRL's past research efforts were displayed as part of the "Window to Our Past," which was unveiled during this Anniversary celebration. This "window" pictorialized the first psychomotor tests used by AFHRL to test pilots. Some of the tests featured were the Dynamic Balance Test, the Finger Dexterity Test, and the Complex Coordination Test. The Finger Dexterity Test, for example, consisted of a wooden peg board with 48 square-bottomed, round-topped pegs. Subjects had to remove each peg, rotate it clockwise 180 degrees, and reinsert it. The Complex Coordination Test used three double rows of green and red lights and required subjects to manipulate a joystick to light a green light when the corresponding red light appeared. The latter test was the basic psychomotor test used for pilot selection in WWII. The Window to Our Past visually illustrates the progress AFHRL has made in the area of aircrew selection, from a wooden peg board to the highly sophisticated, computerized Portable Basic Attributes Test used today.

The first day of the Anniversary Celebration began with the dedication of the Window to Our Past followed by a discussion of AFHRL current events and briefings with past AFHRL commanders. The day ended with a festive Texas-style barbecue and a speech by guest speaker Col Dan D. Fulgham, a former AFHRL Commander. On the second day of the celebration an Open House was held for the families and friends of AFHRL employees. Tours of the library, the computer facility, and the Laboratory Operations Center were conducted, and exhibits were provided in the lobby.

AFHRL ORGANIZATION & RESOURCES



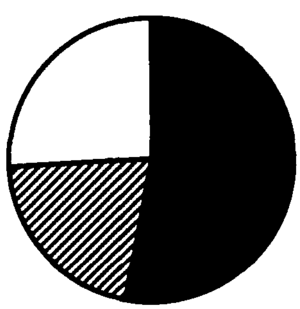
FISCAL HIGHLIGHTS

FUNDING SUMMARY (1000)

	FY84	FY85	FY86
LABORATORY DIRECTOR'S FUND	815	945	945
RESEARCH 6.1	830	752	1,368
EXPLORATORY DEVELOPMENT 6.2	29,421	30,557	30,674
ADVANCED DEVELOPMENT 6.3	15,215	19,291	16,804
INTERSERVICE TRANSFERS & REIMBURSEMENTS	10,966	9,781	13,495
TOTAL	57,247	61,326	63,286

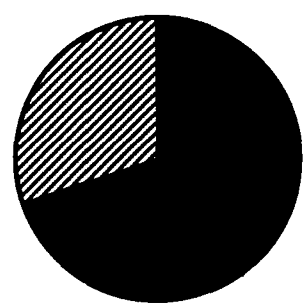
FY86

DISTRIBUTION OF FUNDING



- 6.2 LABORATORY DEVELOPMENT (48%)
- 6.1 RESEARCH (4%)
- LABORATORY DIRECTOR'S FUND (1%)
- INTERSERVICE TRANS & REIMB (21%)
- 6.3 ADVANCED DEVELOPMENT (26%)

FUNDING BY DIVISION ALL SOURCES



- OPERATIONS TRAINING (25.4)
- TRAINING SYSTEMS (7.7)
- MANPOWER & PERSONNEL (11.0)
- LOGISTICS & HUMAN FACTORS (19.2)

HRL-SD-1-2

DISTRIBUTION OF AUTHORIZED PERSONNEL
FY86

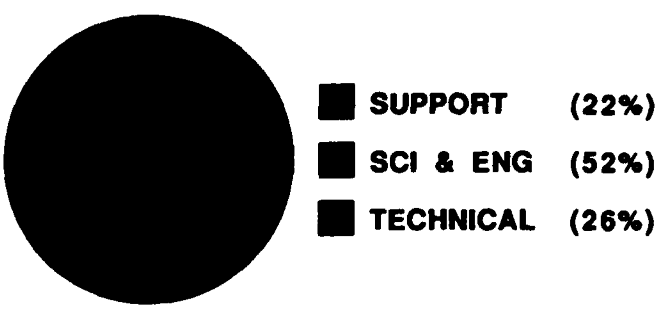
BY DIVISION

MANPOWER AND PERSONNEL	81
LOGISTICS & HUMAN FACTORS	72
OPERATIONS TRAINING	65
TECHNICAL SERVICES	94
TRAINING SYSTEMS	70
HEADQUARTERS	43
TOTAL	425

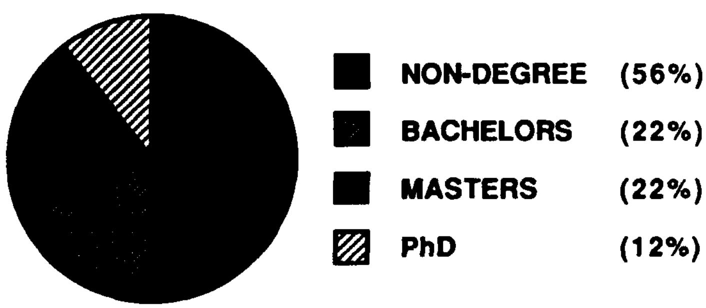
CLASSIFICATION

OFFICERS	105
AIRMAN	95
CIVILIANS	225
TOTAL	425

PERSONNEL TYPES



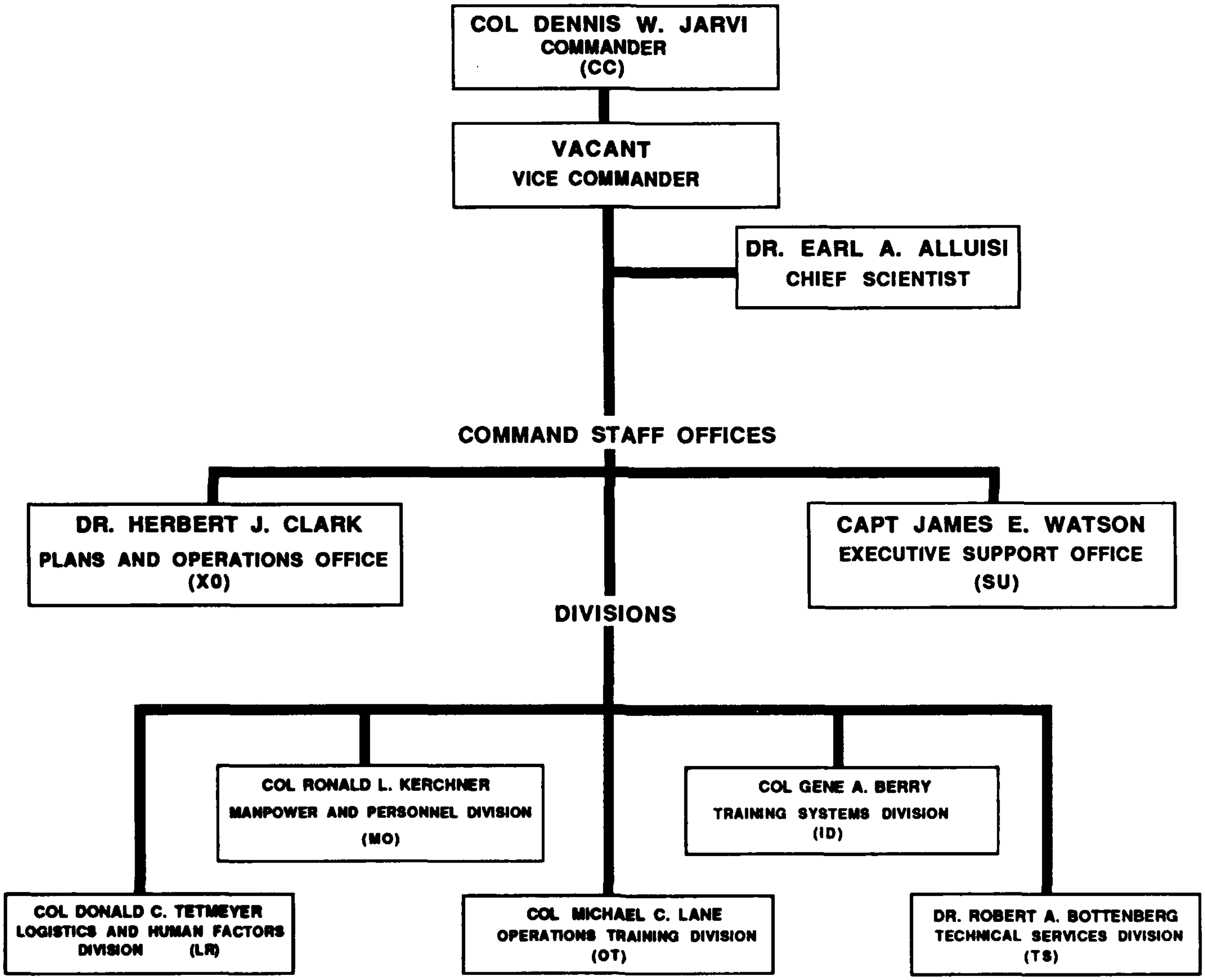
ACADEMIC DEGREES



FY86

AIR FORCE HUMAN RESOURCES LABORATORY

ORGANIZATION



AS OF: 30 SEPT 86*

* CURRENT ORGANIZATIONAL CHART IS PROVIDED ON PAGE 130.

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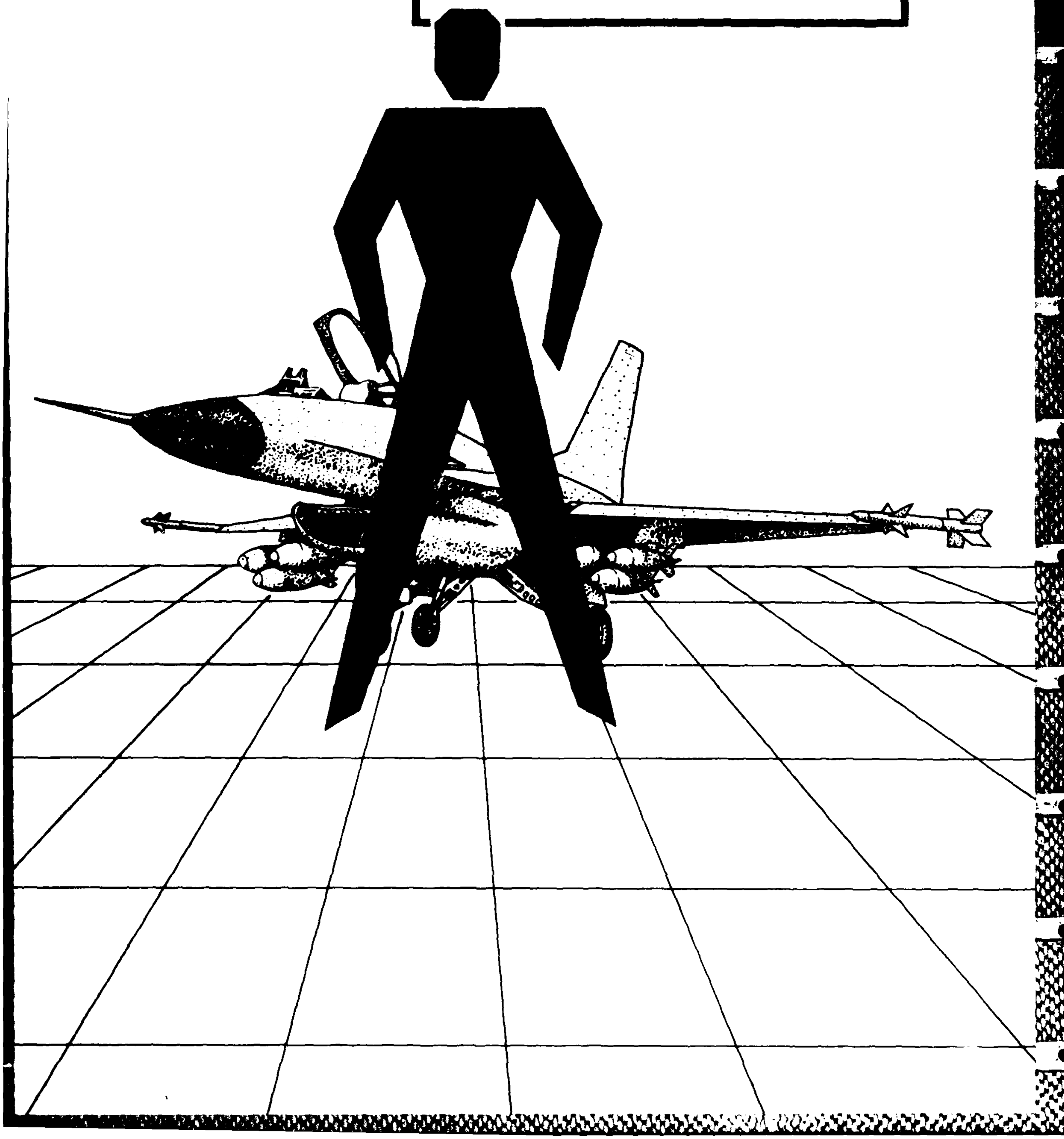
TECHNOLOGIES TRANSITIONED



TECHNOLOGIES TRANSITIONED

MANPOWER AND PERSONNEL DIVISION

FY80 PRODUCTS	USERS
Task Analysis Handbook	Air Training Command (ATC)
Armed Services Vocational Aptitude Battery (ASVAB) Forms 8, 9, and 10	Office of the Assistant Secretary of Defense, Manpower, Reserve Affairs & Logistics (OASD/MRA&L), All Services
Senior Executive Appraisal System (SEAS) and General Manager Appraisal System (GMAS)	HQ USAF, Directorate of Civilian Personnel (MPK) HQ USAF, Office of Civilian Personnel Operations (OCPO)
Recruiter Resource and Goal Allocation Model	HQ Air Force Recruiting Service (USAFRS)
Organizational Assessment Package (OAP)	Leadership and Management Development Center (LMDC)
Weighted Airman Promotion System (WAPS) Impact Analysis	HQ USAF, Directorate of Personnel Plans (MPX)
Enhanced Likelihood Function Estimation (LIFE) Model	USAFRS
Air Force Occupational Research Data Bank (ORDB)	USAF Occupational Measurement Center (USAF/OMC)

FY81 PRODUCTS	USERS
Job Performance Appraisal System (JPAS) and Civilian Potential Appraisal System (CPAS)	HQ USAF/MPK, OCPO
Enlistment Screening Test (EST), Forms 81A and 81B	OASD/MRA&L, All Services
Safety Training Priorities	Air Force Inspection and Safety Center (AFISC)
Job Aptitude Requirements	Air Force Manpower and Personnel Center (AFMPC), ATC
Modification of Person-Job-Match System	AFMPC, ATC
Standardized Position-Oriented Training System (SPOTS)	HQ USAF, Directorate of Personnel Programs (MPP)
Mission Impact Generalized Explanatory Base Operating Support Model (GEBOS-M)	HQ USAF, Directorate of Manpower and Organization (MPM)
Computer Adaptive Testing (CAT) Study on Sample Size vs Item Pool Size	OASD/MRA&L, All Services
Handbook on Costs of the First-Term Enlisted Force	HQ USAF/MPX

Air Force Officer Qualifying Test (AFOQT) Form O and Officer Screening Composites	USAFRS, Officer Training School (OTS) Air Force Reserve Officer Training Corps (AFROTC)
FY82 PRODUCTS	**USERS**
Air Force Reading Abilities Test (AFRAT)	ATC, All Major Commands (MAJCOMs)
National Labor Market Research	HQ USAF/MPX
Occupational Retraining Guidelines for Retrainee Management	HQ USAF/MPP, AFMPC
Test Battery for Air Traffic Controllers	AFMPC, ATC, Air Force Communications Command
Physical Strength and Stamina Requirements	Armstrong Aerospace Medical Research Laboratory (AAMRL)
Enlisted Assignment/Reassignment System (EARS)	HQ USAF/ MPX, AFMPC
FY83 PRODUCTS	**USERS**
Modified Non-Appropriated Fund (NAF) Supervisory Appraisal Form	OCPO
Alternative Weighting Systems for the WAPS	HQ USAF/MPX
Classification of Situational Constraints in Air Force Work Settings	LMDC
Enhanced Hierarchical Grouping Computer Program (HIER-GRP)	USAF/OMC, All Services
ASVAB Forms 11, 12, and 13	OASD/MRA&L, All Services
Historical Airman Database (HAD) Applications	HQ USAF/MPX, OSD
FY84 PRODUCTS	**USERS**
Counselor's Manual and Technical Supplement for ASVAB Form 14	OASD/MRA&L, All Services
Revised NAF Employee Appraisal Form; Revised CPAS Rating Factors and Weights	OCPO
Air Force Systems Command (AFSC) Incentive Awards Survey	HQ AFSC/DPC
Relationships of ASVAB Forms 8, 9, and 10 and Air Force Technical School Grades	AFMPC, ATC
Subgroup Norms for ASVAB Form 14	OASD/MRA&L
Validations of AFOQT	AFMPC, HQ USAF/MPX, OTS, AFROTC
Improved Pilot Selection Systems	ATC

Statistical Study of Enlisted Retention Trends	HQ USAF/MPX
Procurement Management Information System (PROMIS) R&D	AFMPC, ATC, USAFRS
Validation of English Diagnostic Test for Journalism-Related Programs	HQ AFSC/DL
Skills Projection Analysis	HQ USAF/MPM
Improved Selection Procedures for Air Force Physicians	Air Force Medical Service Center
Mathematical and Statistical Software Index for AFHRL Univac 1100 Computer System	USAF/OMC, School of Aerospace Medicine
Learning Difficulty Indices for Refinement of Aptitude Requirements	AFMPC, USAF/OMC
Jet Engine Mechanic Job Performance Measures	HQ USAF/MPX, AFMPC, OASD/MRA&L, All Services
Development of Computerized Adaptive Testing (CAT) Item Pools	OASD/MRA&L, All Services
Development of 1980 Norms and Conversion Tables for the Enlistment Screening Test (EST)	OASD/MRA&L, All Services
Enhanced Comprehensive Occupational Data Analysis Programs (CODAP)	USAF/OMC, All Services

FY85 PRODUCTS	USERS
ASVAB Deliberate Failure Keys	OASD/MRA&L, All Services
ASVAB 14 Technical Manual	AFMPC, HQ USAF/MPX, AFROTC
Psychomotor Pilot Selection Systems	ATC, Air National Guard
Cognitive Task Analysis Guide	ATC
Learning Difficulty Technology	AFMPC, USAF/OMC
Job Performance Measurement Technology	Army, Navy
Policy Specifying Software	USAF/OMC, All Services
Revised Comprehensive Data Analysis Programs	USAF/OMC, All Services
Occupational Research Data Bank	USAF/OMC
Enhanced Hierarchical Grouping Program	USAF/OMC, All Services
Air Force Retention Analysis Package	HQ USAF/MPX, AFMPC

OPERATIONS TRAINING DIVISION

FY80 PRODUCTS	USERS
Simulator for Air-to-Air Combat (SAAC) Visual Dysfunction Study	Air Training Command (ATC), Tactical Air Command (TAC)
Interface Between SAAC and the Advanced Simulator for Pilot Training (ASPT)	ATC, TAC
ASPT Multiple Moving Models Update	ATC, TAC
A-10 Manual Reversion Flight Control System Simulation R&D	ATC, TAC

FY81 PRODUCTS	USERS
Force Cue Requirements for A-10 Air-to-Surface Weapons Delivery Simulation	TAC and USAF Tactical Air Warfare Center (USAF/TAWC)
Improved F-16 Back-Up Fuel Control (BUC) Restart	ATC, TAC
Transfer of Training from ASPT to RED FLAG under High-Threat Conditions	ATC, TAC
Operational Test and Evaluation Handbook for Aircrew Training Devices	Air Force Operational Test and Evaluation Center (AFOTEC), MAJCOMs
Measurement of In-Flight Electronic Warfare Officer (EWO) Performance	Strategic Air Command (SAC)
Visual Acquisition of Air Combat Maneuvering Targets in the SAAC	TAC
Desk-Top Trainer Demonstration	TAC, Military Airlift Command (MAC), SAC
Linear Systems Analysis of B-52 Weapons Delivery Accuracy	SAC
Guidelines for Management of Nonflying Intervals for Skills Maintenance	MAJCOMs
Surface Attack Mission Simulation	TAC, Simulator Systems Program Office (SIMSPO)
Recommendations for G-Cueing Devices in Fighter-Type Simulators	TAC, SIMSPO
Vertical Cue Requirements for Simulated Low-Altitude Flight	TAC, SIMSPO

FY82 PRODUCTS	USERS
U-2/TR-1 Cockpit Procedures Trainer (U-2 CPT)	SAC

Biological Correlates of Pilot Workload and Stress	Air Force Office of Scientific Research (AFOSR)
Visual Display System Functional Requirements	Aeronautical Systems Division (ASD/EN)
A-10 Combat Scenario Development and Evaluation: Low-Altitude Simulation Training	TAC
F-16 Stores Management System (SMS) Training Study	TAC, MAC, SAC

FY83 PRODUCTS	USERS
Integrated Simulator/Airborne Performance Measurement System for C-5A	MAC
Directed Energy (Laser) Flash Effects Study	TAC, Army
Comparison of Some Flight Simulator Visual Displays	MAJCOMs, ASD/EN
Assessment of Workload and Prediction of Performance by Combined Psychophysiological and Behavioral Techniques	AFOSR, Arizona Air National Guard
Fiber Optic Helmet-Mounted Display	ASD, Armstrong Aeromedical Research Laboratory (AAMRL), Army, Navy
Low-Altitude Database Development and Evaluation Research	TAC
Field of View (FOV) for Selected F-16 Weapons Delivery Tasks	TAC
Radar Warning Receiver/Electronic Countermeasures Part-Task Trainer (RWR/ECM PTT)	TAC, SAC, MAC
Generic Threat Recognition Trainer	SAC

FY84 PRODUCTS	USERS
C-130E Weapon System Trainer Operational Test and Evaluation	MAC
Advanced Visual Technology System	Army
The Tactical Training Center: An Integration of Advanced Simulator and Range System Concepts	TAC, Training Data Analysis Center (TDAC)
A-10 Close Air Support Performance in a Flight Simulator: Effects of Visual Display Field-of-View	TAC
A Unitary Measure of Performance for the Close Air Support Mission	TAC
Aircrew Training Task Surveys	MAC, SAC

Investigation of Real Versus Collimated Imagery in Flight Simulator Visual Display	ASD, MAJCOMs
Artificial Intelligence Research in Pilot Training-Visual Attention	AFOSR, Defense Advanced Research Products Agency (DARPA

FY85 PRODUCTS	USERS
Radar Warning Receiver & Fuel Savings Advisory Part-Task Trainers	TAC, SAC, MAC
Air-to-Air Measurement System Specification	ATC, TAC
Model Aircrew Training System Specification	ATC, TAC, MAC, SAC
Air Force Electronic Combat Training Roadmap	SAC
Low-Altitude Navigation & Targeting Infrared Night Simulation	TAC, SIMSPO
Advanced Visual Image Generation	ASD/EN, MAJCOMs
Visual Collimation Requirements	ASD, AAMRL, Army, Navy
Second Generation Fiber-Optic Helmet-Mounted Display	ASD, AAMRL, Army, Navy

LOGISTICS AND HUMAN FACTORS DIVISION

FY80 PRODUCTS	USERS
Models of Maintenance Resource Interactions	Air Force Wright Aeronautical Laboratories (AFWAL)

FY81 PRODUCTS	USERS
Handbook for Selection of Format Options for Procurement of Technical Data	Air Force Logistics Command (AFLC), Air Force Institute of Technology (AFIT) SPOs, Technical Order Management Agencies (TOMAs)
Air Force Aircraft Battle Damage Repair Study	AFLC, Air Force Logistics and Engineering (HQ AF/LE), US Air Forces in Europe (USAFE), ASD, Air Force Acquisition Logistics Division (AFALD), AFWAL
Draft Military Specifications for Maintenance Task Analysis and Logic Tree Troubleshooting Aids	ASD
Sensor Simulation for Target Acquisition Training	ASD

FY82 PRODUCTS	USERS
Analysis to Improve the Maintenance Environment	AFLC, MAJCOMs, AF/LE
Tactical Air Warfare Center Support	USAF/TAWC

Three-Dimensional Display for Training Weapons Directors	TAC, ATC
Acquisition of Supportable Systems Evaluation Technology (ASSET)	AFSC, ASD, AFLC, Army, Navy
Sneak Circuit Analysis Applied to Development of Fault Isolation Procedures	TAC, AFALD, Air Force Coordinating Office for Logistics Research (AFCOLR), AFLC, ASD, Air Forces Logistics Management Center (AFLMC)
<u>FY83 PRODUCTS</u>	<u>USERS</u>
Unified Database Technology	AFALD, B-1 SPO
Logistics Analyses for the Integrated Communications Navigation Identification Avionics (ICNIA) System	AFWAL
Maintenance Demand Metrics for Peacetime Operations	AFLC, AFALD, TAC
Analysis to Improve the Maintenance Environment (Missiles and Reserve Forces)	AFLC, AF/LE, SAC, Air Force Reserve (AFRES)
<u>FY84 PRODUCTS</u>	<u>USERS</u>
Pilot Study of Wartime Demand Rates for Aircraft Electronic Countermeasures Equipment	AFLC, AFWAL, TAC
Impact Analysis Techniques	AFLC, AFALD, AFWAL
Tactical Battle Management Software Simulation (TBMS) System	Electronic Systems Division (ESD), Rome Air Development Center (RADC), USAFE, TAC
Tactical Command and Control Combat Planning and Attack Capability (COMPAC)	ESD, RADC, USAFE, TAC
<u>FY85 PRODUCTS</u>	
Prediction Models	AFWAL
Automated Databases	AFLC
Prototype Demonstration	MAJCOMs
Maintenance & Logistics in Computer-Aided Design Demonstration	AFWAL
Specification & Standards	AFLC, AFIT, SPOs, ASD
Unified Database for Acquisition Logistics	AFALD, B-1 SPO
Computer Graphics Model of Maintenance Technician	AFWAL

TRAINING SYSTEMS DIVISION

FY80 PRODUCTS	USERS
Writers Aid Computer Program	AFSC
Development and Validation of the Learning Strategies and Skills Training Program	ATC
Evaluation of the High-Fidelity 6883 Maintenance Simulator	SIMSPO, ATC
Development of the On-the-Job Training (OJT) Capacity Model	HQ USAF/MPP

FY81 PRODUCTS	USERS
A Testing and Instructional System Based on Microterminal and Microfiche Devices	ATC
Computer Dialog for Graphics Simulation Programs	ASD, ATC, MAC, SAC, Space Command
Handbooks and Model Specifications for the Design and Development of Maintenance Simulators	ASD, B-1 SPO, F-15 SPO, SIMSPO
Functional Literacy Task Inventory	USAF/MPP

FY82 PRODUCTS	USERS
Computerized Adaptive Measurement of Achievement	ATC, Army, Navy
Forward-Looking Resource Scheduling (FLRS)	TAC
Maintenance Training Analysis and Functional Specification Development for a Minuteman Maintenance Training Simulator	ASD, SAC
Individualized Student Pre-Course Skill Training for Computer-Managed Instruction	ATC, Army, Navy
Computer-Assisted Instruction (CAI) Course-ware Development	AFMPC, Department of Energy (DOE), SAC, Navy
Development of the Flat-Panel 6883 Simulator	ASD, ATC

FY83 PRODUCTS	USERS
Improved USAF Non-Destructive Inspection Technician Capabilities	AFLC

Personnel Requirements for Non-Conventional Instruction	ATC
Development of Instructional Treatment Alternatives Applicable to Technical Training	ATC
Comparative Evaluation of High- and Low-Fidelity 6883 Maintenance Simulators with Actual Equipment	ASD
Acquiring Better Maintenance Trainers	SIMSPO, ATC

FY84 PRODUCTS	USERS
Instructional Support Software (ISS)	ATC, MAJCOMs
Ada Manpower and Training Requirements	Joint Ada Program Office
Ada Computer-Aided Instruction (CAI) Courseware Development	Joint Ada Program Office
Integrated Training System (ITS) for Air Force OJT	AFSC, TAC
Development Procedures for Task Evaluation Forms	TAC
CAI Decision Handbook	ATC
Field Evaluation of a Low-Cost Microcomputer Fische-Based Simulation System for Flight Simulator Troubleshooting Training	SAC
Computer-Based Training (CBT) Selection Assistance for Space Command	Space Command
Intelligent Systems Technology	AFSC
Maintenance Training Simulator Synthesis Study	SIMSPO
Graphics/Actual Equipment Maintenance Training Study	SIMSPO, ATC

FY85 PRODUCTS	USERS
Instructional Support Software System	ATC, MAJCOMs
Speech Recognition	ATC, MAJCOMs
Knowledge Engineering	ATC
Knowledge Acquisition/Intelligent Authoring Aids	AFSC

Advanced On-the-Job Training System Prototype	HQ USAF/MPP
Operational Unit Job Proficiency Assessment Methodology	AFSC, TAC
Training Programs for Individuals & Teams	ATC
Automated Task Data Collection Tools	ATC
Human Performance Design Guides	ATC, Army, Navy

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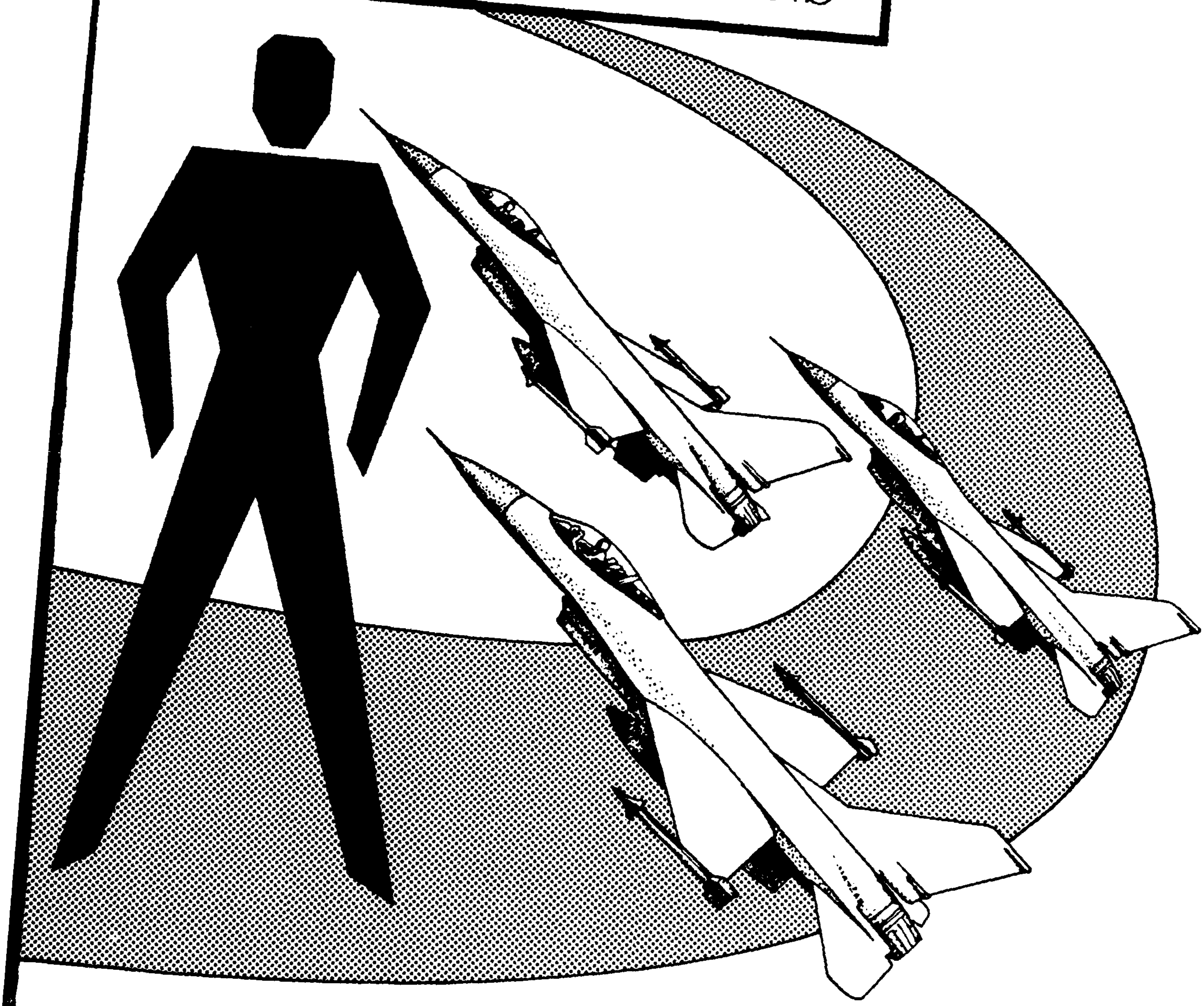

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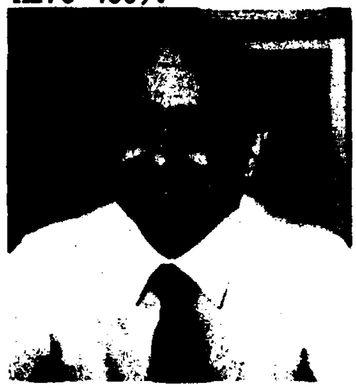

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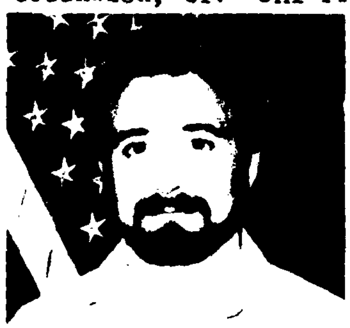

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Christal, R. (1986, April). Application of cognitive science principles: A view from the experts. Paper presented at the American Educational Research Association Conference, San Francisco, CA.

Dr. Raymond Christal

Clay, J.D. (1986, April). Development of computer-based maintenance aids system. Paper presented at the 10th Annual Psychology in the DOD Symposium, Colorado Springs, CO.

Coleman, J. W. (1986, April). A comparison of estimation techniques for the pareto distribution. Paper presented at the joint national meeting of the Institute of Management Science and the Operation Research Society of America, Los Angeles, CA.

Lt Col Joseph Coleman

Collins, D.L. (1986, April). Training issues relevant to non-traditional human-computer interfaces. Paper presented at the 10th Annual Psychology in the DOD Symposium, Colorado Springs, CO.

Maj Daniel Collins

Collins, D.L. (1986, August). Educational opportunities associated with computer-assisted instruction and computer-generated speech. Paper presented at the American Psychological Association Convention, Washington, DC.

Cummins, J., Lamm, J., & Weaver, C.N. (1986, March). Confidence in bankers: Evidence from five nationwide surveys. Paper presented at the Southwestern Society of Economists, Dallas, TX.

Dallman, B. (1986, March). Intelligent tutorial systems research. Paper presented at the 1986 Air Force Technology in Training and Education Conference, Montgomery, AL.

Drake, G. (1986, May). Pilot selection and classification research. Paper presented at the Meeting of the Department of Defense Sub-Technical Advisory Group on Aviation Selection and Performance, Cocoa Beach, FL.

Edwards, B.J., & Miller, J. (1986, March). Effectiveness of low-cost simulation for aircrew procedures training. Paper presented at the 1986 Air Force Technology in Training and Education Conference, Montgomery, AL.

Geri, G. A., & Neri, D. F. (1986, October). An evaluation of the Kintz solid-state anomaloscope. Paper presented at the Optical Society of America, Seattle, WA.

Squadron Leader Ken Given

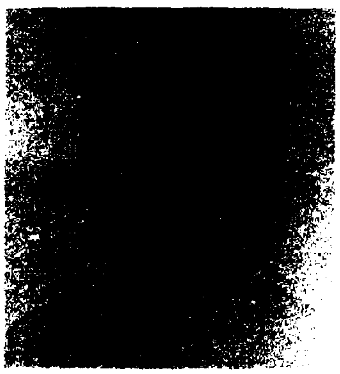
Given, K. C. (1986, April). Aircrew selection and screening. Paper presented at the Australian Air Attache Seminar, Washington, DC.

Gott, S. P. (1986, April). Tutoring troubleshooting in an electronics micro-world. Paper presented at the American Educational Research Association Conference, San Francisco, CA.

Dr. Sherri Gott

Gott, S.P. (1986, April). Utility of cognitive task analysis for examining complex technical skills. Paper presented at the American Educational Research Association Conference, San Francisco, CA.

Gray, T. H . (1986, October). Perspectives on training research and development at the Operations Training Division. Paper presented at the U.S. Army Simulator Definition Conference, Fort Rucker, AL.



Dr. Thomas Gray

Hartke, D. D., & Short, L. O. (1986, August). Meta-analysis of Air Force Officer Qualifying Test validities. Paper presented at the American Psychological Association Convention, Washington, DC.

Hedge, J.W. (1986, August). Issues in job performance measurement research. Paper presented at the American Psychological Association Convention, Washington, DC.

Dr. Jerry Hedge

Hedge, J.W., Ballentine, R.D., & Gould, R. B. (1985, October). Examining the link between training evaluation and job performance criterion development. Paper presented at the NATO Defense Research Group Panel VIII, Brussels, Belgium.

Dr. Bruce Gould

Hedge, J.W., & Lipscomb, M.S. (1986, August). The identification of surrogate indices of hands-on performance. Paper presented at the American Psychological Association Convention, Washington, DC.

Hedge, J.W., & Teachout, M.S. (1986, April). Job performance measurement: A systematic program of research and development. Paper presented at the Annual Conference of the Society for Industrial/Organizational Psychology, Chicago, IL.

Hubbard, D.C. (1986, August). Graphical data analysis of two selected data sets. Paper presented at the 1986 Joint Statistical Meeting, Chicago, IL.

Hubbard, D.C., & Polzella, D.J. (1986, March). Utility and utilization of advanced instructional features in Air Force electronic warfare trainers. Paper presented at the 1986 Air Force Technology in Training and Education Conference, Montgomery, AL.

Mr. Robert Johnson

Johnson, R. C. (1985, October). Integrated maintenance information system. Paper presented at the NSIA Integrated Diagnostics Meeting, Long Beach, CA.

Johnson, R.C. (1986, June). Computer-based maintenance aids system/integrated maintenance information system. Paper presented at the Interservice Group on Exchange of Technical Manual Technology, Roseville, MI.

Mr. Jerry Kamchi

Kamchi, J.S., Furman, J., & David, M. (1986, July). Simulation capabilities: The facility and TEMPEST part of the equation. Paper presented at the 1986 Summer Computer Simulation Conference, Reno, NV.

Mr. Jonathan Furman

Kantor, J.E. (1986, August). Air Force aircrew selection and classification research. Paper presented at the American Psychological Association Convention, Washington, DC.

Kellogg, R. S., & Gillingham, K. K. (1986, September). USAF experience with simulator sickness, research and training. Paper presented at the 30th Annual Meeting of the Human Factors Society, Dayton, OH.

Kerchner, R., & Weaver, C. (1986, May). *Participation on performance standards* and measures panel, 6th Annual NSIA/DOD/ Industry Conference on Personnel and Training Factors in Systems Effectiveness, San Diego, CA.

Knerr, C. M., & DeYoe, P. (1986, May). Decision support system for part-task training. Paper presented at the Institute of Electrical and Electronics Engineers Conference, Dayton, OH.

Kyllonen, P. C., & Tirre, W. C. (1986, April). Memory organization as a determinant of learning. Paper presented in R.E. Snow (Chair), Determinants of individual differences in learning. Symposium conducted as part of the Annual Meeting of the American Educational Research Association, San Francisco, CA.

Lohman, D.F. (1986, April). Improving spatial abilities: What transfers after practice on mental rotation? Paper presented at the Annual Meeting of the American Educational Research Association, San Francisco, CA.

Looper, L. T. (1986, April). Decision analysis seminar on ongoing research. Panel discussion at the Joint National Meeting of the Institute of Management Science/Operations Research Society of America, Los Angeles, CA.

Mr. Larry Looper

Looper, L. T., & Stone, B. M. (1986, April). Air Force reenlistment analysis model. Paper presented at the Joint National Meeting of the Institute of Management Science/Operations Research Society of America, Los Angeles, CA.

Massey, R.H. (1986, March). A taxonomy of maintenance simulator trainers. Paper presented at the 1986 Air Force Technology in Training and Education Conference, Montgomery, AL.

Mitchell, J.L., & Driskill, W.E. (1986, August). Optimizing integrated personnel system training decisions and development. Paper presented at the American Psychological Association Convention, Washington, DC.

Mittleholtz, D. J., & Lohman, D. F. (1986, April). Effects of extensive practice without feedback on performance on a spatial synthesis task. Paper presented at the Annual Meeting of the American Educational Research Association, San Francisco, CA.

Mr. Jerry Moran

Moran, G. V., & Ballentine, R.D. (1986, August). Effects of job experience on performance scores. Paper presented at the American Psychological Association Convention, Washington, DC.

Mumford, M. D., Harding, F. D., Weeks, J.L., & Fleishman, E.A. (1986, August). Assessing the difficulty of military occupations. Paper presented at the American Psychological Association Convention, Washington, DC.

Nichols, P. D., & Lohman, D. J. (1986, April). Intelligence, spatial ability, and the automaticity of information processing. Paper presented at the Annual Meeting of the American Educational Research Association, San Francisco, CA.

Obermayer, R., Waag, W. L., & Comstock, W.J. (1986, March). Performance measurement systems for flight combat mission instruction and instructional research. Paper presented at the 1986 Eastern Simulation Conference, Norfolk, VA.

Olson, W.R., Kryway, J.T., & Easter, A.W. (1985, November). Instructional features and the user. Paper presented at the 7th Interservice/Industry Training Equipment Conference, Orlando, FL.

Pellegrino, J.W. (1986, April). Individual differences in skill acquisition: Information processing efficiency and the development of automaticity. Paper presented in R.E. Snow (Chair), Determinants of individual differences in learning. Symposium conducted as part of the Annual Meeting of the American Educational Research Association, San Francisco, CA.

Dr. Manuel Pina, Jr.

Pina, M., Jr. (1986, April). The Air Force's job assignment procedures. Paper presented at the Joint National Meeting of the Institute of Management Science/Operations Research Society of America, Los Angeles, CA. Utility and utilization of aircrew training device advanced instructional features. Paper presented at the 30th Annual Meeting of the Human Factors Society, Dayton, OH.

Pritchard, R.D. (1985, October). Productivity. Society for Organizational Behavior, and the Houston Association of Industrial/Organizational Psychologists, Houston, TX.

Ree, M. J. (1985, December). Validity for 1990s and beyond. Keynote address. Educational Testing Service Conference, Princeton, NJ.

Regian, J.W., Shute V.J., & Pellegrino, J.W. (1985, November). The modifiability of spatial processing skills. Paper presented at the 26th Annual Meeting of the Psychonomic Society, Boston, MA.

Richardson, J. J. (1986, February). Artificial intelligence technology for the maintainer's associate. Paper presented at the National Security Industrial Association's Conference on Implementation of Integrated Diagnostics, Alexandria, VA.

Siem, F.M., & Carretta, T.R. (1986, May). The development and initial validation of the Basic Attributes Test system. Paper presented at the 2nd Annual South Texas Symposium on Human Factors and Ergonomics, University of Texas at San Antonio.

Stephenson, R.W. (1986, May). Relative costs and benefits of aircrew training equipment systems. Paper presented at the 1986 National Aerospace and Electronics Conference, Dayton, OH.

Steuck, K.W, & Perea, P. (1986, April). An assessment of multi-option questions in metamemory research. Paper presented at the Annual Meeting of the American Educational Research Association, San Francisco, CA.

Mr. Mark Teachout

Teachout, M. S. (1986, August). Developing a composite measure of job performance: Problems and solutions. Paper presented at the American Psychological Association Convention, Washington, DC.

Teachout, M.S., Dickinson, T.L., Woods, S.B., & Mathieu, J.E. (1986, April). A time-based assessment of the construct validity of performance ratings. Paper presented at the 7th Annual Industrial/Organizational and Organizational Behavior Graduate Student Convention, Minneapolis, MN.

Tirre, W.C. (1986, February). Information processing correlates of intelligence: New information from computer-administered tests. Paper presented at the Annual Meeting of the Southwestern Educational Research Association, Houston, TX.

Tirre, W. C., & Rancourt, C. R. (1986, April). Individual differences in learning by accretion: It all begins with comprehension. Paper presented in R.E. Snow (Chair), Determinants of individual differences in learning. Symposium conducted as part of the Annual Meeting of the American Educational Research Association, San Francisco, CA.

Towle, K. E., & Thomas, M. (1985, November). Spectral matching of light valve projectors used for simulation. Paper presented at the 7th Interservice/Industry Training Equipment Conference, Orlando, FL.

Venturino, M. (1986, September). Peripheral vision and peripheral displays. Symposium chaired at the 30th Annual Human Factors Society Meeting, Dayton, OH.

Venturino, M. (1986, September). Timesharing, cognition, and human performance in complex information systems. Symposium chaired at the 30th Annual Human Factors Society Meeting, Dayton, OH.

Watson, T. W. (1986, August). Full-scale test of an empirical model of turnover. Paper presented at the Annual Meeting of the Academy of Management, Chicago, IL.

Watson, T. W., & Appel, V. H. (1986, April). Implications of the results of recent turnover research for Air Force policy. Paper presented at the 10th Psychology in the DOD Symposium, Colorado Springs, CO.

Dr. Thomas Watson

Weaver, C. N. (1985, December). Increasing productivity in Air Force jobs through feedback, goal setting, and incentive systems. Paper presented at the 1985 Department of Defense Productivity Conference, Leesburg, VA.

Weaver, C.N. (1986, May). Productivity R&D at the Air Force Human Resources Laboratory. Paper presented at the National Security Industrial Association's Conference on Implementation of Integrated Diagnostics, Alexandria, VA.

Weaver, C.N. (1986, June). Enhancing productivity through feedback, goal setting, and incentive systems. Paper presented at the 1986 Electronic Security Command, San Antonio, TX.

Weaver, C.N., Alais, R.M., & Franz, R.S. (1986, March). Public attitudes and trade relations. Paper presented at the Southwestern Economics Association, San Antonio, TX.

Weaver, C.N., Alais, R.M., Franz, R.S., & Carpenter, J.B. (1986, April). U.S. public attitudes and trade relations with eight countries: Further tests for relationship. Paper presented at the International Atlantic Economic Association, St. Thomas, U.S. Virgin Islands.

Weaver, C.N., & Carpenter, J.B. (1986, April). Is labor to blame for the decline in U.S. productivity? Paper presented at the International Atlantic Economic Association, St. Thomas, U.S. Virgin Islands.

Dr. Charles Weaver

Weaver, C. N., & Schultz, M. (1986, March). Professionals and job autonomy: Do they really want more? Paper presented at the Southwestern Society of Economists, Dallas, TX.

Wegner, T.G. (1986, April). Appropriateness of the Armed Services Vocational Aptitude Battery for ninth and tenth graders. Paper presented at the 10th Annual Psychology in the DOD Symposium, Colorado Springs, CO.

Welch, B. L., & Kruk, R. (1986, May). Engineering and human visual considerations in development of a fiber-optic helmet-mounted display. Paper presented at the Royal Aeronautical Society, London, England.

Welsh, J. (1986, April). The development and calibration of an adaptive ASVAB item pool. Paper presented at the 1st Annual Convention of the Society for Industrial and Organizational Psychology, Chicago, IL.

Woltz, D.J. (1986, April). The role of working memory in associative learning. Paper presented in R.E. Snow (Chair), Determinants of individual differences in learning. Symposium conducted as part of the Annual Meeting of the American Educational Research Association, San Francisco, CA.

Yasutake, J.Y. (1986, May). Participation on skills sustainment panel, 6th Annual NSIA/DOD/Industry Conference on Personnel and Training Factors in Systems Effectiveness, San Diego, CA.

CONFERENCES/WORKSHOPS HOSTED BY AFHRL IN FY86

30 October-1 November 1985 23-25 June 1986	Semiannual Progress Reviews, Basic Job skills Research Program: At both reviews, Air Force and university/industrial researchers, plus interested representatives from the Air Staff and MAJCOMs attended. Audiences were between 60 and 75 people.
November 1985	Joint Services Selection and Classification Working Group
9-11 January 1986	Defense Advisory Committee on Military Personel Testing
27-31 January 1986	SIMSCRIPT II.5 Course taught by CACI, Inc.-Federal, Brooks AFB, TX
18-19 March 1986	Reliability and Maintainability in Computer-Aided Design (RAMCAD) Technical Interchange Meetings at the Institute for Defense Analysis, Washington DC
April 1986	Conference on Validity for the 1990s and
April 1986	R&D Coordination Conference, Phoenix, AZ Beyond
1-2 May 1986	Division Advisory Group Visit, Phoenix, AZ
2-6 June 1986	EURO-NATO Aircrew Selection Working Group Brooks AFB, TX
21-23 July 1986	Working Group on Operator Capacity Limits in Complex Information Processing Systems, Dayton, OH
August 1986	DOD Future Test Technology Committee
3-4 September 1986	Air Force Human Resources Laboratory Research Planning Forum for Intelligent Tutoring Systems, San Antonio, TX

12 February 1987

BROOKS AFB, TEXAS

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- **VICE COMMANDER** — Col H G Jensen — Ext 3605 — AB (CV)
  - **CHIEF SCIENTIST** — Vacant — Ext 3605 — AA (CCN)
  - **PLANS AND OPERATIONS OFFICE** — Dr H J Clark — Ext 3611 — FO (XO)
  - **EXECUTIVE SUPPORT OFFICE** — Capt J E Watson — Ext 3386 — ABA (SU)
  - **DET 26, 6592 MES** — Ext 3662 — AML (MET-26)

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- FORCE UTILIZATION BRANCH — Lt Col Short — Ext 3648 — UFB (MOO)
- COGNITIVE SKILLS ASSESSMENT BRANCH — Vacant — Ext 3570 — UFD (MOE)
- FORCE MANAGEMENT SYSTEMS BRANCH — Maj T. Bergquist — Ext 3942 — UFC (MOM)
- PROGRAM SUPPORT OFFICE — Capt J. Furru — Ext 3845 — UFF (MOP)
  - OFFICE OF SCIENTIFIC REVIEW — Dr B Alley — Ext 2244 — UFE (MOS)
    - OFFICE OF TECHNICAL DIRECTION — Vacant — Ext 2244 — UFG (MOT)

TECHNICAL SERVICES DIVISION — Dr R Bottenberg — Ext 3841 — GP (TS)
- COMPUTER OPERATIONS BRANCH — Mr R Martinez — Ext 4388 — GPP (TSC)
- INFORMATION RESOURCE MANAGEMENT OFFICE — Vacant — Ext 3677 — GPL (TSM)
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- SCIENTIFIC & TECHNICAL INFORMATION OFFICE — Ms N Perrigo — Ext 3877 — GPN (TSR)

TRAINING SYSTEMS DIVISION — Col G A Berry — Ext 2913 — UE (ID - BROOKS)
- SKILLS DEVELOPMENT OFFICE — Lt Col H Burns — Ext 2981 — UEE (IDE BROOKS)
- TECHNOLOGY DEVELOPMENT BRANCH — Vacant — Ext 2775 — UED (IDE)
- TRAINING SYSTEMS DEVELOPMENT BRANCH — Maj J H Blackhurst — Ext 2666 — UEC (IDD BERGSTROM)
- PROGRAM SUPPORT OFFICE — Capt R Schafer — Ext 3914 — UEB (IDA BROOKS)

OPERATIONS TRAINING DIVISION — Col M C Lane — Ext 6561 — UC (OT)
- AIRCREW TRAINING BRANCH — Vacant — Ext 6561 — UCC (OTA)
- TECHNOLOGY DEVELOPMENT BRANCH — Mr H Geltmacher — Ext 6561 — UCB (OTE)
- OPERATIONAL UNIT TRAINING BRANCH — Dr T H Gray — Ext 6561 — UCE (OTU)
- PROGRAM SUPPORT OFFICE — Lt Col C Pate — Ext 6561 — UCD (OTS)

LOGISTICS AND HUMAN FACTORS DIVISION — Col D C Tetmeyer — Ext 6797 — UG (LR)
- ACQUISITION LOGISTICS BRANCH — Lt Col Coleman — Ext 3871 — UGA (LRA)
- GROUND OPERATIONS BRANCH — Dr L Reed — Ext 5910 — UGE (LRG)
- COMBAT LOGISTICS BRANCH — Mr R C Johnson — Ext 2606 — UGF (LRC)
- LOGISTICS SYSTEMS BRANCH — Maj J F Nerad — Ext 8418 — UGB (LRL)
- PROGRAM SUPPORT OFFICE — Ms D Smith — Ext 3611 — UGC (LRS)

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