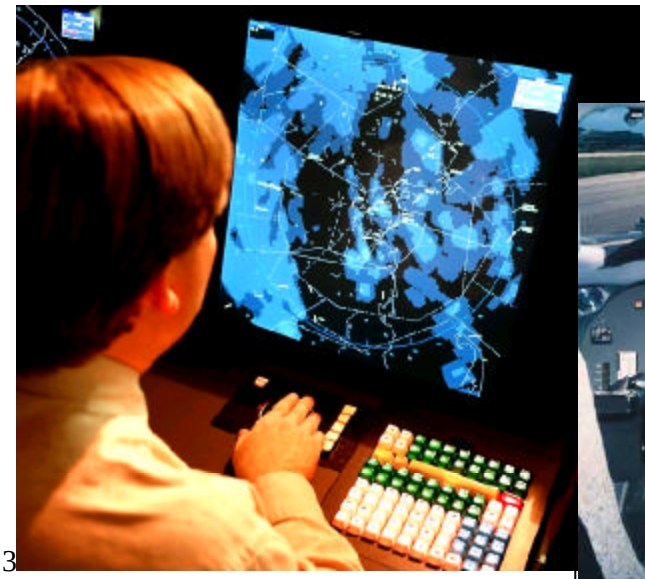

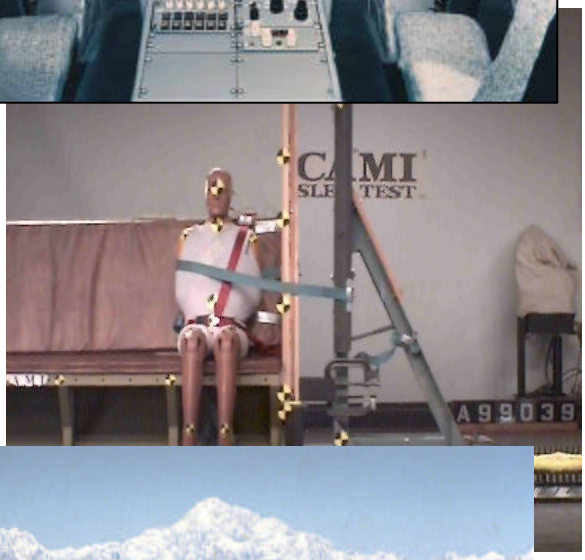

OFFICE OF THE CHIEF SCIENTIST FOR HUMAN FACTORS ANNUAL REPORT 2001

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Our mission – Our focus

2001 - A SUCCESSFUL, YET CHALLENGING YEAR

The Human Factors and Aerospace Medicine Program entered the new century on a wave of change brought on by the rapid evolution toward increased operational demand, diversity of aircraft and systems, changing technology, and globalization of the airline/ aircraft industry. To meet these challenges, the human factors team took aggressive steps to go forward with research and management initiatives designed to meet Federal Aviation Administration (FAA) Goals for safety and acquisition:

- Our Safety Research Mission
  - Identify methods that can contribute to the FAA goal of reducing the fatal accident rate by 80 percent;
  - Develop human performance information and guidance critical to the design, operation, regulation, and certification of equipment, training, and procedures; and
  - Provide recommendations for FAA regulatory and medical certification personnel to enhance the safety of aircraft crewmembers and aircraft cabin occupants.
- Key Management Initiatives
  - Ensure that human factors policies, processes, and best practices are integrated in the research and acquisition of 100 percent of FAA aviation systems and applications.

To ensure success in accomplishing these goals, the Human Factors and Aerospace Medicine team:

- Conducted research focused on those areas directly impacting aviation safety;
- Formed partnerships with research and university laboratories;
- Capitalized on opportunities to leverage government and industry resources to rapidly transfer the results of research to the aviation community; and
- Worked throughout the agency to ensure that human factors expertise is represented across functional disciplines and that human factors considerations are addressed throughout the FAA acquisition process.

ANTICIPATING DIRECTION AND GOING FORWARD WITH OUTCOMES THAT DIRECTLY IMPACT THE FLYING PUBLIC

Human Factors and Aerospace Medicine researchers are increasing the safety and efficiency of the National Airspace System (NAS) by developing scientifically validated information and guidance for improving the performance and productivity of air carrier crews, general aviation pilots, aviation maintenance and inspection personnel, air traffic controllers, NAS system maintenance specialists, and improving the health, safety, security, protection, and survivability of aircraft passengers and aircrews. This program directly responds to FAA Strategic Plan goals to "eliminate accidents and incidents caused by human error" and to "implement new decision support systems and associated functional improvements that fully account for the proper role of people in the system." Human Factors research is also initiated in support of the FAA goal to "reduce the costs of flying by making the air traffic management system more efficient to use."

Human Factors research guides the incorporation and expansion of human factors considerations in aircrew training, and supports the development of human-centered flight controls and displays. It identifies aircrew-training innovations that enhance safety and reduce performance inefficiencies. Researchers consider the aircrew, evaluators, simulators and the management culture in addressing aviation-training systems. Human factors research also explores prospects for safety enhancement through automated analysis of flight-recorded data and through application of human factors in certification of new aircraft and equipment design and modification. The human factors research program develops more effective methods for maintenance technician and inspector training, and improves aviation maintenance technician and inspector task performance. Aviation maintenance human factors research efforts are evaluating the effects of enhancing maintenance resource management, and conducting human error risk analyses in aviation maintenance and flight line operations to identify strategies to mitigate errors.

In general aviation, safety is being improved through data-driven research efforts to understand the underlying human causal factors associated with accidents. Advancements in safety will be realized through the application of human-centered principles in development of advanced displays and controls, in developing procedures that improve pilot decision-making and performance, and in evaluation of flight training devices.

Human factors research will integrate vertical flight into the NAS in a safe and efficient manner. Efforts directed toward measuring visual flight rules (VFR) helicopter pilot's navigation performance when using instrument flight rules (IFR) qualified global positioning system receivers and developing an inexpensive, valid, and reliable night vision imaging system for rotorcraft civil operations are already underway.

In air traffic control, an improved approach to classifying the human factors associated with operational errors, incidents, and deviations will result in improved investigation techniques leading to recommendations such as in procedures and training for decreasing the frequency of those events. Human factors design guidance along with research findings and recommendations from assessments of human performance will guide the development of human-centered automation and procedures that will enhance controller decision-making and reduce error-prone conditions. These efforts will also guide the development of tools and procedures to support collaborative decision-making in Air Traffic Management required for the future NAS to meet increased demand. Safety will be enhanced through development and distribution of educational aids designed to mitigate runway incursions and underlying human performance issues, and which will mitigate controller fatigue resulting from shift work. Human factors research provides improved techniques used in forecasting hiring requirements and in selecting applicants for Air Traffic and Airway Facilities positions.

The FAA is able to exploit new and evaluate existing bioaeronautical guidelines, standards, and models for aircraft cabin equipment, procedures, and environments. This serves as a base for new regulatory action and the evaluation of existing regulations to enhance appropriate human performance at a minimum cost to the aviation industry. By reviewing pilot medical histories, flight histories, and information from accidents and incidents, existing and advanced biomedical criteria, standards and assessment/ certification procedures can be proposed to ensure optimal performance capability. By examining pilot, flight attendant, air traffic controller, and passenger work, environmental, behavioral, and disease issues, guidelines for actions to improve the health and safety of the aircraft occupant can be proposed based on rigorous scientific criteria.

THE HUMAN FACTORS RESEARCH PROGRAM PROVIDES INNOVATIVE OUTPUTS AND CONCEPTS THAT DELIGHT OUR CUSTOMERS, ENHANCE SAFETY, AND OFFER NEW SOLUTIONS AND IMPROVEMENTS TO TECHNOLOGY.

- Operational needs and problems involving human performance are identified and addressed.
- Comprehensive and systematic analyses of human causal factors in accidents are performed and intervention strategies are identified.
- Research projects which address operational priorities are funded and guided.
- Pilot, controller and aircraft procedures required with advanced systems (e.g., global positioning satellites) are evaluated.
- Partnerships with industry and academia are formed.
- Participation by the nation's top scientists and professionals is elicited.
- Human factors guidance is provided to the FAA for development and implementation of new technologies, training and procedures.
- Transfer of research products to the operational community is facilitated.
- Data and other forms of information which support notices and regulations applicable to aircraft occupant health and safety is produced and analyzed.
- Recommendations and guidelines are developed in response to a public demand (e.g., better restraints for children in aircraft settings).
- Assessements of disease transfer and other aircraft occupant health factors are prepared.
- Recommendations are developed to support seat and restraint certification, protective breathing equipment and emergency medical equipment certification, and life support/rescue equipment certification.

The FAA is concerned with ensuring the safety and efficiency of NAS operations, a critical element of which is operator performance. Through guidelines, handbooks, advisory circulars, rules, and regulations, the agency provides industry with human performance information and guidance critical to the design, operation, regulation, and certification of equipment, training, and procedures. The human factors program conducts the research that provides the technical information needed to generate these products and services. Problems with understanding and properly using automation have been cited as a contributing factor in aircraft accidents (e.g., the AA965 crash at Cali). Human factors research is examining flight deck automation design, operation, use and training, and has developed a prioritized research agenda of issues to be addressed. Air carrier training initiatives, such as the Model Advanced Qualification Program (air carrier pilot training program which integrates both technical and crew resource management performance requirements), will allow air carriers to develop and use proficiency-based training that addresses issues related to automated systems. The Automated Performance Measuring System will provide airlines the ability to analyze routine operations for dangerous trends and tendencies. It also will provide insight into the details of daily carrier line operations, uncovering automation usage problems that occur while operating in a complex environment.

Validated pre-hire assessments for air traffic controllers, electronics technicians, and transportation system specialists will enable the FAA to select persons with appropriate knowledge, skills, and abilities for each occupation, thus reducing training required after employment as well as attrition because of poor person-job fit. Human factors assessments will be conducted to evaluate safety and efficiency gains associated with automated decision aids in air traffic control.

Scientists from the Office of Aerospace Medicine and the National Institute for Occupational Safety and Health are examining cabin environmental quality issues and their effect on passengers and flight crews. Aerospace Medicine is also developing bioengineering criteria to support aircraft seat and restraint system certification, human performance and ergonomic data to support emergency evacuation regulations and standards, biomedical criteria to support protective breathing equipment and operational procedures certification, and biochemical/toxicological criteria supporting the use or certification of aircraft interior fire, smoke, and toxicity limits. The aerospace medical program is executed through three primary initiatives. Protecting humans in decelerative environments, existing radiation environments, protective breathing equipment, cabin evacuation, and water survival are investigated in the human protection and survival initiative. Toxicological assessment and sudden or subtle pilot incapacitation are key features of the accident investigation initiative. A program to survey the nature of in-flight medical emergencies, particularly the effectiveness of defibrillators carried on airlines, new vision corrective methods for aviation personnel, aircraft cabin environmental hazards, air ambulance medical requirements, and development of protocols for safe use of lasers in laser light shows to prevent incapacitation of pilots, represent current investigations under the aviation medicine program support initiative.

THE RIGHT BUSINESS MODEL: A PROGRAM AREA STRUCTURE THAT SERVES FAA ORGANIZATIONS, SERVES THE AVIATION COMMUNITY, AND IS ANCHORED IN STABILITY AND FLEXIBILITY

The human factors program addresses operational requirements through research in five technical areas as identified in the *National Plan for Civil Aviation Human Factors: An Initiative for Research and Application*:

Human-Centered Automation: Researchers in this area focus on the role of the operator and the cognitive and behavioral effects of using automation to assist humans in accomplishing their assigned tasks. Their research addresses the identification and application of knowledge concerning the relative strengths and limitations of humans in an automated environment. They investigate the implications of computer-based technology in the design, evaluation, and certification of controls, displays, and advanced systems.

Selection and Training: Researchers in this area strive to understand the relationship between human abilities and aviation task performance by enhancing measures and methods for the prediction of current and future job/task performance; establishing a scientific basis for the design of selection systems, training programs, devices and aids for individuals and teams; defining criteria for assessing future training requirements; and, identifying new ways to select aviation system personnel.

Human Performance Assessment: Within this area, researchers identify those human causal factors associated with accidents and incidents; examine the intrinsic cognitive and decision-making factors for individuals and teams that determine how well they are able to perform aviation tasks; characterize the impact of environmental and individual factors on human performance; and improve and standardize methods for measuring human performance.

Information Management and Display: Researchers in this area address the presentation and transfer of information among components in the NAS. They also seek to identify the most efficient and reliable ways to display and exchange information; determine what, when, and how one might best display and transfer information to system components; design systems to reduce the frequency of information transfer errors and misinterpretations; and strive to minimize the impact when such errors do occur.

Bioaeronautics: Research in this area involves the bioengineering, biomedicine, and biochemistry associated with performance and safety. The objective is enhancement of personal performance and safety by maximizing crew and passenger protection, health, and physiological integrity. The program consists of three research areas: human protection and survival; medical and toxicological factors in accident investigation; and support for aeromedical certification and in-flight aeromedical applications through aeromedical applications.

HIGH VISIBILITY CUSTOMER AND STAKEHOLDER INVOLVEMENT

The Human Factors Program directly supports a range of aviation community initiatives and congressional mandates, such as research into the effects of fatigue in the controller workforce leading to the identification of effective fatigue countermeasures (including the distribution of educational materials on shift work and fatigue).

The FAA Operational Evolution Plan (OEP) addresses air transportation needs for the next ten years, focusing on maintaining safety, increasing capacity, and managing delays. Human factors will support the OEP's business management plan by working with the OEP Program Office, Free Flight Program Office, airlines, NASA, and the DoD to provide research findings and guidance on air traffic decision support tools, airspace and route design, and advanced communication, navigation, and surveillance technologies. Integration of flight deck and air traffic control tools will use a wide range of methods, including human-in-the-loop simulation to ensure viability of procedures while balancing workload.

The FAA 2001 Performance Plan has identified areas of human factors research concentration that have led to collaborative efforts between the agency and industry. These include efforts to reduce operational error as a factor in aviation incidents and accidents and to integrate human factors into system acquisition.

The Mission Goal for Safety identified in the 2001 FAA Strategic Plan ("by 2007 reduce the U.S. aviation fatal accident rate by 80% from 1996 levels") has fostered collaboration with the aerospace community in efforts that include: building on currently successful initiatives to identify the individual, organizational, and system factors associated with past accidents; using new data sources in a more proactive analytical approach to identifying and reducing key human factors risks; and working with NASA, DoD, and other public and private organizations in studying issues and technologies with potential to improve policies, procedures, and equipment. Human factors research is responsive to a number of congressional mandates and aviation community initiatives. This has led to a wide range of collaborative research efforts. These include:

- Issues addressed by the Runway Safety Program, including training for tower controllers, pilot and controller communications phraseology, runway markings and lighting, air traffic control teamwork enhancement training, improved procedures designed to avoid runway incursions, and memory enhancement techniques.
- Human factors research associated with the *Safer Skies* program, which employs the latest technology to help analyze U.S. and global accident data to determine root causes and identify appropriate actions to break the chain of events that lead to accidents.
- Research guided by a coherent national agenda which ensure an adequate human factors emphasis in bioaeronautics with resulting insights utilized in making significant improvements in NAS safety and efficiency. These concerns were identified through extensive aviation community participation and were listed in the *National Plan for Civil Aviation Human Factors: An Initiative for Research and Application*.

- Research focused on priority issues associated with crew training, the collection and use of safety data, the application of emerging technologies, and aircraft maintenance procedures and inspection as identified in The Aviation Safety Plan.
- Research necessary to implement recommendations in an FAA report on *The Interfaces Between Flight Crews and Modern Flight Deck Systems*. The report resulted from a study of the interfaces between flight crews and automated systems on highly automated airplanes, with primary focus on interfaces that affect flight path management.
- Research which is responsive to the FY 1998 Department of Transportation Appropriations Act which cites human factors as the greatest cause of aviation accidents and calls for high priority research.
- Research which addresses the Aviation Safety Research Act of 1988, requiring that human factors research be conducted to "enhance air traffic controller performance, develop a human factors analysis of the hazards associated with new technologies, identify innovative and effective corrective measures for human errors, and develop dynamic simulation models of the ATC system."
- Research on issues identified by the RTCA "Free Flight Action Plan". This document addresses recommendations to: establish more flexible decision support systems involving collaborative decision making; conduct human-in-the-loop simulations for assessing controller and pilot perceptions of hazards, risks, and discomfort; measure performance, workload, and situation awareness associated with controller and pilot responses to time and distance buffers for aircraft separation; conduct real-time human-in-the-loop simulations to study controller and pilot behaviors, interactions, and effects within NAS environments that represent dynamic densities and sector configurations anticipated for free flight.
- Research which addresses key elements of the FAA Operational Evoluation Plan – a approach the FAA is using to integrate solutions and help determine the increasing effect of capacity on airspace users. AAR-100 is participating in preparing modeling analyses and human-in-the-loop simulations to demonstrate traffic levels projected for 2010.
- On-site, realistic research made possible through access to the personnel and facilities of airline and aviation maintenance organizations. These organizations have benefited from research products, such as electronic job aids, intelligent tutoring systems, guidance on work site environmental conditions, shiftwork studies, and advanced training methods.

The Aerospace Medicine program directly supports a number of aviation community initiatives and congressional mandates, including:

- Research in the protection and survival of aircraft occupants; medical accident investigation and airman medical certification; toxicology and the effects of drugs on human performance; and the impact of disease and disability on human performance, as required by Public Law 100-591 [H.R. 486]; November 3, 1988 (known as the Aviation Safety Research Act of 1988).
- Toxicological analyses on specimens from, and special pathologic studies on, aircraft accident fatalities as required by DOT Order 8020.11A, Chapter. 4, Paragraph 170.
- Investigations of selected general aviation and air carrier accidents and searches for the biomedical clinical causes of accidents, including evidence of disease and chemical abuse, as required by DOT Order 1100.2C, Chapter 53, Paragraph 53-15.
- State-of-the-art toxicological tests on the blood, urine, and tissue of pilots involved in fatal accidents to determine the levels of both licit and illicit drugs at both the therapeutic and abnormal levels, as requested by National Transportation Safety Board Safety Recommendations A-84-93.

The Aerospace Medicine Program is an integral participant and research provider under the FAA, Joint Aviation Authorities, and the Transport Canada Aviation Aircraft Cabin Safety Research Plan (established in 1995), which sets forth long-term research goals and ensures coordination between international aviation agencies. Programs within Aerospace Medicine that study aircraft cabin environmental quality and the nature and extent of in-flight medical emergencies are a direct result of specific congressional mandates to study these topics.

High Impact Alliances and Partnerships

We have formed alliances and partnerships with leading research organizations, colleges, and universities to collaborate on joint research that brings products to the aviation community. Our alliance partners share our absolute commitment to safety and our expectation that products will exceed our sponsors' expectations. With this shared vision and our combined resources and innovation, we can succeed in achieving the FAA goals for safety.

High Impact at a glance

- **NASA**: Flight Deck Risk Assessment, Air Carrier Operating Documents, Interruptions, Distraction, Lapses of Attention in the Cockpit, Night Vision, Human Error Risk Analysis in Maintenance, Air/Ground Integration
- **Volpe National Transportation Systems Center**: Simulation Fidelity, Head-Up Display Design, Runway Incursions
- **DoD**: Night Vision, Air Traffic Control Automation, Crashworthiness, Technical Interchange
- **University of Texas**: Human Error and Air Carrier System Safety
- **University of Illinois**: Causal Factors of General Aviation Incidents/Accidents
- **Purdue University**: Proactive Safety Assessment in Aviation Maintenance
- **Ohio State University**: Flight Deck Error Management
- **San Jose State University**: Airspace Modeling
- **EUROCONTROL**: Human Error in Air Traffic Management
- **Joint Aviation Authorities and Transport Canada Civil Aviation**: Cabin Safety Research
- **National Institute for Occupational Safety and Health**: Cabin Air Quality

Specific areas of coordinated program execution with NASA include cockpit automation, crew resource management, team decision-making, and controller-pilot data link communications. DoD joint efforts involve enhanced vision and automation. Additionally, the Human Factors Office maintains a membership in the DoD Human Factors Engineering Technical Advisory Group that provides a forum for the coordination of research across a variety of technical areas.

The FAA/NASA Ames Inter-Agency Air Traffic Management Integrated Product Team (IAIPT) joint research product description (JRPD-12) addressing human factors in evolving environments continued to organize and conduct a series of collaborative technical interchange meetings (TIMs) in FY01. TIM number 4 was held in November 2000 at the William J. Hughes Technical Center (ACT) and focused on the research management process. A series of 18 presentations addressed management perspectives from the Office Aviation Research (AAR), the Office of National Airspace System Operations (AOP), Free Flight Phase 1 Program Office (AOZ), Air Traffic Strategic Requirements Office (ARQ), Air Traffic Plans/Procedures (ATP), System Development and Architecture Analysis (ASD), Air Traffic Systems Development (AUA), NASA Ames, and MITRE. TIM number 5 was held in June 2001 at the Free Flight

Program Office. This TIM examined the integration of human factors in Free Flight Phase One acquisitions spanning air traffic control and Airway Facilities program activities. A total of 32 participants attended this TIM, including human factors practitioners, researchers, and program office managers. These individuals represented several FAA offices including AAR, ACT, AOP, AOZ, ASD, and AUA along with individuals from MITRE, NASA Ames, contractors, and universities. There were a total of 18 presentations during the course of the two-day TIM.

The Human Factors Office maintains an active membership on all Society of Automotive Engineering G-10 Human Factors subcommittees related to on-going and future research areas to ensure transition of the results to standards and guidelines. The Human Factors Office places grants with universities supporting research on air carrier training, flight deck automation, general aviation, aviation maintenance technician training, and air traffic control. Coordinated research efforts are conducted with NASA in areas such as air carrier training, aviation maintenance, vertical flight, data link, free flight, instrument procedure design, and human error assessment. Special attention is being paid to training enhancements that develop aviation teamwork skills and the utility of advanced technologies for delivering team training. Human factors researchers are collaborating with the Naval Research Laboratory in the collection of low-light visible and infrared imagery. The objective of this research is to investigate the feasibility of using enhanced vision on technology to aid tower controllers in gaining and maintaining situation awareness at night and under low visibility conditions. The project will also assess enhanced sensor surface surveillance systems to aid airport security personnel in detecting intruders.

The Human Factors Office participates in collaborative research with EUROCONTROL on the reduction and management of human error in Air Traffic Management, human performance issues in the design of decision support tools, and on developing a human-centered approach to integrating technologies to ensure aircraft separation. An effort is underway with the Joint Aviation Authorities (JAA) and Transport Canada Civil Aviation (TCCA) to identify and coordinate human factors research in areas of joint interest that will support enhanced certification harmonization. Included is a joint project focused on development of a methodology to identify potential human error and flight crew vulnerabilities during certification of flight deck interfaces. The Cabin Safety Research Technical Group brings together cabin safety research efforts of the FAA, JAA, TCCA, and Japan Civil Aviation Bureau by establishing an international framework to allow for the systematic joint identification, prioritization, and coordination of needed research.

The Office of Aerospace Medicine collaborates with the National Institute for Occupational Safety and Health on a study addressing the cabin environment and flight attendant and passenger symptomatology and diseases. In addition, a liaison is maintained with the American Society of Heating, Refrigeration, and Air Conditioning Engineers Committee addressing aircraft cabin air quality status and research. The Office of Aerospace Medicine maintains direct cooperative research processes with all the manufacturers responsible for safety products (seats, restraint systems, oxygen masks, evacuation slides, etc.). The Office of Aerospace Medicine is also represented on appropriate subgroups of organizations, such as the Aerospace Medical Association, the Society of Automotive Engineers, the Civil Aviation Medical Association, and the Professional Aeromedical Transport Association. Appropriate liaison with the military is maintained either through direct project collaboration (e.g., crashworthiness, eye injury from lasers) or through the more global participation in the Tri-Services Aeromedical Research Panel and the North Atlantic Treaty Organization (NATO) aerospace medical advisory group.

Solving Problems, Seeking Solutions, Enhancing Human Performance

Past Accomplishments

INFORMATION MANAGEMENT AND DISPLAY

- Developed a manual that addresses appropriate human factors considerations in designing flight deck operating documents.
- Developed the first industry standard and guidance document on implementing an aviation maintenance human factors program.
- Conducted a comprehensive assessment of the Standard Terminal Automation Replacement System (STARS) operational radar display and maintenance control workstations.
- Identified the priorities, organization, and sources of information accessed by pilots during various phases of flight.
- Completed software tools for enhanced aviation maintenance documentation.
- Completed human factors guidelines for assessing advanced general aviation transportation cockpit displays/controls.
- Identified operational functions in controller use of paper flight progress strips to support transition to Free Flight Phase 1 decision-support automation.
- Developed the Human Factors Design Guide for system acquisitions by Integrated Product Teams.
- Developed human factors design and evaluation considerations for Electronic Flight Bags.
- Completed assessment of human factors issues and current knowledge concerning use of air transport head-up displays.
- Developed the Aviation Maintenance Document Design Aid incorporating simplified English and utilizing advanced technology to standardize aviation maintenance documentation.
- Developed guidance and recommendations on human factors best practices in flourescent penetrant inspection. This project provided a more systematic view of human/system interaction.
- Completed human factors guidelines for assessing advanced general aviation transportation experiment (AGATE) cockpit controls/displays.
- Completed Data Link lessons learned compendium for inclusion in RTCA DO-238A, "Human Factors Requirements and Guidance for Controller/Pilot Data Link Communications Systems."
- Guidelines on use of Color in ATC Displays – Provided Integrated Product Teams (IPT) reference guidance on the most effective uses for color coding operational information in new system displays.

HUMAN-CENTERED AUTOMATION

- Completed a complex human-in-the-loop simulation to develop recommendations for improved controller performance and team communications in use of a medium term conflict probe decision aid.
- Developed a pocket certification guide for human factors evaluation of multifunction displays.
- Developed aircraft certification human factors and operations checklist for stand-alone global positioning receivers.
- Completed Human Factors Certification Job Aid Version 1.0 and Version 2.0 for FAR Part 25 flight deck displays.
- Flight Strip Studies – Identified operational functions in controller use of paper flight progress strips to support transition to Free Flight Phase 1 decision-support automation.
- Auditory Alarm Database – Developed database of alarms for use in the design of future AF alerting systems for centralized maintenance centers.

HUMAN PERFORMANCE ASSESSMENT

- Developed and field tested (with several airlines) a prototype Automated Performance Measurement System (APMS) which allows for gathering and analysis of data from aircraft flight data recorders. This information and analysis capability is used by the Flight Operations Quality Assurance program, a joint FAA and airline venture to enhance aviation safety.
- Validated human performance transfer functions for full flight simulators.
- Developed initial mapping of flight data parameters into Advanced Qualification (AQP) standards.
- Initiated a process to integrate shift-change error identification and mitigation processes into the aircraft maintenance error-detection and reporting system.
- Developed pilot performance data through flight simulation for use in establishing certification standards for general aviation auto-navigation and control systems.
- Developed the Post-Operations Evaluation Tool that has now been deployed nationally as a common framework for assessing coordinated strategic responses to ATM restrictions.
- Initiated collaborative research with EUROCONTROL scientists to develop a harmonized model to investigate human error in air traffic management.
- Completed human factors analysis of Part 121/135 air carrier accidents and Part 91 fatal general aviation accidents contained in the NTSB database using the Human Factors Analysis and Classification System.
- Completed the congressionally-mandated survey of fatigue in air traffic controllers.
- Distributed a CD-ROM to the controller workforce designed to improve controller awareness of the fatigue related effects of shiftwork and potential fatigue countermeasures that can be adopted.
- Distributed a human factors educational booklet for that provides controllers with helpful information about techniques to enhance job performance, such as involving communications and memory.
- Assessed the impact of restructuring en route airspace on air traffic controller performance.
- Designed, developed, and administered the FAA-wide employee attitude survey.
- Completed the Job Task Analysis of the Aviation Maintenance Technician Workforce.
- Developed a pilot performance profile, through flight simulation,, for use in establishing certification standards for general aviation auto-navigation and control systems.

SELECTION AND TRAINING

- Developed a model AQP for use by training centers to support regional air carrier participation in AQP, a proficiency-based approach to pilot training.
- Validated use of simulator parameters and flight data for evaluating AQP effectiveness.
- Developed error mitigation training for cockpit crews.
- Developed proceduralized Crew Resource Management guidelines for regional airlines.
- Provided Flight Standards guidance for developing pilot training regulations based on a study of 40,000 domestic air carrier pilots which examined their perception of training effectiveness.
- Developed preliminary training guidelines for cockpit distractions and interruptions.
- Incorporated air carrier and FAA user comments into an enhanced reconfigurable event set scenario development system to be used in simulator training/evaluation.
- Developed the line audit methodology used by air carriers to help determine safety vulnerabilities.
- Provided FAA and industry guidance on approaches to incorporating realistic radio communications into simulators to train pilots for complex operating environments.
- Produced and presented the FAA Human Factors Course to increase understanding of the importance of considering the "human factor" in design/acquisition of FAA systems.
- Produced and distributed a handbook for Advanced Crew Resource Management training.
- Identified and documented the best practices for engine nondestructive training and related inspections.
- Developed the Maintenance Resource Management Handbook for use by industry.
- Developed an automated system of self instruction for specialized maintenance training.
- Developed CD-ROM general aviation training programs on personal minimums checklists, decision-making, and recognizing cues for deteriorating weather.
- Completed the evaluation and recommendations for using PC-based aviation training devices in pilot instrument flight training.
- Prototyped a proof-of-concept Variable Item Generator (VIGOR) computer tool to generate knowledge test items for screening applicants for Airway Facilities positions.
- Completed an initial validation study of the Airway Facilities Centralized Applicant Pool System for operational use in selecting electronics personnel.
- Developed guidance on situation awareness, error mitigation, and teamwork to support the NAS Infrastructure Management Maintenance Concept and its transition to centralized maintenance management.

BIOAERONAUTICS

- Provided aeromedical accident analysis for evaluation and enhancement of medical certification standards.
- Initiated use of computer simulation (dynamic modeling) of crash responses for seat occupant-aircraft interface, and used biodynamic sled test results to validate system capability.
- Completed cabin evacuation research project, evaluating effects of passageway, exit hatch, passenger density, and passenger motivation on evacuation efficiency.
- Completed evaluation of access to under-seat flotation devices and seat belt tension/cushion compression based on range of human anthropometry.
- Evaluated autopsy and toxicological data from fatal aviation accidents to

recommend protective equipment and design practices and to determine the incidence of licit and illicit drug use.

- Initiated development of an advanced consolidated data base that integrates accident/incident information with medical certification data to establish a methodology for continuous evaluation or airmen medical certification standards.
- Completed assessment of potential for flight attendant reproductive health hazards by integrating flight data, measurements of radiation, and other aircraft cabin environmental parameters and information from epidemiological studies.
- Evaluated applicability of analytical modeling on dispersion and removal of gaseous and aerosol contaminants in different types of aircraft heating, ventilation, and air conditioning systems.
- Updated educational material and improved access to information on potential exposure to air contaminants and other environmental parameters in aircraft.
- Provided assistance in review and updates of bulletins, reports, and regulations on air quality in aircraft cabins.
- Reported on the suitability of component tests for showing regulatory compliance with crashworthiness standards for aircraft.
- Completed evaluation of child restraint systems and initiated proposed regulations for optimum safety.
- Developed fit and comfort standards for aviation oxygen mask systems.
- Assessed operational hazards of in-flight laser exposure.
- Used new DNA probes for determining the existence of post-mortem alcohol in accident fatalities.
- Evaluated the success of automatic external defibrillators and in-flight medical kits used in commercial aviation.
- Developed biodynamic test data on side-facing seats and restraint devices to support rule-making organizations.

FY2001 – New World, New Thinking, New Solutions

HUMAN PERFORMANCE ASSESSMENT

Human Factors Analysis of Commercial and General Aviation Accidents using HFACS

The human factors analysis of all fatal and a random sample of non-fatal general aviation (GA) accidents occurring between 1990 and 1998 has been completed. To date, over 14,000 human causal factors associated with nearly 5,000 GA accidents have been analyzed (2,770 fatal and 2,212 non-fatal accidents) by five independent raters (all were certified flight instructors and GA pilots) using the Human Factors Analysis and Classification System (HFACS). Significant among the findings was the observation that roughly 80 percent of all general aviation accidents are attributed at least in part to skill-based errors, and that many of those are associated with deficiencies in training and other issues of proficiency and currency. In addition, fatal accidents were four times more likely (roughly 40% of all accidents examined) to be associated with violations of the rules, than non-fatal accidents (only 10% of non-fatal accidents examined). An equal percentage of decision errors (roughly 40%) were associated with both fatal and non-fatal accidents examined, while perceptual errors were associated with nearly 10% of the accidents examined. Analysis of the remaining non-fatal GA accidents is ongoing with an early FY02 completion date. Results from this effort have been incorporated into two *Safer Skies* initiatives (Aeronautical Decision Making JSAT and the General Aviation Data Improvement Team). In addition to the GA analysis, researchers under an FAA grant at the University of Illinois have completed the analysis of all FAR Part 121 and 135 accidents occurring between 1990-98

using HFACS and their pilot SMEs. Results from this effort are expected early in FY02.

JANUS

Research and development of JANUS continued in 2001. The JANUS technique is a method to provide more detailed and more exhaustive information about causal factors related to air traffic operational errors than is currently collected. The technique probes the controller's cognitive processes during the event and situates them relative to the immediate environment as well as to more distal organizational processes, which might have shaped the controller's performance. The data is collected via a highly structured diagnostic interview, and the process is parallel to but independent of the existing investigation process.

FAA EUROCONTROL Action Plan 12: Management and Reduction of Human Error in ATM

Scientists from the aviation community participated with the FAA Office of the Chief Scientist and Technical Advisor for Human Factors (AAR-100) in activities to harmonize HFACS and its European counterpart -- two existing techniques for analyzing causal factors in aviation incidents—into a single technique. A series of joint meetings was held to coordinate development of the combined technique. Close coordination was maintained with personnel from AAR-100 and the FAA Air Traffic Office of Investigations (AAT-200) throughout the year in preparation for beta testing of the harmonized model. Plans and schedules were discussed for concurrent beta testing at several FAA facilities and in several European nations. Extensive ongoing coordination with Agency managers and NATCA was completed. The project was also briefed to several groups including national (AAT-20) and regional air traffic quality assurance managers, representatives of the Office of Aviation Safety (ASY-300), regional management teams from Western Pacific and Southwest Regions, National Air Traffic Controllers Association (NATCA) Article 55 Workgroup, ATX-100, Runway Safety Program Managers, Chicago Air Route Traffic Control Center (ARTCC) personnel, and the Great Lakes Regional Runway Safety Workshop. An invited paper covering several FAA initiatives was presented jointly by AAT-200 and CAMI at the 5th EUROCONTROL Human Factors Workshop in Prague. A TIM following the workshop was held to finalize plans for the beta test and was attended by representatives of the FAA and several European member states who would be participating. The FAA's beta test will be conducted by researchers on "go teams" using an automated interface to collect the data. The first version of the interface was completed and demonstrated at the Prague TIM. A computer specialist continued collaboration with EUROCONTROL to facilitate their use of the tool in beta test activities. A paper summarizing the results of Action Plan 12 activities to date was submitted to the Fourth USA/Europe ATM R&D Seminar.

Shift Work and Fatigue and its Effects on Performance Among Air Traffic Controllers

In 2001, we completed data collection from laboratory and field studies of shift work and fatigue in response to the recent Congressional request. The laboratory study was designed to compare the effects on fatigue and performance of a forward rotating versus the typical backward rotating shift schedule used in air traffic control. The field study involved extensive data collection from controllers at two ATC facilities - a large tower in the eastern part of the country and an en route center in the southwest. Results from these investigations were presented at the Annual Scientific Meeting of the Aerospace Medical Association in Reno, Nevada, and during the International Conference on Night and Shiftwork held in Japan. Work has also continued on the development of a multi-media CD for providing information to controllers regarding coping with shiftwork and fatigue in air traffic control. A final review by the ATC management/union team (Article 55 Team) is complete and the CD is ready for production and distribution to all controllers. In addition, the pamphlet describing outcomes from the ATC shiftwork survey has undergone final review by NATCA and management officials and is ready for reproduction and distribution. The Article 55 team supported briefings provided by human factors scientists for AT and NATCA

personnel regarding survey recommendations developed by the scientific work group. Additional analyses of the data have been completed and abstracts for presentations at scientific meetings in FY-02 have been submitted.

Controller Teamwork

Data were collected to assess team communications involving controller interactions across simulated ATC scenarios with multiple traffic levels. Key team communication findings are as follows. First, there were more R-side and D-side communication exchanges under high task load conditions compared with low task load conditions. This finding is consistent with last year's DSAR-1 (Decision Support Automation Research 1) experiment. Second, it appears that task load moderates the relationship between subjective workload, R-side and D-side communications and perceived situational awareness. Under high task load conditions, as perceptions of workload increased, there was a corresponding increase in the frequency of intra-team communications. The data suggested that the increase in communications was used to maintain situational awareness. However, under low task load conditions the above relationships were not observed. The differences between high and low task load (i.e., aircraft density) moderated the interplay between communications, workload, and situational awareness. Third, the Cochran-Weiss-Shanteau index of expert performance was used to evaluate the quality of the subject matter experts used in coding R-side and D-side communication exchanges. The results demonstrated that one of the two coders was superior to the other in the use of the Controller-to-Controller communication and Coordination Typology (C^4T). The value of this finding is that heretofore it was difficult for researchers to determine the quality of expertise contained in the judgment of subject matter experts used in experiments. Meetings have been held to coordinate planned research for FY02.

Air Traffic Control Operational Incidents/Runway Incursions – Booklet

Researchers developed a booklet entitled *Runway Safety: It's Everybody's Business*, explaining to pilots and controllers what they can do to prevent runway incursions and how to work together more effectively. It also identifies situations where extra vigilance is required. The booklet has been distributed by NATCA to tower facilities, and the Airline Pilot's Association and Air Transport Association will distribute it to their safety representatives at member airlines. The booklet is being used in controller training programs in the US and abroad.

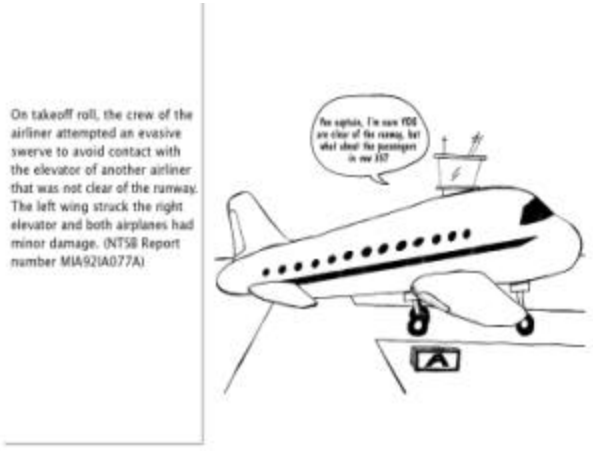


Illustration from *Runway Safety: It's Everybody's Business*

Air Traffic Control Performance Assessment

Researchers are developing a performance measurement tool called POWER (Performance and Objective Workload Evaluation Research). The purpose of the project is to develop a set of measures (numbers) derived from routinely recorded en route ATC data that will be indicative of controller workload and performance. If the measures accurately predict controller workload and performance, they can be used to identify potential negative effects on controllers of using new forms of automation or ATC procedures. Development of an interim set of Performance and Objective Workload Evaluation Research (POWER) measures was completed in FY01 (the set will grow and change over time). Baseline System Analysis Recording (SAR) data from three en route centers were processed to produce output files that are undergoing additional processing using the National Airspace System (NAS) Data

Management System (NDMS) and POWER software. A report describing the analysis of POWER measures derived from these data is currently being prepared. Another report describing the POWER measures was submitted for review, as was a third report describing the relationship between the POWER measures and measures of controller/pilot voice communications. The initial technical report describing a preliminary evaluation of the validity of the POWER measures was published as a technical report

Workforce Performance Optimization

The FAA distributed the Employee Attitude Survey (EAS) to more than 48,000 employees. Results from the more than 24,000 employees who responded to the survey were analyzed and briefings provided to the Administrator's management team. More than 1,000 specialized reports describing the survey outcomes across the FAA lines of business were prepared, placed on a CD and distributed to senior managers. Outcomes are being used by senior FAA managers to develop action plans as a means of furthering efforts to develop a model work environment.

Human Error in Airway Facilities

Researchers are assessing a new AF operations concept, which will help to improve customer satisfaction in managing NAS infrastructure services. The new concept consolidates management and maintenance functions into fewer, more centralized facilities, combined with an increase in remotely monitored, unmanned facilities. As part of this research, a study was conducted to identify potential causal factors of human errors, classify errors by type, and investigate strategies to mitigate the occurrence of errors. The study identified three sources of error: communication and coordination, the introduction of new software or equipment, and procedural errors. It was also found that fatigue related to shift work might be involved in some of the errors that occur.

Tower Cab Metrics

Researchers continued an effort to develop human factors measures for different operational environments in the ATC system. The focus of this work is on human factors measures for the local and ground controllers in the Tower Cab. The result is a proposed battery of objective and subjective candidate measures. In addition, an effort to develop behavioral rating scales for use by subject matter experts to evaluate performance was initiated. Taken as a whole, these measures provide a broad look at performance for researchers to apply in a simulation environment. This allows for conducting experiments to obtain both baseline and comparison measures for assessing the effects of any proposed changes in technology, automation or procedures.

INFORMATION MANAGEMENT AND DISPLAY

Enhanced Vision Security Surveillance Suite

Tower air traffic controllers (ATCs) separate aircraft to expedite the flow of traffic. During poor visibility (e.g., fog) aircraft recovery and departures decrease significantly which results in passenger delays. The purpose of this study was to investigate the feasibility of using electro-optic sensors to enhance tower ATCs visual capabilities during poor atmospheric or low-illumination conditions. In FY01, the FAA participated with the Naval Research Laboratory in collecting low-light

visible and infrared imagery from the roof of the Naval Air Station (NAS) Patuxent River Air Ops building. To validate the collected imagery, a human-in-the-loop analytic model was used to predict an average military observer's visual discrimination of a target on the airport surface and an atmospheric propagation was modeled to determine the effects of various weather conditions on sensor performance. The field data collection and model results found that electro-optic sensors, in particular long-wave infrared, improved operators nighttime detection, recognition, and identification of targets on the airfield surface. It was concluded that actual or potential applications of this research include integrating electro-optic sensors into the ATC tower to improve aircraft movement during poor visibility. In addition, NAS representatives suggested that this system could be used to identify unauthorized personnel entering the airfield. Currently, airport mangers are expending large resources to defend miles of coastline, roadways, and terrain from unauthorized intruders whose intention may be to inflict injury or damage resources on an airport surface. To reduce security manpower costs while improving threat detection for a designated area, a single operator located in a command unit could effectively monitor an area by viewing sensors (thermal, visible, radar, and acoustic) located in the area.

(a)

(b)

Two deer (left center) near the airfield in the (a) visible, (b) long-wave infrared bands were digitally captured at 2330 local time. The deer were not detectable in the visible image, but were clearly detectable in the infrared sensors. The thermal signature of the deer allowed the observers to easily detect small heat emitting objects at far distances much more efficiently than the "naked eye" or visible camera. In fact, the vehicle driver (center right) did not detect the deer even though the deer was 100 yards in front of the vehicle.

AGATE (Advanced General Aviation Transport Experiment)

Assessments of the AGATE "pathway-in-the-sky" display involving both head-down and head-up formats in the AGARS (Advanced General Aviation Research Simulator) were completed. Results were briefed to the certification sponsor and presented at two professional meetings. Data contributed to the development of criteria for the certification of pathway-format displays. The final technical report on guidelines for the design of multi-function displays was delivered for use by one of the AGATE participants (Avidyne) in the design of displays for AGATE aircraft.

Instrument Panel Configurations

Collaboration with the Air Safety Foundation was initiated to assess the effects of vacuum-system / attitude-indicator failures on general aviation pilot performance. FAA scientists completed data collection for two different simulated aircraft and five instrument panel configurations. Results were

briefed to the sponsors and the data were reported at two professional meetings. The airborne portion of data collection, being performed by the Air Safety Foundation, was in progress. Data collection in a Piper Archer was completed and data collection in a Bonanza is under way.

Personal Computer-Based Aviation Training Device (PCATD)

With funding under an FAA grant, researchers at the University of Illinois assessed the effectiveness of general aviation PCATDs for maintaining instrument proficiency. Evidence to support the use of PCATDs for maintaining proficiency was found. Outcomes also suggested that a significant percentage of the pilots who were instrument current could not successfully complete the inflight instrument proficiency check Follow-on research will explore the efficacy of PCATDs and a flight training device for the conduct of proficiency checks.

SafeFlight 21

Support for the SafeFlight 21/Alaska Capstone Project has involved a number of separate activities. A human factors working group was formed under the direction of the Safe Flight 21 Office. The group consists of both FAA personnel and personnel from the Volpe NTSC. The group has met both individually and with personnel from the Capstone Program office in Anchorage, Alaska to discuss research thrusts related to human factors that have been accomplished to date and to plan future research in support of the project. Among the future research efforts is a usability study of the Capstone Phase I avionics, both in an aircraft and in a research simulator. In addition, pilot interviews, observation flights, and training evaluations of Capstone are planned. Researchers are installing Capstone Phase I avionics in their research simulator. The same researchers were also involved in development of an experimental protocol for research being conducted at the Volpe Center regarding Phase I avionics in an aircraft. A meeting will be scheduled to assist in a data collection effort in the Bethel, Alaska region that is designed to gather Phase I avionics usability and performance data from pilots. Researchers were also involved in the development of the request for proposal for the Capstone Phase II contract, and participated in the down-select process for Capstone Phase II avionics.

Scientists continued their support of the SafeFlight 21 Program Office's Ohio Valley and Capstone Projects. As part of Ohio Valley's Operational Evaluation (OpEval) of Automatic Dependent Surveillance Broadcast (ADS-B) and Cockpit Display of Traffic Information (CDTI) applications, a researcher served as a member of the Human Factors Team and participated in meeting of the Operational Coordination Group for the second of three evaluations (OCG). In addition to evaluating air traffic control and pilot voice communication from OpEval-2, support was provided to the group involved in writing and editing the final report. Researchers are also involved in Capstone activities currently taking place in Bethel and Anchorage Alaska.

Display Concepts for En Route ATC

Previous FAA research explored factors that describe the complexity facing a controller. Based on this research, new technologies and procedures have been developed that may aid the controller and reduce complexity in ATC. Most of these technologies were designed to reduce ATC complexity associated with air traffic density, identification and resolution of conflict situations, and the operational efficiency of the human-computer interface. A new study was designed to explore and prototype new display enhancements that may further reduce complexity in ATC. Four complexity factors were identified in a pilot study as suitable for a graphical enhancement: weather effects on airspace structure, the effects of active Special Use Airspace, the amount of transitioning aircraft, and the reliability of radio and radar coverage. To evaluate the usability of display enhancements and their possible impact on ATC complexity, a user evaluation was conducted at Jacksonville ARTCC. The prototype was shown to controllers and data was collected on acceptability of the display enhancements together with ratings on the degree to which the enhancements would reduce complexity. For each of the four complexity factors, controllers also explained actions they have to take when confronted with each factor, how frequently each factor adds

difficulty to controlling traffic, and to what extent each factors impacts the job. Results showed that controllers favor the proposed display enhancements and predict a substantial reduction in job complexity from these enhancements.

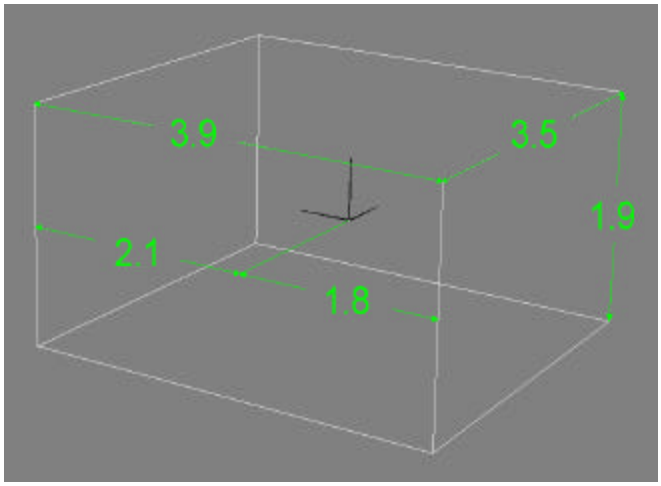
Symbol Standardization for AF

Researchers cataloged symbols displayed with the various interfaces used by AF specialists. The report includes a high-level overview of each system and the symbols and coding conventions used by each system. It also contains observational information from several AF sites. Researchers used the information from the Human Factors Design Guide, International Organization for Standardization standards, and other sources to provide recommendations for visual symbols. They also compared symbols in the document to the recommendations, taking into consideration the observed environmental conditions. This document provides a first step toward symbol standardization in AF.

Head-up Display Certification Guidelines

Research was completed with regard to applicable certification guidelines for head-up displays. For given head-up display (HUD) optics and symbology placement, the Cockpit Head Motion Box (CHMB) can be defined as a fixed volume of space in which the pilot's head must remain for all flight critical symbology to be visible to at least one eye. For certification purposes, the volume should be large enough to accommodate most of the natural head motion that pilots exhibit when attempting to look through the HUD. The research determined the range of this head motion by unobtrusively measuring the head motion of eight pilots flying two aircraft, one representing general aviation and another representing transports.

Infrared head motion measuring device (the white box on the glare shield) installed in a light twin airplane.



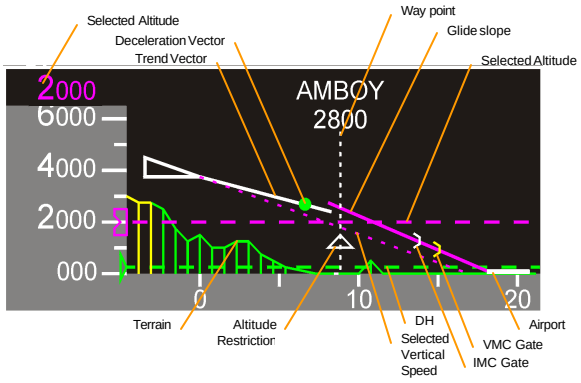
Recommended Cockpit Head Motion Box for certification of head-up displays for civil aircraft

As much as feasible, flight was conducted in turbulent conditions to capture its effect on head motion. Range of head motion was observed to be consistent within a pilot, varying little across each phase of flight. Based on the collected data, a recommended minimal CHMB was derived by

determining the volume that would comprise about 90% of the pilot head motion for about 90% of the pilots. The initial values were then adjusted so that both eyes of the vast majority of pilots would remain in the CHMB most of the time. The recommendations are as follows: for HUD use in any flight phase, the lateral dimension should be at least 3.5 inches centered on the cockpit design eye position (DEP), and the vertical dimension should be at least 1.9 inches centered on the DEP. For the longitudinal dimension, the forward face (as the pilot sits) of the CHMB should be at least 2.1 inches from the DEP and the rear face should be at least 1.8 inches for a total length of 3.9 inches. These measurements are relative to the plane of the floor of the cockpit.

Profile Situation Awareness Displays (PSAD)

Human factors researchers completed a literature and industry review of profile situation awareness displays, presenting the results to FAA certification officials. A PSAD is a new two-dimensional display that graphically represents the strategic flight environment around an aircraft along the longitudinal and vertical dimensions. A PSAD's purpose is to enhance the pilot's situation awareness in the vertical dimension much as plan-view moving map displays do for the lateral dimension.



Conception of Boeing's profile situation awareness display.

Boeing, Airbus, Honeywell, Collins, and other manufacturers, along with various university laboratories are developing prototypes of these displays, and the FAA requires background information to develop the appropriate technical standards. The review found that various forms of PSADs have been designed specifically to improve awareness of spatial position, stability, aircraft energy, flight automation mode and path, terrain, weather, and traffic. Based on their separate research and development efforts, designers of PSAD are converging on a number of design features including display position, ratio of the vertical scale to the horizontal scale, swath characteristics, and dynamics of the aircraft symbol. The review also found some unresolved human factors issues including effects of omitting terrain, compatibility of weather and traffic display with other features, integration with other information sources used by the pilot, and requirements for displaying flight paths with turns.

Electronic Flight Bag

An Electronic Flight Bag (EFB) is an electronic information management device for use by pilots in performing flight tasks. An EFB could support activities such as management of electronic documents, electronic checklists, flight performance calculations, electronic charts, and other real-time functions such as display of weather, traffic, or flight planning information. More recently, functions, such as cabin video surveillance and display of surface moving maps, have been identified for EFBs.

A Northstar CT-1000, showing an electronic chart application.

A portable tablet computer used in the cockpit for performance calculations.

In FY01, the Flight Deck Human Factors Program facilitated development of FAA advisory material for evaluation and operational approval of EFBs. Researchers produced a draft of Version 2 of a document entitled "Human Factors Considerations for the Design and Evaluation of Electronic Flight Bags: Basic and Advanced Systems." As part of this effort, scientists validated the guidance in the September 2000 Version 1 of the document against industry EFBs. The draft Version 2 document also incorporated industry feedback from the Air Transport Association's Digital Data Working Group (ATA DDWG) and included new material on electronic charts. Materials from this document were incorporated into and referenced by the draft Advisory Circular on EFBs (AC 120-EFB), which was released for public comment late in August 2001. That document is currently undergoing final review internal to the FAA.

ATC Integration

Researchers completed an overview of integration issues for TRACON and En Route ARTCC and Oceanic. The research focused on the following areas: (1) Are the subsystems integrated sufficiently to support optimal system effectiveness; (2) Is information from different sources consistent; (3) Are controls and function operations consistent (same functions should have the same name, same method of operation, and use the same unit of measurement across subsystems); (4) How does use of the subsystem affect the controller's task (workload, roles and responsibilities, etc.). The research identified examples of human factors integration issues such as: (1) Are solutions generated by the automated decision support tools provided to TRACON, tower and ARTCC controllers compatible, and (2) How could the use of subsystems affect the roles and responsibilities of controllers and pilots.

Flight Symbology

In 2000, the Flight Deck Human Factors Program supported a short-term rapid-response request from the FAA to conduct a study comparing the United States fly-over and fly-by waypoint symbols with those of the International Civil Aviation Organization (ICAO) (Report No. DOT-VNTSC-FAA-00-23). At issue were the international standards for the depiction of these symbols. The symbols in use by the United States and the International Civil Aviation Organization (ICAO) are currently in conflict. Because fly-over waypoints are often used to ensure obstruction clearance, it is critical for safety of flight that the symbols are unambiguous and salient to pilots. Volpe NTSC researchers collected limited data in a paper and pencil study. The FAA representative presented results of the study to ICAO. The results supported a change to the ICAO standard fly-over symbol. As of January 2002, ICAO has supported the OCP compromise, but is awaiting responses from its individual member states as to whether they will choose to comply with the standard, or differ from it.

	US	***ICAO***	***Tested***	***OCP***
Fly-Over Waypoint				
Fly-By Waypoint				

Human Factors Design Guide

The Human Factors Design Guide for Acquisition of Commercial Off-the-Shelf Subsystems, Non-Developmental Items, and Developmental Systems (HFDG) is an exhaustive compilation of human factors practices and principles integral to the

procurement, design, development, and testing of FAA systems, facilities and equipment. Updates of the HFDG incorporate review comments collected from experts. The HFDG covers a broad range of human factors topics that pertain to automation, human interfaces, workplace design, maintenance documentation, system security, safety, the environment, and anthropometry. The report contains an updated and expanded version of the Automation Chapter (Chapter 5) and the Human-Computer Interface Chapter (Chapter 8). A research team evaluated the existing guidelines for relevance, clarity and usability. They drafted new guidelines and reorganized the document for clarity. This resulted in extensive changes including more than 100 new guidelines and 126 new sources in Chapter 5, and 500 new guidelines and 22 new sources in Chapter 8.

HUMAN CENTERED AUTOMATION

Flight Strip Reduction

Scientists from the FAA and the University of Oklahoma teamed with a group of subject matter experts (SMEs) to continue research to assess en route controllers' usage of paper flight progress strips. The team collected additional data from two en route centers during FY01. Results were briefed to senior FAA managers in the Free Flight Office, ATC managers, and personnel at the involved facilities. This research prepares for the NAS Architecture Version 4.0 where it is anticipated that paper strips will be replaced by electronic flight objects.

Air Traffic Control Advanced Research Simulator (ATCARS)

While additional features will be added to expand the capabilities of ATCARS, the basic simulation capability is now available for development of the first study. The contractor has delivered the basic simulation prototype. Human factors personnel have worked with ATC specialists from the FAA Academy to identify any remaining problems in how information is presented on the displays. Final modifications to fine-tune the system are underway. A simulation scenario that will be used to collect data from controllers has been designed and is planned for FY02.

NAS Infrastructure Management System Build 1.5 CHI

Results of the evaluation of the NAS Infrastructure Management System (NIMS) Build 1.5 CHI software were reported in 2001. The goal of the evaluation was to identify CHI issues prior to completing software development. The results of the evaluation identified four major issues that would improve functionality: integrating the three software components, providing the correct information needed to support task performance, handling error messages and error management, and providing proper and sufficient feedback regarding user and system actions. Participants indicated that NIMS Build 1.5 was not capable of providing this support in an operational environment; however, if these issues are addressed, a future build could support a centralized monitoring and control facility. They also concluded that most of the issues could be mitigated through application of human factors principles.

Field Survey of ATC Specialist Decision-Making and Strategic Planning

Increased levels of automation in ATC facilities are identified in the Air Traffic Concept of Operations for 2005 and the NAS Architecture Version 4 to accommodate the growth in the number of flights projected over the next decades. Automation efforts will focus on development of decision aids for conflict resolution and for maintaining separation. Human factors researchers conducted semi-structured interviews with ATC specialists to examine their perspective on controller decision-making and planning and related cognitive processes such as learning, memory, and situation awareness. The ATC specialists described decision-making and planning strategies including back-up plans, use of buffer zones, coordination and teamwork regarding plans, and various levels of situation awareness. The results may guide designers of decision support systems and help match tools with user's perceived needs and facilitate user acceptance.

SELECTION AND TRAINING

Air Traffic Controller Selection

Results from the concurrent validation of the new computerized test for selecting air traffic controllers (AT-SAT) were briefed to ATC and Human Resources management in planning for operational implementation of the test. A two-volume technical report describing the validation effort was published. Scientists worked with personnel from AHR and a contractor to develop the best strategy for mitigating the adverse impact from the test. An assessment of AT-SAT by an independent scientific group was completed and a report was prepared. High marks were given for the approach used in the validation and overall outcomes. While it was recognized that there was potential adverse impact, the reviewers indicated that the test was in compliance with appropriate government and professional guidelines. It is anticipated that a decision regarding the operational implementation of AT-SAT will be made in FY02.

Airway Facilities Centralized Applicant Pool System (AFCAPS)

As part of the FAA Selections Within Faster Time (SWIFT), AFCAPS was developed by CAMI scientists and implemented in the fourth quarter of FY96. AFCAPS provides a standardized, automated process of evaluating applications for positions in the FAA's technical electronics maintenance and systems management workforce. An evaluation of the fairness of the AFCAPS rating and ranking process was completed in FY01. Results of the evaluation indicate that there is no adverse impact against protected classes. The modular nature of the systems allows it to adapt to changing occupational requirements. The implementation of this process has reduced the time required to process applications and provides for a more consistent process across regions.

Airway Facilities Systems Specialist Job Task Analysis

Occupational workforce planning requires the establishment of a baseline to compare future requirements and identify potential gaps between the current skills of the workforce and future requirements. To support occupational workforce planning in Airway Facilities, CAMI awarded a contract to conduct a baseline, selection-oriented job/task analysis (JTA) for the Airways Transportation Systems Specialist (ATSS; FG-2101) occupation in the AF field maintenance workforce in FY2001. This contract will result in a baseline description of the work performed by field specialists and the knowledge, skills, and abilities required. This baseline description will be captured in a modern database, as the first step toward developing a job analysis data repository for ATS. The work was awarded to an 8(a) minority-owned enterprise, with the American Institutes for Research under sub-contract. The work will be completed in three phases over approximately 2 years: (a) Phase I - develop job task/duty and KSA lists iteratively through a series of five subject matter expert panels (four panels of incumbents, one HQ management review panel); (b) Phase II - based on the products of Phase I, design and administer a job/task analysis survey to all incumbent FG-2101s in the AF field maintenance workforce (n = about 5,700), analyze data, and identify critical and/or important clusters of tasks/duties and KSAs; (c) Phase III - identify linkages between critical and/or important task/duty clusters and KSA clusters iteratively through a series of five SME panel workshops (four incumbent panels, one HQ review panel), write and deliver a job/task analysis report, and deliver a job analysis database for the FG-2101 occupation. As of the end of FY2001, three of the four field SME panels had been completed, with the remaining work in Phase I to be completed in FY02. The survey in Phase II will be distributed to all incumbent FG-2101s in the AF field maintenance workforce in the mid- to late-spring 2002 timeframe. Phase II work will begin in mid- to late-summer of 2002, with completion expected by the end of FY02.

Realistic Radio Communications Simulation Requirements

Today's airline environment requires that training and evaluation simulations present airline pilots with realistic scenarios requiring both cognitive and technical skills. Although literature and

experts agree on the importance of realistic radio communications from Air Traffic Control (ATC) and company during training and evaluation, radio communications are typically simulated by the instructors/evaluators who are already busy with other tasks. This impoverishes the fidelity of radio communications and potentially jeopardizes the validity of simulator checks and training by reducing pilot workload, relevance of world outside the cockpit, and equivalence of workload across crews. This hypothesis was bolstered by a review of the Aviation Safety Reporting System (ASRS) incident reports on Initial Operating Experience (IOE), which indicates that not only does training continue during IOE, but also up to 87 percent of these reports involve radio communications as a contributing factor. This work has been published in conference proceedings, a government report, and an Air Traffic Control Quarterly article.

The lack of realistic radio communications is presumably due to the fact that airlines deem the provision of communications by separate ATC impersonators as too costly, given the lack of conclusive evidence for its benefit. Another factor is the state of the art of the technology to simulate ATC/company and communications from other aircraft automatically, although there have been promising attempts by airlines and industry as well as progress in intelligent systems and automated speech generation/recognition. Researchers are investigating the requirement for Realistic Radio Communications and fostering collaboration between regulators, the airline industry, pilot organizations, ATC organizations, and the simulator and supporting industries to promote the development of automated RRS. One such effort is participation in the International Air Traffic Association's initiative to specify a desirable system.

A typical training situation with the instructor/evaluator simultaneously managing the simulator systems, observing the flight crew, and simulating radio communications. Note the absence of headsets. Radio communications contributed to as many as 87% of ASRS reports on Initial Operating Experience, and were the primary factor in 72% of events prompting a report.

CAPT Survey

Exploring Pilot Experiences with/and Perceptions of AQP

The Commercial Airline Pilot Training (*CAPT*) Survey was administered to 30,732 airline pilots, from 24 different airlines, to collect information on pilots' experiences in and perceptions of CFR 14 Part 121 and Advanced Qualification Program (AQP) training. This survey was the largest training survey ever conducted in aviation. Pilots were asked to report the extent to which they found their training useful, the extent to which they liked different aspects of their training, and their opinions about different training issues, such as the importance of integrating Crew Resource Management (CRM) throughout training. Over 11,700 pilots responded to the survey, yielding just over 10,000 usable responses that were found to be highly representative of the pilot population. Overall, the results suggested that pilots, regardless of which program they are trained under, like their training and find it extremely useful. When comparing AQP to Part 121, pilots trained under AQP tended to rate their training as more

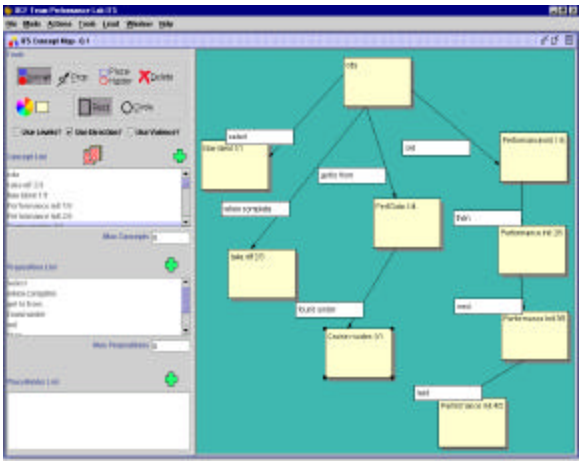
enjoyable and more useful. Meaningful differences were found for a number of survey items that spanned several important components of pilot training. Examining the results in more detail revealed that this difference was, in part, attributable to the fact that the AQP was perceived to be more line-oriented than Part 121. This finding is not too surprising given distinct differences between AQP and Part 121.

- *AQP requires that training be conducted in a full cockpit crew environment.*
- *AQP requires the integration of CRM concepts throughout the pilot training curriculum.*
- *AQP requires pilots to demonstrate proficiency on technical and CRM skills in line operational evaluation (LOE) scenarios prior to certification.*

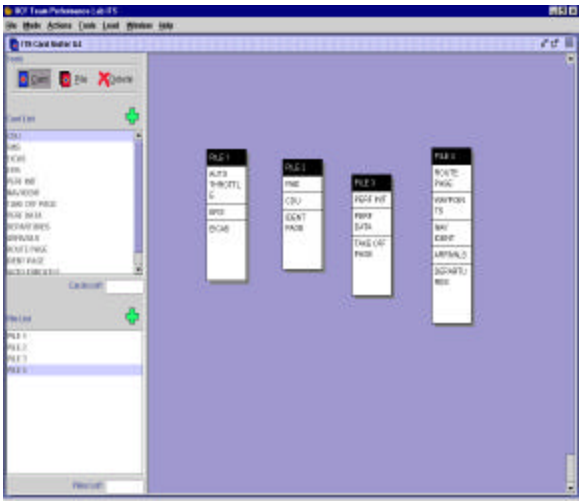
What is surprising, or at least was unknown prior to this survey, was the extent to which pilots would value this shift to more line-oriented training. The results from the *CAPT Survey* indicated that this is in fact the case.

Knowledge Assessment Tool

With funding under an FAA research grant, researchers have created a new software tool for assessing knowledge structures and mental models necessary for the operation of automated aircraft. This tool, referred to as the Team Performance Lab Knowledge Assessment Tool Set (TPL-KATS), has the capability of performing computerized versions of both Card Sort and Concept Map techniques, two common knowledge elicitation methods. These procedures can assist in the evaluation of automation training among pilots. In addition to the automated administration of these techniques, scoring functions also exist within the software. This will help to streamline the process of eliciting and assessing mental models of aviation automation training, saving time and energy while reducing the error associated with these assessments. Research is being conducted with the cooperation of several airlines involving the capabilities of the TPL-KATS to evaluate pilots' knowledge of automation. Currently investigations are underway that compare reliability and validity of computerized administrations versus more traditional manual assessments.



TPL-KATS Concept Map Technique



TPL-KATS Card Sort Technique

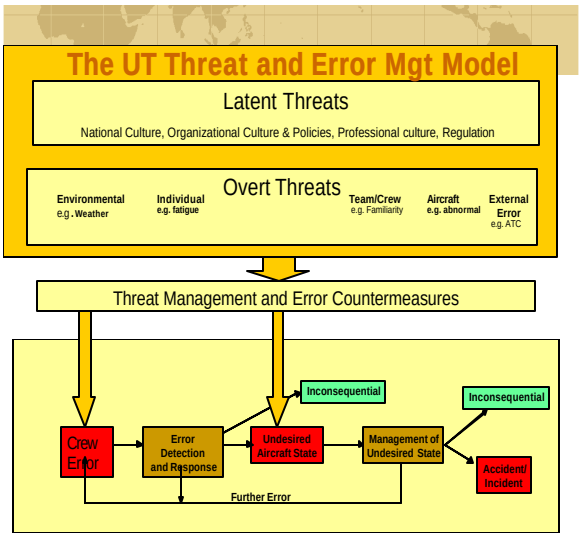
Line Operations Safety Audit (LOSA) and ASAP Incident Analysis

Under an FAA research grant, LOSA was developed in 1992 by the University of Texas as a systematic methodology using pilots to primarily assess Crew Resource Management (CRM) performance during normal flight operations. In the late 1990s, the methodology was changed to focus on identification of the threats and errors

(both internal and external to the crew) in the flight environment and how they are managed. In this context, CRM skills are viewed as threat and error countermeasures and management tools. LOSA audits using the new methodology have been conducted at major and regional airlines in the U.S. and around the world. One of the great strengths of LOSA is that it identifies superior as well as normative and substandard performance. Its attractiveness to airlines is that it is a data based program that provides information about normal operations, not training or check environments, which do not accurately reflect the way the crews actually fly the airplanes. Data from LOSA audits conducted in FY2001 allow *proactive* safety training interventions to be devised, rather than post-hoc responses such as would be derived from incident analysis. Many airlines have used LOSA data to devise new training programs and to refine procedures.

The list of carriers who would like researchers to conduct LOSA is growing rapidly each year and includes U.S. and foreign carriers. The international acceptance of LOSA has been stimulated by ICAO's adoption of LOSA as the number one human factors priority for the next five years. IATA has also endorsed LOSA as a safety initiative. In addition, pilots' organizations in the US and internationally are strongly supportive.

LOSA is based conceptually on a Threat and Error Management Model (TEMM), which was derived empirically from LOSA data. Unlike other error models, TEMM examines threats and errors encountered, and the crew's management of them, along with any undesired aircraft states that may be caused by their mismanagement. The second major initiative of the group is the enhancement of ASAP. The group was asked by several airlines to develop a more structured framework of factors contributing to aviation incidents to enhance the commonly used narrative descriptions. This pilot self-report strategy is now going on-line as a web-based program at Continental Airlines. The researcher's role will be development of analytic strategies and fitting them within the framework of the TEMM. The TEMM guides the data collected and the analytic strategy for data collected in such diverse environments as normal line operations (LOSA), incidents (ASAP), and accidents.



Threat and Error Management Model

Rapidly Reconfigurable LOE Scenario Generation Software

The Rapidly Reconfigurable Line Oriented Evaluations (RRLOE) scenario generation software was developed by the University of Central Florida under an FAA research grant. This tool allows airlines to reduce significantly the time and cost of creating scenarios for flight simulations. Once the software is seeded, a developer can generate a flight simulation scenario in minutes using the tool, rather than in the days or weeks it previously took to develop and script a scenario. In addition, the RRLOE tool improves the linkage between training objectives and evaluation scenarios, thereby increasing the validity of training and evaluation. The software was released in the Spring of 2000. Currently , over 50 individuals at over 35 airlines, training organizations, and at the FAA are part of the user network for the RRLOE software.

Human factors researchers continue to update the software, including improvements and additions. RRLOE Version 1.3 is now employable worldwide with expanded navigation functions and navigation databases. RRLOE 1.3 is also customizable to a much greater degree than previous versions. For example, RRLOE 1.3 allows users to specify less than the standard eight event phases, and it gives users the option of calculating difficulty sums

rather than averages. Finally, RRLOE 1.3 has a number of features that facilitate the sharing of data across fleets. For example, users can now copy routes from one aircraft type to another, an operation that was previously impossible. Researchers have also created event sets for automation training that can be used in the RRLOE software. Each event set targets a specific set of automation knowledge and skills and was developed in accordance with the procedure outlined above. The eight event sets are:

1. Rejected Take-Off (RTO)
2. IRS Failure after Level-Off in Climb
3. Using ROSE Mode on the Navigation Display
4. Waypoints and In-Flight Diversions
5. VNAV: Making a Crossing Restriction
6. Holding on Arrival
7. Setup for an Automatic Landing
8. Rejected (Auto-) Landing

The event sets described above, although shown in the base RRLOE version for either the Boeing B757/767 or the Fokker F-100 aircraft, are generalizable across automated aircraft. That is, by merely changing the visual stimuli to match the current aircraft, these event sets can be used across a wide range of aircraft.

RRLOE Software CD-ROM

Simulator Motion Requirements

One of the major cost drivers in simulator acquisition and maintenance is the motion system, which is required for higher-level simulators used for total training and evaluation. A preliminary review of simulator requirements, however, found that research results with regard to the effectiveness of motion are inconclusive. A first study aimed at testing the effect of typical motion on sensitive tasks did not find an operationally significant effect on the performance and control behavior of commuter airline pilots for recurrent evaluation, course of training, or transfer of training. The results of this study were presented at forums, such as the Royal Aeronautical Society, American Institute of Aeronautics and Astronautics, International Symposium on Aviation Psychology. Follow-up research is currently under way. As a consequence of the national and international interest gathered by this work, NASA Ames Research Center is collaborating in this study and providing half of the funding for the experiment cost.

BIOAERONAUTICS

Cabin Evacuation Study (Type III) Over-wing Exit)

The largest aircraft cabin evacuation study ever conducted was completed in July 2001. The study evaluated aircraft design and human factors affecting passenger egress through Type III (over-wing) emergency exits in transport aircraft. A total of 2,544 research subjects evacuated the FAA's Aircraft Cabin Evacuation Facility in various conditions of passageway configuration, exit hatch removal and disposal technique, research subject density in the cabin, and subject motivation level. The results of the study are to be used initially by the Cabin Safety Harmonization Working Group of the FAA's Aviation Rulemaking Advisory Committee to support efforts by the FAA and JAA to establish a standardized Type-III exit passageway configuration for both the US and Europe. Overall, the study identified human factors (passenger (passenger size, age, and gender) as the most important factors in aircraft evacuation rates.

Research subjects exiting a Type III (Over-wing) exit from the CAMI Aircraft Evacuation Research Facility.

Altitude Study of Continuous Flow Oxygen Masks

An altitude research study evaluating the physiological protection provided by three different types of continuous flow oxygen masks used with portable oxygen bottles for flight attendants was completed. Continuous flow oxygen masks with re-breather bags or phase dilution valves provide for longer duration use of an oxygen supply; thus, these two masks were tested against the standard "Dixie Cup" style passenger oxygen mask. Test subjects evaluated the masks at a simulated cabin altitude of 25,000 feet in a research altitude chamber. All three mask types were found to provide adequate physiological protection at 25,000 ft. The information developed from this study assists FAA aircraft system certification and supports flying safety.

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Altitude chamber test subject in the CAMI altitude research chamber using a re-breather type continuous flow oxygen mask

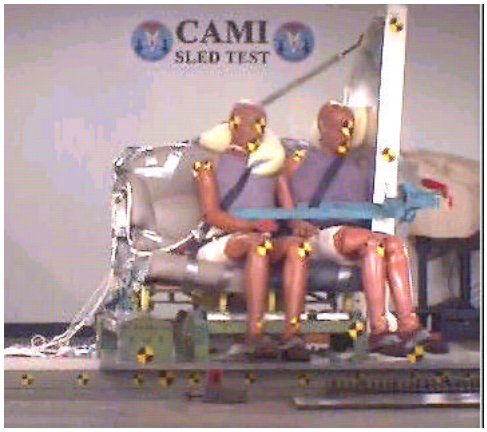
747 Aircraft Environmental Research Facility (AERF)

The 747AERF was completed and is in service supporting a variety of safety, security, training and testing functions and programs. While mentioning all of the programs that the 747AERF has been tasked to participate would be lengthy, it should be said that the simulator has been used for projects in support of the FAA in new runway visual ranging technology, Air Force One security, and chemical/biological air flow studies. NASA is currently using the device to complete a study involving the mitigation of airline turbulence injuries. The simulator has been used to support local and federal law enforcement training such as anti-terrorism, and special weapons and tactics (SWAT) team training. Fire and ARFF training has been conducted to include hose-down interior operations.

The CAMI 747 Aircraft Environment Research Facility

Crash injury protection for aircraft seats and restraint systems.

Research was conducted in support the agency's goals to enhance safety and reduce the likelihood of serious injury from civil aviation accidents. The FAA's Biodynamics Research Team performed impact tests of new concepts for child restraints in transport airplanes and air bag restraints for side facing sofas in executive airplanes. The findings from these programs provide the scientific and technical basis for ongoing regulatory development, enforcement, and policy activities by the FAA Certification Service.



Side facing seat impact sled test photos showing pre-impact and impact sequences. Test evaluated the effectiveness of a developmental airbag neck restraint system

Human Factors Associated with the Use and Access to Safety Devices on Transport Passenger Seats.

Research studies were conducted which focused on ergonomic and performance factors associated with passenger lap belts and under-seat life preservers. Human subjects were used to measure lap belt adjustment, tensioning, and release characteristics. Tests were also performed to assess human performance factors associated with retrieval of passenger life preservers. The effects of seat-to-seat installation geometry and life preserver stowage locations under the seat pan were measured in this program. Data gathered from this study assisted FAA aircraft certification to develop requirements for placement of the life preserver.

Test sequence showing a young, slim female test subject reaching under an airline passenger seat to retrieve the passenger life preserver.

Photograph of a test sequence showing that a large male subject was unable to reach under the seat to access the life preserver.

Review of Automatic External Defibrillator Use in Aircraft

A final FAA rule required Automated External Defibrillators (AED) and some additional items in the Emergency Medical Kit was passed on April 12, 2001, less than 3 years after the Aviation Medical Assistance Act was passed by Congress on April 24, 1998. As required by the Act, the FAA included a summary of the findings from a year of data collection on the actual in-flight use of

the AEDs. This year of data collection confirmed that passenger lives were saved by the use of the defibrillators. A more detailed analysis of the data was completed during CY 2001 to further define the use and effectiveness of the AEDs. Aeromedical evaluation of in the nature of in-flight medical emergencies and the use of defibrillators on commercial flights will be maintained as an ongoing initiative.

First passenger saved by the use of AEDs and the Flight Attendant who used the AED.

Epidemiological assessment of biochemical and toxicological factors from fatal accidents

The FAA's toxicology research laboratory conducted state-of-the-art toxicological analyses on postmortem samples from pilots/copilots involved in 95% of all fatal aviation accidents occurring nationwide. This research led to a completed epidemiology study of data collected from fatal aviation accidents occurring between 1994 and 1998 and published study in the peer reviewed literature: "Prevalence of Drugs and Alcohol in Fatal Civil Aviation Accidents Between 1994 and 1998," Aviation Space Environment Medicine 2001; 72:120-124. This research supported findings of a very low incidence rate found in the FAA random drug-testing program. Additionally, the CAMI biochemical/ toxicology research program developed publications identifying "Blood Carbon Monoxide and Hydrogen Cyanide Concentrations in the Fatalities of Fire and Non-Fire Associated Civil Aviation Accidents," (Forensic Science International, Vol. 121, No. 3, Oct 2001, 183-188) and a paper entitled, "Abnormal Glucose Levels found in Transportation Accidents," published in Aviation Space Environment Medicine 2001; 72:813-815

NIOSH cabin environment study

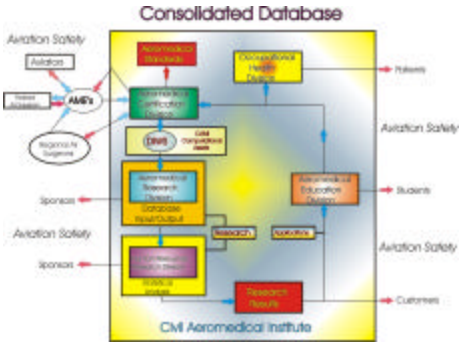
The aviation medicine research program continued to support the 5-year National Institute for Occupational Safety and Health cabin environment study ordered by Congress. Portions of the study completed in CY 2001 included a questionnaire survey of flight attendants and a cohort group of schoolteachers. Of the 8,388 women in the target study population, 2553 (30%) successfully completed a 2-hour telephone interview. NIOSH employees are still requesting medical records from the survey participants to confirm medical events that were reported during the interview, and work was begun in July 2001 to define exposure variables based on the detailed flight histories that were reported. Additionally, a contract to gather cabin airflow data was awarded in October 2001. The data will serve to characterize the cabin airflow and will be used to validate results from a computational fluid dynamics model. Experimental work will begin in FY 2002 to evaluate aircraft cabin airflow using a variety of techniques in cabin mock-ups. These include conducting the adapted tracer gas tests to measure the age of air in aircraft that are on the ground with their ventilation systems operating. The results of the biological literature and methods survey have also been used to formulate a sampling plan for bioaerosols on commercial aircraft.

CARI-6 computer program (solar particle events)

The CARI-6 is an interactive version of the computer program CARI-6. The program allows the user to estimate the dose of galactic cosmic radiation received on an aircraft flight. In addition, feasibility has been established of developing a system to warn of the onset of an explosive emission of energetic particles from the sun and advise that aircraft at high altitudes to descend to lower altitude to reduce radiation exposure of air travelers.

Aviation Accident Medical Database

Aerospace medical research into the causes of air and space vehicle accidents requires an integration of several currently existing, sand-alone databases, including the airman's medical history. The integration of this information into a data warehouse system (Aerospace Accident Medical Database (AAMD) that can be rapidly interrogated and that will present statistical, user-friendly, decision-making information is essential in the modern certification and regulation environment. The development of the AAMD warehouse will proceed in specific phases based on the development of system software/hardware to accommodate each of the currently separate databases. Recent progress on the Aeromedical Research Division's AAMD warehouse includes the development of the Phase I prototype that encompasses the Aeromedical Certification's DIWS data. Also completed is the Phase II prototype that adds the FAA's Accident Incident Data System (AIDS) and the National Transportation Safety Board (NTSB) database. Final refinements and user training sessions have been performed for the Phase I and II prototypes. The Aeromedical Research Division is currently defining requirements for the Phase III prototype that includes the Aircraft Accident Research Autopsy, Incapacitation, and Special Medical Circumstances databases and the Toxicology and AMEIS databases.



The consolidated warehouse system for the (AAMD) Aviation Accident Medical Database that provides a unique ability to integrate medical data with accident information.

Moving forward ..... 2002 and beyond

LONG-RANGE VIEW

The FAA has accepted national responsibility to initiate and maintain research and development programs that support modernization, regulation, certification, and NAS issues, and, with equal importance, national responsibility to initiate research which is proactive in identifying emerging safety trends. The Human Factors investment strategy directly supports proactive research efforts to identify and reduce targeted safety issues.

Research programs will be directed at targets that will have the greatest impact on aviation safety, and will require stabilized resources to plan, execute, and complete multi-year efforts. Successful implementation of research outputs will require full partnerships and close cooperation within FAA organizations and the aviation community.

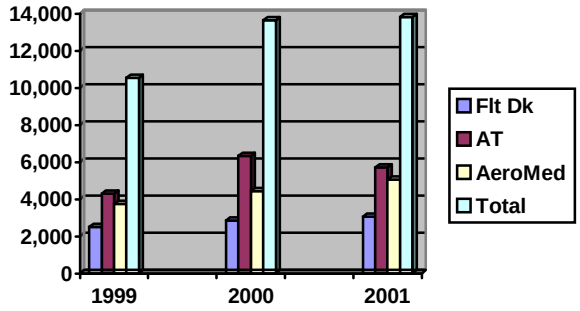
Research strategies will focus on technology, partnerships, and measurements. For example, methods will be developed to identify interventions to address human performance issues in aviation maintenance and air traffic operations. With regard to partnership strategies, research plans will be developed with NASA, addressing long-range, high pay-off priorities. Measurement strategies will be developed to monitor trends and identify opportunities for research to mitigate risks.

Public and congressional interest in the maintenance of a healthy and comfortable environment for each category of civil aviation's participants is not abating. The interagency agreement between FAA and NIOSH initiated in FY97 addresses this issue through research on infectious disease and other health considerations in the aircraft cabin environment.

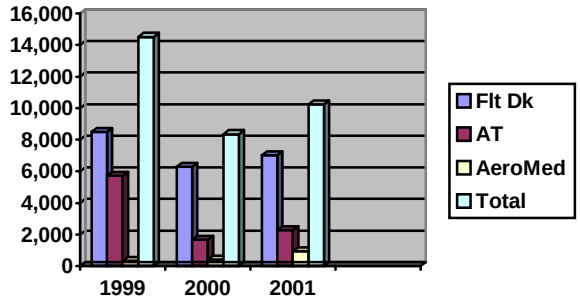
The Aviation Medicine program will continue to emphasize the mitigation of accidents and reduction in the severity of injuries encountered in such precautionary events as evacuation of passengers from an aircraft after recognition of a safety concern by the flight crew. Through this approach, the program will remain a critical component of FAA efforts to meet its safety and survivability goals.

Additionally, in concert with the targets expressed in Challenge 2000 and with FAA's broad commitments to harmonize safety regulations on a global scale, the Aviation Medicine Program will focus its collaborative interactions with domestic and international laboratories to generate research data. This information will be used in the development of internationally harmonized aviation standards and regulations. Aeromedical research will be increasingly necessary to interpret data derived from around the world, and to assess whether the data are appropriate or require additional investigation prior to use in regulatory or other actions.

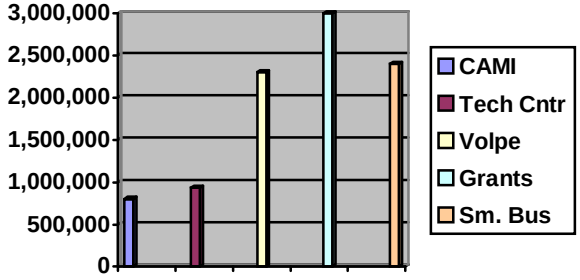
ANNEX 1 – FINANCIAL HIGHLIGHTS



HISTORICAL – IN-HOUSE FUNDING



HISTORICAL – CONTRACT FUNDING



FY01 SPENDING

Annex 2 – FY2004 Planning Document

(Draft)

Budget Item	Program Title	Budget Request
A08a	**Flightdeck/Maintenance/ System Integration Human Factors**	**$10,457,000**

GOALS:

Intended Outcomes: The FAA intends to improve air transportation safety by:

- Developing more effective methods for aircrew, inspector, and maintenance technician training.
- Enhancing the understanding and application of error management strategies in flight and maintenance operations.
- Increasing human factors considerations in certification of new aircraft and equipment design and modification.
- Improving aircrew, inspector, and maintenance technician task performance.

Agency Outputs: The FAA is concerned with ensuring the safety and efficiency of operator performance through guidelines, handbooks, advisory circulars, rules, and regulations. It provides industry with human performance information and guidance critical to the design, operation, regulation, and certification of equipment, training, and procedures. With this in mind, the Human Factors Program conducts and manages research that provides the technical information necessary to generate these products and services.

Customer/Stakeholder Involvement: The Human Factors Program directly supports a number of aviation community initiatives:

- *FAA Strategic Plan Mission Goal for Safety*. By FY 2007, reduce U.S. aviation fatal accident rates by 80% from 1996 levels.
- ARA FY 2002 Performance Plan:
  - Goal 1. Contribute to the FAA goal to reduce the fatal aviation accident 80% by FY 2007 as compared to 1994 -1995 baseline rate.
- The FAA/Industry *Safer Skies* initiative, which will use the latest technology to help analyze U.S. and global data to find the root causes of accidents and determine the best actions to break the chain of events that lead to accidents.
- The *National Plan for Civil Aviation Human Factors: An Initiative for Research and Application* published in March 1995, with FAA, NASA, and DOD as signatories. This document, which had extensive aviation community participation in its development, outlines a coherent national agenda for human factors research and application leading to significant improvements in NAS safety and efficiency. The Flight Deck, Maintenance, System Integration Human Factors research program is developed around research thrust areas identified in the National Plan:
  - Information Management and Display - Determine what, when, and how to best display information through the computer-human interface; design the system to reduce the frequency of information transfer errors; and minimize the impact when such errors do occur. Display designs are optimized to reduce information overload.
  - Human-Centered Automation - Keep the operator in the loop and situationally aware of automated system performance while balancing operator workload; resolve issues related to the degradation of basic skills should the automation fail.
  - Human Performance Assessment – Improve the quality of critical decisions; assess cognitive and contextual factors leading to human error; develop effective countermeasures to reduce errors and performance inefficiencies; assess the impact of organizational culture on performance; and improve and standardize methods for measuring human performance.
  - Selection and Training – Understand the relationship between human abilities and aviation task performance; develop a scientific basis for the design of training programs, devices and aids; enhance the measures and methods for prediction of job/task performance; assess the knowledge, skills and abilities needed to excel in highly automated environments; identify methods by which to select aviation system personnel.
  - Bioaeronautics – Improve the health, safety, protection, survivability and security of aircraft passengers and aircrews through identification of human tolerances, capabilities, and failure modes (physiological, psychological, and performance) both in uneventful flight, and during aircraft incidents and accidents.

- NASA's Aviation Safety Program.
- The FAA report entitled "The Interfaces Between Flight Crews and Modern Flight Deck Systems".
- Public Law 100-591, which establishes requirements for human factors research and its application.
- The Advanced Qualification Program (AQP), which has been adopted by every major U.S. carrier, incorporating human factors training into pilot qualification and recurrent training programs.
- Crew Resource Management (CRM) training procedures, a variant of which has been adopted by virtually every major domestic air carrier.

Accomplishments: The program output of data packages, models, and regulatory documents includes:

Information Management and Display

- Developed a manual that addresses appropriate human factors considerations in designing flight deck operating documents. This manual has been adopted by International Civil Aviation Organization (ICAO) for distribution to its member states.
- Published the *Aviation Maintenance Human Factors Guide.*
- Developed and implemented the Agency's first virtual collaborative research team to communicate and disseminate information in real time regardless of distance or other constraints on research team members.
- Developed (with industry) the first industry standard and guidance document on implementing an Aviation Maintenance Human Factors Program.
- Developed the Aviation Maintenance Document Design Aid incorporating simplified English and utilizing advanced technology to standardize aviation maintenance documentation.
- Developed guidance and recommendations on human factors best practices in flourescent penetrant inspection. This project provided a more systematic view of human/system interaction.
- Completed human factors guidelines for assessing advanced general aviation transportation experiment (AGATE) cockpit controls/displays.
- Developed human factors design and evaluation considerations for Electronic Flight Bags, Version 1.0 and Version 2.0.
- Completed assessment of human factors issues and current knowledge concerning use of head-up displays in air transports.
- Addressed human factors issues for Cockpit Head Motion Box associated with air transport head-up displays.
- Completed data link lessons learned compendium for inclusion in RTCA DO-238A, "Human Factors Requirements and Guidance for Controller/Pilot Data Link Communications Systems".

Human-Centered Automation

- Completed human factors Certification Job Aid Version 1.0 and Version 2.0 for FAR Part 25 flightdeck displays.
- Developed aircraft certification human factors and operations checklist for stand alone global positioning system receivers.
- Developed initial performance models for automation usage in air carrier cockpits.

Human Performance Assessment

- Developed prototype Automated Performance Measurement System (APMS) which allows air carriers to gather and analyze flight data from aircraft data recorders. This information and analysis capability provides the backbone for the Flight Operations Quality Assurance Program (FOQA), a joint FAA, industry and labor initiative to enhance aviation safety.
- Provided industry and FAA with preliminary reports on the antecedents of flight deck error.
- Completed the job task analysis of the aviation maintenance technician workforce.
- Developed guidance and standardized shift turn over procedures for use in aviation maintenance.
- Developed pilot performance profile, through flight simulation, for use in establishing certification standards for general aviation autonavigation and control systems.
- Provided expanded APMS methodologies and analysis capabilities in order that air carriers can collect and analyze increasing amounts of flight and simulator data.
- Developed initial mapping of flight data parameters onto AQP qualification standards.

- Completed assessment of the utility of PC-based aviation training devices in maintaining general aviation pilot instrument proficiency.
- Completed a comprehensive human factors analysis of scheduled air carrier and fatal general aviation accidents using the human factors analysis and classification system (HFACS).

Selection and Training

- Developed and validated a proceduralized pilot CRM training and assessment system.
- Developed the Model AQP to support regional air carrier participation. AQP is a proficiency based approach to pilot training that is considered to be highly effective and efficient for aircrew training.
- Developed air carrier training data analysis tools used by carriers and the FAA for quality assurance efforts.
- Provided Flight Standards guidance for developing pilot training regulations based on data from a study of 30,000 domestic air carrier pilots. The study examined pilot's perceptions of training effectiveness across the entire U.S. aviation industry.
- Developed line operations safety audit (LOSA) methodology used by air carriers to help determine safety vulnerabilities. This methodology has been adopted by ICAO and was distributed to member states.
- Provided industry and FAA with preliminary guidelines on air carrier training for flight deck interruptions and for the performance of concurrent critical tasks.
- Provided industry and FAA with air carrier training guidelines for pilot decision-making, addressing first officer's hesitancy to challenge the captain in potentially high risk situations.
- Developed a system to allow air carriers to reconfigure FAA approved flight scenarios to unique training segments and developed a generic line oriented evaluation event set database to be used by any air carrier.
- Incorporated air carrier and FAA user comments into an enhanced reconfigurable event set scenario development system.
- Provided FAA and Industry preliminary guidelines on managing pilot skill degradation through innovative training schedules.
- Provided industry and FAA preliminary training guidelines for automated flight decks.
- Provided FAA and Industry guidance on approaches to incorporating realistic radio communications into simulators to train pilots for the complex operating environment.
- Developed the Maintenance Resource Management (MRM) handbook for use by industry.
- Completed the prototype MRM distance learning project that will be implemented and used by the U.S. Navy for training their aviation maintenance technicians. Further application can be applied to U.S. Coast Guard aviation maintenance technicians.
- Developed an Advisory Circular on training, qualification, and certification of nondestructive inspection personnel.
- Developed a prototype automated system of self instruction for specialized training for the industry aviation maintenance inspector workforce.
- Developed a CD-ROM training program that guides general aviation pilots through the creation of a personal checklist that incorporates minimum operating conditions and procedures based upon their own personal capabilities and experience.
- Developed a CD-ROM training program which describes the structured decision-making style of experienced general aviation pilots compared to less experienced pilots. The program stresses situational awareness, diagnosis, resolution, and vigilance.
- Developed a CD-ROM training program which teaches general aviation pilots to recognize the cues associated with deteriorating weather while in-flight, and to take appropriate action to avoid weather.
- Defined critical flight task performance that decays over time in air carriers.
- Developed methodologies to analyze cognitive strategies for using automation systems in air carrier cockpits.
- Developed methods to incorporate automation specific training scenarios into the system that reconfigures event sets for unique training sessions.
- Developed advanced data analysis methods for linking FOQA and simulator training data.

- Analyzed data from line observations and laboratory studies to provide training guidance on human error management.

R&D Partnerships: Collaboration has continued between the FAA and industry partners to develop intervention strategies and reduce aviation accidents through the various Joint Safety Analysis Teams (JSATs) and Joint Safety Implementation Teams (JSITs) developed as part of the Safer Skies agenda. The program is coordinated with NASA through the NASA Aviation Safety Program's emphasis on human factors concerns associated with air carrier and general aviation pilot training, aviation maintenance, human performance modeling, and weather displays. DOD joint efforts are in automation and enhanced vision. Additionally, the FAA is represented on the DOD Human Factors Engineering Technical Advisory Group, a forum for the coordination of research across a variety of technical areas. A collaborative research effort is underway with the Joint Aviation Authorities (JAA) and Transport Canada (TCCA) to produce human factors input for the harmonization of regulatory guidancematerial.

Through aviation maintenance partnerships with industry, the FAA and industry are receiving real world applied research results. Aviation maintenance human factors is also working with other countries (such as Transport Canada) for globalization of aviation maintenance and inspection human factors. The FAA participates on all of the Society of Automotive Engineers G-10 human factors subcommittees related to human factors research areas, ensuring transition of the results to standards, guidelines, etc. The FAA also has extended seventeen grants to universities supporting research on air carrier training, flight deck automation, aviation accident analysis, general aviation, and aviation maintenance technician and inspector training.

MAJOR ACTIVITIES AND ANTICIPATED FY 2003 ACCOMPLISHMENTS:

Information Management and Display

- Initiated development of guidance on human factors improvements to Notice to Airmen (NOTAMs).
- Completed initial computational model to assess information accessibility for air transport head-up display/head-down display combinations.
- Completed human factors guidance on integrating multiple weather information features on weather displays.
- Defined display location boundaries that correspond to established eye position/head position for general aviation aircraft during actual operations.
- Conducted human factors investigations of advanced terrain and weather displays.
- Expanded the evaluation of broadband applications to aviation maintenance safety.

Human-centered Automation

- Completed human factors Certification Job Aid Version 4.0 for FAR Part 25 flight deck displays.
- Provided human factors technical information on airport surface maps and vertical profile displays for FAA Technical Standard Order on moving map displays.

Human Performance Assessment

- Provided initial human factors technical guidance to land-and-hold-short operations (LAHSO).
- Initiated analysis of the safety implications of monitored approaches.
- Examined simultaneous non-interfering operations for visual flight rules (VFR) helicopter and fixed wing visual flight rules/instrument flight rules (IFR).
- Expanded research into causal factors of general aviation accidents and incidents attributed to human error.
- Conducted research into human performance measures for situation awareness, workload, and trust of flight deck displays in complex general aviation tasks and environments.
- Continued examination of navigation performance of VFR helicopter pilots using IFR-qualified Global Positioning System (GPS) receivers, required navigation performance (RNP) measurement.
- Continued research into a vision testing requirement for persons maintaining and inspecting aircraft and aircraft components.
- Continued development of prototype Automated Performance Measurement System (APMS) which allows air carriers to gather and analyze flight data from aircraft data recorders. This information and analysis capability provides the backbone for the Flight Operations Quality Assurance Program (FOQA), a joint FAA, industry and labor initiative to enhance aviation safety.

Selection and Training

- Defined the process to allow credit for an instrument rating in a general aviation Flight Training Device.
- Continued research on comparing the effectiveness of a Personal Computer Aviation Training Device, a Flight Training Device and an airplane in conducting general aviation instrument proficiency checks.
- Initiated development of guidance on new air carrier CRM training post 9/11.
- Initiated development of guidance on training air carrier flight crews for unexpected events.
- Enhanced Rapidly Reconfigurable Line Oriented Evaluations (RRLOE) scenario generation software and expanded collection of air carrier user data.
- Expanded Realistic Radio Communications in simulator training to include data link and other forms of nonverbal communication.
- Expanded Knowledge Assessment software tool for assessing knowledge structures and mental models necessary for the operation of automated aircraft.
- Distributed report on tools and methods to support the training of cognitive skills for automation performance in air carrier cockpits.
- Distributed to the FAA and industry training development guidelines for the integration of crew resource and technical skills in air carrier AQP training programs.
- Developed methodologies to link performance data to curriculum modification procedures in AQP programs.
- Developed report on methodology for integrating Aviation Safety Action Program (ASAP), FOQA and AQP data.
- Developed report on training guidelines to handle interruptions, distractions, and lapses of attention in air carrier cockpits.
- Completed validation of training intervals for air carrier pilot training programs.
- Developed training guidelines for error management in air carrier cockpits.
- Developed analytic strategy to build ASAP enhancements to reporting of factors contributing to aviation incidents.
- Completed validation of simulator requirements for air carrier pilot training.
- Expanded analysis of technology to support aviation maintenance inspection training in corporate, regional and general aviation.
- Assessed requirements for, and availability of, qualified aviation maintenance technicians by 2005.

FY 2004 PROGRAM REQUEST:

The program continues to focus on providing technical information and consultation to improve aircrew, inspector, maintenance technician, and aviation system performance. Emphasis is on developing guidelines, tools, and training to enhance error capturing and mitigation capabilities in the flight deck and maintenance environments; and on developing human factors tools to ensure that human performance considerations are adequately addressed in the design and certification of flight decks and equipment.

New Initiatives

Human Performance Assessment

- Evaluation of human factors issues associated with propulsion system malfunction and inappropriate crew responses.

Selection and Training

- Evaluation of weather, visibility and general aviation training.

Ongoing Activities

Information Management and Display

- Develop human factors guidance for instrument procedures design.
- Develop human factors guidance for certification of weather displays.
- Assessment of air transport and general aviation head-up/head-down displays.
- Development of methods to counter controlled-flight-into-terrain CFIT accidents in general aviation.
- Develop flight data recording and analysis capability for flight simulators.
- Determine operational criteria/training guidance for night vision goggles in rotorcraft operations.
- Expand evaluation of broadband applications to aviation maintenance safety.

Human-centered Automation

- Evaluation of human factors issues regarding RNP information on navigation displays.

- Provide expanded guidance addressing training for automated cockpits.
- Development of the human factors Certification Job Aid.
- Analysis of general aviation cockpit displays.

Human Performance Assessment

- Development of improved guidelines for accident investigation and reporting.
- Develop expanded human factors guidance for LAHSO operations.
- Refine air carrier flight and simulator data analysis tools.
- Provide guidance on effectiveness of realistic radio communications in simulator evaluations.
- Examine simultaneous non-interfering operations for helicopter and fixed-wing aircraft to determine human performance implications.
- Continued examination of naviagtion performance of VFR helicopter pilots using IFR-qualified GPS receivers, RNP measurement.
- Conduct research into human performance measures for situation awareness, workload, and trust of flight deck displays in complex general aviation tasks and environments.
- Develop enhanced capabilities for APMS.

Selection and Training

- Expand development of pilot error safety management interventions and enhancements to reporting of accident/incident causal factors
- Provide guidance on simulator motion requirements for recurrent pilot training.
- Expand realistic radio communications in simulator training.
- Develop initial training guidelines for flight deck error management.
- Develop advanced analysis methods linking FOQA and simulator data.
- Develop materials to increase general aviation pilot skills to intervene in accident causation chain.
- Develop methodologies to link air carrier pilot performance data to curriculum modification.
- Develop guidelines for air carrier pilot training intervals.
- Expand analysis of technology to support aviation maintenance inspection training in corporate, regional and general aviation.
- Assess requirements for, and availability of, qualified aviation maintenance technicians by 2005.
- Validate the process to allow credit for an instrument rating in a general aviation Flight Training Device.

KEY FY 2004 PRODUCTS AND MILESTONES:

Information Management and Display

- Complete guidance on human factors improvements to NOTAMs.
- Complete initial human factors guidelines for instrument procedure design.
- Complete guidelines regarding multiple weather sources on a multi-function display.

Human-centered Automation

- Complete human factors certification job aid for FAR Part 23 flight decks.
- Provide human factors guidance for certification of non-profile RNP navigation displays.

Human Performance Assessment

- Expand human factors technical guidance to land-and-hold-short operations.
- Expand research into causal factors of general aviation accidents and incidents attributed to human error.

Selection and Training

- Expand LOSA methodology.
- Develop ASAP enhancements to reporting of factors contributing to aviation incidents.
- Continue development of guidance on new air carrier CRM training post 9/11.
- Continue development of guidance on training air carrier flight crews for unexpected events.
- Continue expansion of Knowledge Assessment software tool for assessing knowledge structures and mental models necessary for the operation of automated aircraft.
- Develop software enhancements to Rapidly Reconfigurable Line Oriented Evaluations (RRLOE) scenario generation tools and collect air carrier user data.
- Continue research on comparing the effectiveness of a Personal Computer

Aviation Training Device, a Flight Training Device and an airplane in conducting general aviation instrument proficiency checks.	

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1983-2002)	$148,758
FY 2003 Request	10,411
FY 2004 Request	10,457
Out-Year Planning Levels (FY 2004-2008)	42,619
Total	$212,245

Budget Authority ($000)	**FY 2000 Enacted**	**FY 2001 Enacted**	**FY 2002 Enacted**	**FY 2003 Request**	**FY 2004 Request**
Contracts:					
Flightdeck/Maintenance/System	6,289	7,016	6,617	6,711	6,869
Personnel Costs	2,367	2,283	2,398	2,855	2,756
Other In-house Costs	486	779	891	845	832
Total	**9,142**	**10,078**	**9,906**	**10,411**	**10,457**

OMB Circular A-11, Conduct of Research and Development ($000)	**FY 2000 Enacted**	**FY 2001 Enacted**	**FY 2002 Enacted**	**FY 2003 Request**	**FY 2004 Request**
Basic	0	0	0	0	0
Applied	9,142	10,078	9,906	10,411	10,457
Development (includes prototypes)	0	0	0	0	0
Total	**9,142**	**10,078**	**9,906**	**10,411**	**10,457**

A08a – Flight Deck/Maintenance/System Integration Human Factors Product and Activities	FY 2004 Request ($000)	Program Schedule					
		FY 2003	FY 2004	FY 2005	FY 2006	FY 2007	FY 2008
081-110 Flightdeck/Maintenance/System Integration Human Factors							
Selection and Training	**$2,653**						
Develop Air Carrier Automation Reconfigurable Event Set Software		◊	◊	◊	◊	◊	
Provide Guidance for Air Carrier Simulator Motion Requirements		◊	◊	◊			
Develop/Distribute Advanced Air Carrier Data Analysis Methods Linking FOQA and Simulator Data		◊	◊	◊	◊		
Develop Training Guidelines for Air Carrier Flight Deck Error Management		◊	◊	◊	◊		
Develop Materials on Air Carrier CRM Training Post-9/11		◊	◊	◊	◊	◊	◊
Using Technology to Support Aviation Maintenance Inspection Training in corporate, regional, and GA		◊	◊	◊	◊	◊	◊
Expanded Research on Effectiveness of GA Personal Computer Training Device		◊	◊	◊			
Human Performance Assessment	**$554**						
Provide Expanded Air Carrier APMS Methodologies and Analysis Capabilities		◊	◊	◊	◊	◊	◊
Provide Guidance on Effectiveness of Realistic Radio Communications in Line-oriented Evaluations		◊	◊	◊			
Develop Improved Guidelines for Accident Investigations		◊	◊				
Determine NAV Performance of VFR Helicopter Pilots using IFR-Qualified GPS Receivers		◊	◊	◊			
Analysis of Causal Factors of general aviation Accidents/Incidents		◊	◊	◊	◊		
Human Centered Automation	**$1,955**						
Provide Industry and FAA Guidance Addressing Training for Automated Cockpits		◊	◊	◊	◊		
Complete Certification Job Aid Version for FAR Part 23/25 Flight Deck Displays		◊	◊	◊	◊		
Provide Human Factors Evaluation of Navigation Displays		◊	◊	◊	◊		
Information Management and Display	**$1,595**						
Complete Human Factors Guidelines for Instrument Procedure Design		◊	◊	◊			
Complete Guidance on Human Factors Improvements to NOTAMs		◊	◊	◊			
Complete Guidelines Regarding Multiple Weather Sources on a Multi-function Display		◊	◊	◊			
Develop Flight Data Recording and Analysis Capability for Flight Simulators.		◊	◊	◊			
Determine Operational Criteria/Training Guidance for Night Vision Goggles in Rotorcraft Operations		◊	◊				
Expanded Evaluation of Broadband Applications to Aviation Maintenance Safety		◊	◊	◊			
Assess Air Transport and General Aviation Head-up and Head-Down Displays		◊	◊	◊	◊		
Personnel and Other In-House Costs	**$3,700**						
Total Budget Authority	**$10,457**						

Note: Out year numbers are for planning purposes only. Actual funding needs will be determined through the annual budget process.

Budget Item	Program Title	Budget Request
A08b	**Air Traffic Control/Airway Facilities Human Factors**	**$10,579,000**

GOALS:

Intended Outcomes: The FAA intends to improve air traffic control (ATC) safety by:

- Developing more effective methods for investigating, reporting, analyzing, and mitigating ATC operational errors and Airway Facilities (AF) incidents.
- Developing human factors educational aids and memory enhancement techniques to mitigate runway incursions.
- Developing human factors educational aids and assessing countermeasures to mitigate controller fatigue resulting from shiftwork.
- Increasing human factors integration in the acquisition and design of ATC automation systems.
- Improving techniques for forecasting hiring requirements and selecting applicants for Air Traffic (AT) and AF positions.

Agency Outputs: Human performance constraints and other human factors issues pose risk to the acquisition, design, operation, and maintenance of ATC systems. Human factors analysis of operational errors including runway incursions identifies improvements in how errors are investigated and reported, which in turn will lead to more effective safety interventions. The study of the relationship between shiftwork schedules and fatigue identifies techniques for mitigating degradations in controller performance. Human factors research provides standards and other information for the design and development of ATC systems and product improvements as well as communication and surveillance technologies. Tests and criteria for the selection of operational personnel will improve applicant screening efficiency and validity and reduce costs associated with attrition and training failures.

Customer/Stakeholder Involvement: The ATC/ AF Human Factors Research Program is directly tied to the following ARA Safety Performance Goals:

Goal 1. *Aviation Safety:* In support of the FAA's mission goal related to system safety, contribute to the FAA goal to reduce the fatal aviation accident rate 80% by FY 2007 as compared to 1994-1996 baseline data.

Goal 2. *Human Factors:* In support of FAA's performance goals, ARA will, by FY 2005, ensure human factors policies, processes, and best practices are integrated in the research and acquisition of 100 percent of FAA aviation systems and applications. Goal 2 implementation uses strategies involving research on NAS integration and human error that respond to Air Traffic Service (ATS) research requirements, and acquisition engineering activities associated with the design, analysis, development, test, and implementation of FAA systems and applications.

The ATC/AF Human Factors Research Program is the product of continued coordination between the Office of the Chief Scientific and Technical Advisor for Human Factors (AAR-100) and its ATS customer base through the Air Traffic Requirements Service (ARS). The detailed research portfolio is coordinated with several organizational elements: the Air Traffic Services Office of Evaluations and Investigations (AAT-20), Air Traffic Plans and Procedures (ATP-400), Air Traffic Tactical Operations (ATT), NAS Operations (AOP-30), Resource Management Program (AFZ-100; ATX-20), and the Research and Requirements Directorate (ARQ). Integrated Product Teams in the Office of Communication, Navigation, and Surveillance Systems (AND) and the Office of Air Traffic Systems Development (AUA), as well as the Free Flight program office (AOZ) and the Offfice of System Architecture and Investment Analysis (ASD), identify research requirements through human factors practitioners.

Research is addressing the highest priority human factors issues among the 70 recommendations identified by the National Research Council in its 1997 and 1998 reports on current and future ATC automation. This research addresses human performance issues associated with mid- and long-term capacity enhancements identified in the Operational Evolution Plan (OEP). The program examines advanced automation and technologies integrated as part of the RTCA National Airspace System (NAS) Concept of Operations, the AF maintenance concept for NAS Infrastructure Management, and the NAS Architecture Version 4.0. Applied research provides the information necessary to understand human performance limitations, enabling human factors engineering to identify and resolve risks, and to assess costs,

benefits, and trade-offs. The ATC/AF Human Factors Research Program addresses the recommendations of the congressionally mandated Research, Engineering, and Development Advisory Committee (REDAC).

The FAA human factors program is coordinated with NASA through the Inter-Agency Air Traffic Management Integrated Product Team (IAIPT), and with the DOD through the Human Factors Engineering Technical Advisory Group. This program is developed around the research thrusts identified in the 1995 joint FAA-NASA-DOD *National Plan for Civil Aviation Human Factors: An Initiative for Research and Application*:

- Information Management and Display - Determine what, when, and how to best display information through the computer-human interface (CHI); design the system to reduce the frequency of information transfer errors; and minimize the impact when such errors do occur. Display designs are optimized to reduce information overload.
- Human-Centered Automation - Keep the operator in the loop and situationally aware of automated system performance while balancing operator workload; resolve issues related to the degradation of basic skills should the automation fail.
- Human Performance Assessment – Improve the quality of critical decisions; assess cognitive and contextual factors leading to human error; develop effective countermeasures to reduce errors and performance inefficiencies; assess the impact of organizational culture on performance; and improve and standardize methods for measuring human performance.
- Selection and Training - Assess the knowledge, skills and abilities needed to excel in highly automated environments; assess retirement and attrition patterns to predict hiring requirements.
- Bioaeronautics – Improve the health, safety, protection, survivability and security of aircraft passengers and aircrews through identification of human tolerances, capabilities, and failure modes (physiological, psychological, and performance) both in uneventful flight, and during aircraft incidents and accidents.

Accomplishments: The program has supported the following research with resulting products:

Information Management and Display

- Standard Terminal Automation Replacement System (STARS) - Conducted comprehensive assessment of the STARS operational radar display and maintenance control workstations. A related initiative yielded a definitive process to integrate human factors in other NAS acquisitions.
- Human Factors Design Standard (HFDS) – Updated and formalized design information into the HFDS to provide Integrated Product Teams (IPTs) with standards and guidelines for effective human factors design of automation and communication/navigation/surveillance (CNS) technologies.
- Human-System Interface (HSI) integration – An overall risk assessment for IPTs identifying inconsistencies in the design of human-system interfaces between baseline systems and their anticipated product improvements and other subsystems to be integrated as part of the NAS evolution.
- NAS CHI standardization – Assessed inconsistencies in display symbology and aural tones in NAS monitor and control commercial systems.
- Operational communications - Assessed pilot/controller communication data from Safe Flight 21 to identify impacts of a cockpit display of traffic information (CDTI) on controller workload, traffic handling capacity, and changes to procedures.

Human-Centered Automation

- Flight strip studies – Identified operational functions in controller use of paper flight progress strips to support transition to Free Flight Phase 1 decision support automation.
- Enhanced vision systems – Demonstrated how use of enhanced vision technology supports tower controller information requirements under reduced visibility conditions.
- Controller performance using decision aids – Completed a complex human-in-the-loop simulation to develop recommendations for improved controller performance and team communications in use of a medium term conflict probe.

Human Performance Assessment

- ATC operational errors – Completed initial field beta testing and validation of a new methodology for reporting and analyzing

causal factors associated with ATC operational errors.

- Runway safety booklet – Developed a booklet for controllers and pilots containing relevant human factors information on communications, attention, and memory in order to help prevent runway incursions.
- Controller fatigue – Completed the congressionally mandated fatigue study through surveys and field and lab biomedical studies of controller shift work schedules.
- Human factors booklet for controllers - Prepared brochure containing helpful information for controllers they can use to enhance job performance.
- Impact of shared separation on ATCS situation awareness – Conducted a study of impacts from distributed air/ground separation responsibility on air traffic controller performance.
- Dynamic airspace boundaries – Assessed the impact of airspace restructuring on controller performance through modeling and simulation.

Selection and Training

- Prototype air traffic applicant screening system – Developed a prototype biographical assessment tool for screening job applicants.
- Computerized selection test battery – Completed concurrent validation of a new computerized Air Traffic Selection and Training (AT-SAT) test battery for air traffic control.
- Statistical Retirement and Attritions Model (SCRAM) – Developed prototype model for projecting retirements and attrition from AT/AF critical occupations using historical data.

R&D Partnerships: Research is coordinated with NASA in the areas of distributed air/ground separation responsibility and human error through the IAIPT, which also provides a framework for coordination with MITRE. University grants are addressing human factors with advanced surveillance technology and collaborative decision making in Air Traffic Management (ATM). Internationally, collaborative research with EUROCONTROL addresses human error in the design and operation of ATC and decision support tools systems, and advanced concept validation and verification strategies.

MAJOR ACTIVITIES AND ANTICIPATED FY 2003 ACCOMPLISHMENTS:

Information Management and Display

- Human-System Interface (HSI) integration – Detailed assessments of HSI inconsistencies and other human factors risks in the integration of enhanced capabilities in en route legacy systems to ensure compatibility with design standards and human performance considerations.
- Human Factors Design Standard – Improved on-line search capabilities for efficient use of the Human Factors Design Standard.
- AF workstation design and crew coordination – Evaluated human performance limitations in transitioning to a paperless centralized maintenance work environment and changes in crew communications.

Human-centered Automation

- Multi-tool inter-operability simulation – Completed a controller simulation to assess inter-operability issues with decision support and data link capabilities collocated in en route controller workstations.
- Tower paper flight strips – Evaluated controller information requirements for use of flight progress strips in control towers.
- Centralized maintenance procedure limitations – Examined lessons learned from the design of centralized maintenance procedures to develop guidelines for effective handling of system maintenance events.

Human Performance Assessment

- Incident investigation methodology refinements – Through field beta testing, verified refinements to identifying causal factors of operational errors and for targeting performance remediation strategies.
- Runway safety training – Developed a multi-media training prototype for controllers providing targeted information on effective techniques to mitigate runway incursions.
- AF human error reporting system – Developed a prototype web-based capability for AF personnel to anonymously report errors and incidents for use in NAS training.
- Fatigue and shift work– Completed a laboratory study relating use of rest period and activity countermeasures with performance in a virtual work environment.

- Organizational assessment – Conducted the FAA-wide Employee Attitude Survey to assess and compare Model Work Environment practices.

Selection and Training

- AF job/task analysis – Completed a selection-oriented baseline job/task analysis for AF field maintenance positions to support development of a new AF selection system.
- Workforce planning – Extended the Statistical Retirement and Attrition Model (SCRAM) functionality to a workforce stock-and-flow model to estimate future hiring requirements.

FY 2004 PROGRAM REQUEST:

The FY 2004 program supports ATS with research to address human performance issues in the acquisition, design, operation, and maintenance of ATC systems over the next several years. Research projects will provide timely information to answer critical human factors questions.

New Initiatives:

Information Management and Display

- Develop design guidelines addressing human factors issues in integrating collocated decision support tools in en route controller workstations.

Human-Centered Automation

- Assess how interdependencies in use of collocated decision support tools impacts controller roles and responsibilities.

Human Performance Assessment

- Evaluate an intranet-based prototype system to manage and integrate operational error reports for analysis.
- Assess Airway Facilities training requirements from maintenance error reporting.

Ongoing Activities:

Information Management and Display

- Examine HSI integration issues with product improvements.
- Assess AF transitions in workstation design and crew coordination.

Human-centered Automation

- Develop baseline requirements for tower controller flight data information needs supporting acquisition mission analysis.
- Assess inter-operability between advanced decision aids.
- Evaluate the distribution of separation responsibility between controllers and pilots.
- Assess information requirements and decision making in centralized maintenance.

Human Performance Assessment

- Assess potential training and automated strategies for mitigation and reduction of human and system errors related to air traffic operations.
- Evaluate sector teamwork and collaborative decision-making.
- Recommend best practices through an organizational assessment addressing the Model Work Environment.
- Validate task load and performance measures obtained before and after implementation of new controller automation tools.
- Fatigue and shift work - Evaluate use of higher priority countermeasures in operational settings.

Selection and Training

- Define changes in applicant skill mixes associated with enhanced capabilities.
- Assess longitudinal validation of ATS selection processes.
- Refine a workforce analysis prototype tool.

KEY FY 2004 PRODUCTS AND MILESTONES:

ATS-related research within the National Plan research thrusts include:

Information Management and Display

- HSI integration issues – Conduct detailed assessments of HSI inconsistencies and other human factors risks in integration of enhanced capabilities in tower and CNS legacy systems.
- Electronic fight data – Assess alternate display techniques for flight progress data to meet tower controller information needs; develop automation guidelines and design recommendations to ensure a human-centered approach.

- Enhanced surveillance data – Assess controller information and display requirements to effectively use Automated Dependent Surveillance-Broadcast (ADS-B) in non-radar operations.

Human-Centered Automation

- Inter-operability between advanced decision aids – Assess the cumulative impact on controller performance, situation awareness, and workload resulting from the incremental integration of decision aids developed in support of the OEP relative to achieving intended benefits.
- Free Flight design guidance - Develop automation guidelines and design recommendations to ensure the inter-operability between FFP1/2 decision aids.
- Reduction in use of paper flight progress strips – Develop refinements to automation, procedures and training to facilitate reducing the operational need for paper flight progress strips.
- Shared air/ground separation responsibility – Assess controller performance effects of distributed air/ground responsibility for pilot self-spacing and separation.
- Human-in-the-loop simulation of centralized maintenance – Assess AFSS information requirements and decision making through simulations of monitor and control functions and procedures.

Human Performance Assessment

- Incident causal factors – Evaluate a web-based prototype knowledge management system to integrate and analyze causal factors data from assessments of operational errors and runway incursions.
- Memory enhancement for tower controllers – develop recommendations to mitigate runway incursions.
- AF errors and incidents assessment – Assess causal factors of human error in AF maintenance operations to identify mitigation techniques.
- Biomedical impacts of controller workload – Develop recommendations based on concurrent behavioral, physiological and biochemical indices of controller workload.
- Air Traffic Management (ATM) collaborative decision-making - Assess human factors information needs for ATM communication and coordination.
- Organizational assessment – Report on lessons learned, organizational issues, and successful practices in developing a Model Work Environment from the FAA-wide Employee Attitude Survey.
- Task load and performance assessments - Assess use of objective task load and performance measures in Performance and Objective Workload Evaluation Research (POWER) to compare task load when using different ATC systems.

Selection and Training

- Changes in AT/AF skill mixes – Define changes in skill mixes for selecting applicants to AT and AF positions necessitated by transitions of FFP1/2 enhanced capabilities.
- Selection of applicants ATS positions – Develop technical enhancements and continue longitudinal validation of screening and testing tools for selection of applicants into ATS positions.
- Complete development of a prototype workforce analysis tool – Refine a prototype workforce analysis tool to assess gaps between actual and predicted AT and AF staffing profiles, workforce retirements/attrition, and hiring patterns.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1983-2002)	$109, 906
FY 2003 Request	10,317
FY 2004 Request	10,579
Out-Year Planning Levels (FY 2004-2007)	43,557
Total	$174,359

Budget Authority ($000)	**FY 2000 Enacted**	**FY 2001 Enacted**	**FY 2002 Enacted**	**FY 2003 Request**	**FY 2004 Request**
Contracts:					
Air Traffic Control/Airway Facilities Human Factors	1,661	2.277	2,756	4,214	4,314
Personnel Costs	5.034	3,984	4,071	4,457	4,652
Other In-house Costs	1,305	1,721	1,673	1,646	1,613
Total	**8,000**	**7,982**	**8,500**	**10,317**	**10,579**

OMB Circular A-11, Conduct of Research and Development ($000)	**FY 2000 Enacted**	**FY 2001 Enacted**	**FY 2002 Enacted**	**FY 2003 Request**	**FY 2004 Request**
Basic	0	0	0	0	0
Applied	8,000	7,982	8,500	10,317	10,579
Development (includes prototypes)	0	0	0	0	0
Total	**8,000**	**7,982**	**8,500**	**10,317**	**10,579**

A08b – Air Traffic Control/Airway Facilities Human Factors Product and Activities	FY 2004 Request ($000)	Program Schedule					
		FY 2003	FY 2004	FY 2005	FY 2006	FY 2007	FY 2008
082-110 AirTraffic Control/Airway Facilities Human Factors							
Information Management and Display	**$935**						
Human Factors Design Standards Development		◊	◊	◊	◊	◊	◊
Human-System Interface Integration		◊	◊	◊			
Tower Controller Flight Data Information Requirements		◊	◊	◊			
AF Information Display and Management		◊	◊	◊	◊	◊	◊
Human Centered Automation	**$1,604**	◊	◊	◊			
Incremental Decision Support Tool Inter-operability Assessments		◊	◊	◊	◊		
Shared Air/Ground Separation		◊	◊	◊	◊	◊	◊
Situational Awareness in Centralized Monitor and Control		◊	◊	◊	◊		
Human Performance Assessment	**$1,275**	◊	◊	◊			
Examination of Causal Factors Related to Operational Errors		◊	◊	◊	◊	◊	◊
Runway Safety Analysis and Educational Guidance		◊	◊	◊			
Airway Facilities Human Error Assessment		◊	◊	◊	◊		
ATM Collaborative Communication and Coordination		◊	◊	◊	◊	◊	◊
Controller Shift Work, Work Schedules, and Fatigue		◊	◊	◊			
POWER Task Load and Performance Assessment		◊	◊	◊			
Team Processes in Centralized Monitor and Control Systems		◊	◊	◊			
FAA-Wide Employee Attitude and Organizational Assessment		◊	◊	◊	◊	◊	◊
Selection andTraining	**$500**						
Prototype Air Traffic Applicant Screening System		◊	◊				
Applicant Evaluation System Longitudinal Validation		◊	◊	◊	◊	◊	◊
Prototype Workforce Analysis Tool Development and Analysis		◊	◊	◊	◊	◊	◊
Personnel and Other In-House Costs	**$6,265**						
Total Budget Authority	**10,579**						

Note: Out year numbers are for planning purposes only. Actual funding needs will be determined through the annual budget process.

Budget Item	Program Title	Budget Request
A08c	**Aeromedical Research**	**$6,650,000**

GOALS:

The FAA safety mission dictates that:

- Injury and death patterns in civilian flight accidents be investigated and meticulously analyzed to determine cause and prevention strategies.
- Recommendations for protective equipment and procedures be developed.
- Options be evaluated on behalf of FAA regulatory and medical certification staff charged with the proposal of safety, health and security regulations addressing all aircraft cabin occupants.

The identification of pilot, flight attendant, and passenger medical conditions that are incompatible with in-flight physiological and performance demands, both in the absence and presence of emergency flight conditions is a concurrent mission. The resulting bioaeronautical data is to be effectively shared using advanced, user-friendly modeling and visualization technologies.

Intended Outcomes: The outcomes addressed by this research program are improved health, safety, protection, survivability and security of aircraft passengers and aircrews. This research program identifies human tolerances, capabilities, and failure modes (physiological, psychological, and performance) both in uneventful flight, and during aircraft incidents and accidents. Formal recommendations for protective and supportive counter measures and techniques are derived from in-house research.

The FAA is able to exploit new and evaluate existing bioaeronautical guidelines, standards, and models for aircraft cabin equipment, procedures, and environments. This serves as a base for new regulatory action and the evaluation of existing regulations to enhance appropriate human performance at a minimum cost to the aviation industry. By reviewing pilot medical histories, flight histories, and information from accidents and incidents, existing and advanced biomedical criteria, standards and assessment/ certification procedures can be proposed to ensure optimal performance capability. By assessing pilot, flight attendant, air traffic controller, and passenger work, environmental, behavioral, and disease issues, guidelines for actions to improve the health, safety and security of the aircraft occupant can be proposed based on rigorous scientific criteria.

Agency Outputs: The program has developed the following guiding principles to support regulatory and certification processes:

- Quantitative bioengineering criteria to support optimum aircraft seat and restraint system certification.
- Quantitative biomedical and performance criteria to support protective breathing equipment, emergency medical equipment, and operational procedures certification.
- Quantitative bioaeronautical criteria to support flotation and onboard life support/rescue equipment certification.
- Quantitative biomedical and performance criteria to support development of optimum protective breathing equipment, emergency medical equipment, and operational procedures certification.
- Identification of biomedical/toxicological factors in aviation incidents and accidents.
- Recommendations for aircrew medical criteria, standards, assessment/certification procedures, and special issuance.
- Quantitative data about the occupational health risks of flight attendants to support regulatory oversight.
- Quantitative data about passenger behavior and health to support regulatory oversight.
- Quantitative data about aerospace radiation exposure and other aircraft environmental factors and threats to aircraft occupants.

Customer/Stakeholder Involvement: This program contributes to meeting the FAA Strategic Plan Mission Goal for Safety and ARA FY 2002 Performance Plan Goals for Safety and Human Factors. The program provides the primary bioaeronautical research (note: defined as the bioengineering, biomedicine, and biochemistry issues associated with safety, security and performance) called for in the *National Plan for Civil Aviation Human Factors*. This program contributes significantly to the application of emerging technologies, as highlighted in the FAA Aviation Safety Plan. The program is an integral participant and research provider under the FAA, Joint Aviation Authorities (JAA), and Transport Canada Aviation (TCA) Aircraft Cabin Safety Research Plan established in 1995 as a

coordinated, living plan to maximize the cost-benefit of aircraft cabin safety research nationally and internationally.

International Civil Aviation Organization (ICAO) initiatives addressing the health of the aircraft occupant (crew and passenger) are developed under this program before final FAA recommendations are provided to ICAO. This program is the only research component of the FAA that can legally access confidential medical data about pilots for use in epidemiological research studies approved by FAA's institutional review board for use of human test subjects. Collaborative studies involving flight attendant and passenger symptomatology and diseases and are part of this budget item.

Accomplishments: Based on aeromedical research at the Civil Aerospace Medical Institute (CAMI), the FAA Administrator announced in FY 2000 the Agency's intention to proceed with regulations for the requirements concerning the performance and use of child restraints in aircraft. Standards and test criteria for child restraints developed at CAMI were adopted by the Society of Automotive Engineers (SAE). Specialized quantitative crashworthiness assessments for aircraft continued, inclusive of side-facing aircraft seats, and included the use of new state-of-the-art anthropomorphic test dummies with enhanced injury assessment capabilities.

Data are continuously provided to the research sponsor on the role of toxicological and clinical factors associated with each aircraft accident and significant incident. Current findings indicate that about one of 6 pilots fatally injured in civilian aircraft accidents show evidence of using a prescription drug; one of 7 has taken an over-the-counter drug; one of 15 has ingested significant positive alcohol; and 1 of 14 is using a significant controlled dangerous substance. Long-term aviation forensic and epidemiological research has helped the FAA to identify bioaeronautical roles in accident/incident causation. Medical and other factors indicative of pilot incapacitation and inability to perform optimally are under continuous evaluation. To promote radiation safety in civil aviation, instructional materials on radiation exposures in-flight were provided to the aviation industry.

R&D Partnerships: In addition to the previously described partnerships (e.g., FAA/JAA/TCA; FAA/NIOSH), academic, industrial, and other national and international governmental coordination and cooperation are maximally leveraged in all research activities. In each of the program area output categories, the FAA maintains direct cooperative research processes with all the manufacturers responsible for the safety products enumerated (seats, restraint systems, oxygen masks, evacuation slides, etc.). FAA investigators also maintain memberships on every Society of Automotive Engineers committee addressing safety research conducted under this program. The agency maintains a liaison with the American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE) committee addressing aircraft cabin air quality status and research. Besides the active involvement in the FAA/JAA/TCA process of oversight for safety research, participants in this program are represented on appropriate subgroups of organizations such as the Aerospace Medical Association, the Civil Aviation Medical Association, and the Professional Aeromedical Transport Association. Appropriate liaison with all military branches is maintained through direct project collaboration (e.g., crashworthiness, aerospace medicine, eye injury from lasers, exposure to cosmic radiation), through participation in national and international aerospace medical advisory groups, the European Union, or collaborations in scientific organizations.

MAJOR ACTIVITIES AND ANTICIPATED FY 2003 ACCOMPLISHMENTS

The following program results have been achieved or are expected to be achieved in FY 2003:

- Performed epidemiological assessment of biochemical and toxicological factors from fatal civilian aviation accidents.
- Assessed the results of automatic external defibrillators and emergency medical kits on commercial aircraft.
- Evaluated autopsy data from fatal aviation accidents for improvement of protective equipment and design practices.
- Completed assessment of flight attendant reproductive and environmental health hazards (Congressionally requested FAA contract study with NIOSH).
- Initiated use of computer simulation (dynamic modeling) of crash responses for seat-occupant -aircraft interface and utilized biodynamic sled test results to validate/expand system capability.

- Conducted human performance testing to quantify the synergistic effects of altitude and antihistamine use by airmen.
- Competed recommendations resulting from cabin evacuation research project evaluating effects of passageway, exit hatch, passenger density, and passenger motivation on evacuation efficiency.
- Developed biodynamic test data on side-facing seats and restraint devices to support rule-making organizations.
- Utilized 747 Aircraft Cabin Environment Research Facility to define time requirements for a NASA developed clear air turbulence detection system relative to the need for the cabin crew preparation.

FY 2004 PROGRAM REQUEST:

The Office of Aviation Medicine continuously encounters complex medical decisions during the initial and follow-up medical assessments of airmen who request special medical issuances (e.g., cardiac conditions, neurological deficits, etc.) to permit their continued flying. The prospective epidemiological assessment of special issuance methodology and medical outcomes in the airman population is required to ensure that medical issuances do not result in unexpected or increased aircraft accident or incident rates or risks. Advanced aeromedical database development facilitates the ability to expediously respond to medical assessments and accident response

Ongoing Activities

- Support safer aircraft cabin evacuation approval guidelines and safer field applications under routine and emergency operational conditions.
- Reduce head, neck, torso, and extremity injuries in aircraft crash environments.
- Evaluate trends in toxicological, biochemical, physiological, and clinical findings from all major civil aviation aircraft crashes.
- Assess cabin environmental guidelines for aircraft crew and passenger environmental safety/comfort.
- Assess effectiveness of new programs dedicated to the enhancement of passenger performance in emergencies.
- Evaluate in-flight use of medical kits/equipment and determine the adequacy of the equipment, kits and procedures.
- Track special medical issuance pilots to evaluate relative risk and the continuance of specific aeromedical certification standards.
- Provide recommendations for limits to radiation exposure (laser and ionizing).
- Continue development and enhancement of an advanced aeromedical research accident database that is user friendly, has rapid response, and produces advanced statistical and graphics analysis.
- Develop dynamic modeling capabilities in support of cabin safety research, biodynamic protection/survivability research, cabin environmental quality and aircraft accident research.

New Initiatives

- Expand development of molecular biological techniques to enhance forensic toxicological aspects of aircraft accident investigations.
- Initiate use of cabin evacuation simulation model updated with data from completed experimental studies.

KEY FY 2004 PRODUCTS AND MILESTONES

The following program results are being scheduled in FY 2004:

- Develop bioaeronautical research data that will support aeromedical certification aimed at reduction of in-flight sudden/subtle incapacitation.
- Complete interactive database allowing evaluation of autopsy data from fatal aviation accidents to determine protective equipment and design practices and support of aircrew medical certification standards.
- Provide guidelines for aircraft cabin occupant health maintenance, including development of a version of the CARI computer program for estimating the radiation exposure of air travelers during large solar-particle events.
- Initiate wide-body, dual-aisle aircraft evacuation research to support evacuation modeling.
- Evaluate pilot reported medication usage with actual toxicology findings to determine the accuracy of self-reporting.
- Continue development of cabin airflow characteristics in the 747 AERF to support evaluation of cabin environmental quality/health and mitigate chemical-biological terrorist attacks.

- Continue refinement of molecular biological laboratory techniques that will enhance forensic toxicological aspects of aircraft accident investigation.
- Initiate use of a cabin evacuation simulation model updated with data from completed experimental studies.
- Establish correlation of neck injury and impact dynamics measured using anthropomorphic test mannequins to assess the potential for improved aircraft seat test criteria.
- Initiate an upgrade project to modernize the narrow body cabin egress test facility to allow flexible simulation of aircraft types and configurations.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2002)	72,850
FY 2003 Request	6,603
FY 2004 Request	6,650
Out-Year Planning Levels (FY 2005-2008)	29,187
Total	115,290

Budget Authority ($000)	**FY 2000 Enacted**	**FY 2001 Enacted**	**FY 2002 Enacted**	**FY 2003 Request**	**FY 2004 Request**
Contracts:					
Aeromedical Research	394	938	491	498	510
Personnel Costs	3,858	3,893	4,268	4,749	4,695
Other In-house Costs	577	1,156	1,362	1,356	1,445
Total	**4,829**	**5,987**	**6,121**	**6,603**	**6,650**

OMB Circular A-11, Conduct of Research and Development ($000)	**FY 2000 Enacted**	**FY 2001 Enacted**	**FY 2002 Enacted**	**FY 2003 Request**	**FY 2004 Request**
Basic	0	0	0	0	0
Applied	4,829	5,987	6,121	6,603	6,589
Development (includes prototypes)	0	0	0	0	0
Total	**4,829**	**5,987**	**6,121**	**6,603**	**6,650**

A08c – Aeromedical Research Product and Activities	FY 2004 Request ($000)	Program Schedule					
		FY 2003	FY 2004	FY 2005	FY 2006	FY 2007	FY 2008
086-110 Aeromedical Research							
Cabin Health and Environmental Guidelines	**$0**						
Assessment of Flight Crew Health Risks During a Flying Career and Health Risks associated with Space Travel of Commercial Passengers		◊	◊	◊	◊	◊	◊
Models of Air Flow and Disease Transmission in Aircraft Cabins		◊	◊	◊			
Human Survival and Protection in Civil Aviation	**$200**						
Analyze the Suitability for Component Tests as an Alternative for Showing Regulatory Compliance with Crashworthiness Standard for Aircraft		◊	◊	◊	◊	◊	◊
Assess Impact Protection Performance of Aircraft Seating Systems		◊	◊	◊			
Develop Performance-Based Narrow and Wide Bodied Aircraft Cabin Evacuation Approval Guidelines		◊	◊	◊	◊	◊	◊
Develop Aircraft Cabin Evacuation Model as a Partial Replacement for Evacuation Tests with Human Subjects			◊	◊	◊	◊	◊
Development of Protective Equipment Fit, Comfort, and Performance Standards		◊	◊	◊	◊	◊	◊
Develop Dynamic Modeling Capabilities in Support of Cabin Safety, Protection, and Aircraft Accident Research		◊	◊	◊	◊	◊	◊
Medical/Toxicology Factors of Accident Investigations	**$310**						
Perform Epidemiological Assessment of Toxicology Factors from Fatal Civilian Aviation Accidents		◊	◊	◊	◊	◊	◊
Develop Guidelines to Reduce In-flight Sudden/Subtle Incapacitation		◊	◊	◊	◊	◊	◊
Evaluate Autopsy Data from Fatal Aviation Accidents to Determine Protective Equipment and Design Practices		◊	◊	◊	◊	◊	◊
Develop Advanced Molecular Biochemical Techniques to Enhance Aviation Forensic Toxicology			◊	◊	◊	◊	◊
Develop Instructional Material on the Radiation (Cosmic and Visual) Environment during Air and Space Travel		◊	◊	◊	◊		
Survey of In-flight Medical Emergencies and Defibrillator Usage on Commercial Airline Flights		◊					
Continue development of an Advanced Aeromedical Medical Database		◊	◊	◊	◊	◊	◊
Personnel and Other In-House Costs	**6,140**						
Total Budget Authority	**6,650**						

Note: Out year numbers are for planning purposes only. Actual funding needs will be determined through the annual budget process.