Air Force Research Laboratory
Technology Milestones 2007

Technology Milestones can be reviewed at
http://www.afrl.wpafb.af.mil/news/index.asp?catid=163.
To receive more information about AFRL, visit the home page at
www.wpafb.af.mil/afrl.

Cleared for Public Release

Distribution Is Unlimited

Program/Introduction

AFRL
Technology Milestones Program

*Helping to maintain the Air Force's strong
Science and Technology foundation
one milestone at a time.*

The Air Force Research Laboratory (AFRL) is a tremendously important and exciting organization represented by exceptional people, all dedicated to envisioning solutions and delivering the "art of the possible" to the warfighter.

Our mission is to lead the discovery, development, and integration of affordable warfighting technologies for our air, space, and cyberspace forces. We execute our mission through our nine technology directorates located throughout the United States, our Air Force Office of Scientific Research, and our central staff.

Headquartered at Wright-Patterson Air Force Base, Ohio, AFRL is the Air Force's largest employer of scientists and engineers. In a population of about 3,400, approximately 24% have doctorate degrees in science and engineering disciplines.

The laboratory's research spans the full spectrum of science and technology—from conducting basic research to launching experimental microsatellites. Our scientists and engineers create technologies today that will be used by the nation's air, space, and cyberspace forces of tomorrow.

Innovation and technology are key components of the Air Force's strong foundation. The imagination of the world's best and brightest minds—in government, industry, and academia—ultimately delivers the equipment, weapon systems, and ideas driving our organization. These milestones, which showcase a sampling of technological advances, represent just a fraction of the AFRL technologies currently under development.

Technology Milestones can be reviewed at **http://www.afrl.wpafb.af.mil/news/index.asp?catid=163**.

You can also visit the AFRL Web site at **www.afrl.af.mil/AFRL/**.

Introduction

The Air Force Science and Technology Milestones herein often represent the combined effort of several scientists and engineers working as a team. The basic and applied research, plus the follow-on technology development described, are essential to the continued success of the Air Force mission.

This book contains Technology Milestones selected from one or more of the following categories:

Support to the Warfighter (Air, Space, and Cyberspace)

Technology that has potential for, or has achieved, application on a Department of Defense system that is in development or operation or that has provided "quick-reaction" response to problems or needs of field organizations

Sustainment (Support to the Warfighter-Air, Emerging Technologies, Technology Transfer, Awards and Recognition)

Technology that increases readiness and reduces life-cycle costs of legacy systems, applicable to (1) base infrastructure, (2) maintenance, (3) logistics, (4) training, and (5) human performance

Demonstration Exercises

Examples of significant demonstration exercises, including flight tests, system prototype demonstrations, and joint force exercises

Emerging Technologies

Major innovative technological advancements that offer significant potential for existing and future Air Force systems

Technology Transfer

Technology that has transferred from the laboratory to the private sector, to include industry, academia, and state and local governments

Awards and Recognition

Awards and recognition of AFRL contributions within the scientific community at large, concerning technology advancements in the areas of technology transition, technology transfer, or technical achievement

AFRL Technologies

Air Force Office of Scientific Research (AFOSR)

Mission Statement: As a vital component of AFRL, AFOSR's mission is to discover, shape, and champion basic science that will profoundly impact the future Air Force. This mission is the foundation of the AFOSR vision that the US Air Force will always dominate air, space, and cyberspace through revolutionary basic research.

AFOSR accomplishes its mission by investing in basic research efforts that support the Air Force mission in relevant scientific areas. Central to AFOSR's strategy is the identification of long-range technology options for national defense, as well as the timely transfer of related scientific knowledge to industry, the academic community, and government laboratories that foster developmental research leading to revolutionary technologies for the Air Force.

Atomic and Molecular Physics
Biophysical Mechanisms
Ceramic and Nonmetallic Materials
Cognition and Decision Making
Computational Mathematics
Electroenergetic Physics
Electronic and Detector Material Structures and Device Concepts
Information Forensics and Process Integration for Network Operations
Laser and Optical Physics
Metallic Materials
Optoelectronics: Components and Information Processing
Polymer Chemistry
Remote Sensing and Imaging Physics
Sensor and Detector Materials
Software and Systems
Space Situational Awareness
Surface and Interfacial Science
Unsteady and Rotating Flows
Biomimetics, Biomaterials, and Biointerfacial Sciences
Boundary Layers and Hypersonics
Chronobiology
Combustion and Diagnostics
Dynamics and Control
Electromagnetics
High-Density Optical Memory
Information Fusion and Artificial Intelligence
Mechanics of Multifunctional Materials and Microsystems
Optimization and Discrete Mathematics
Physical Mathematics and Applied Analysis
Quantum Electronic Solids
Sensing, Surveillance, and Navigation
Sensory Systems
Space Power and Propulsion
Structural Mechanics
Theoretical Chemistry

Air Vehicles Directorate

Mission Statement: The Air Vehicles Directorate plans, formulates, and directs US science and technology for research/exploratory/advanced technology development for military air vehicles; orchestrates and executes technology developments in aeronautical/control sciences and aerospace structures; integrates air vehicle technologies with all AFRL technology directorates at the systems level; and orchestrates this technology development with Department of Defense and national labs, industry and academia, the National Aeronautics and Space Administration and Federal Aviation Administration, and the North Atlantic Treaty Organization and other foreign research organizations.

Propulsion Integration
Experimental Aeronautical Sciences
Plasma Physics
High-Speed Aerodynamic Configurations
High-Speed Computational Research
Control Systems and Theory
Space Access and Hypersonics Guidance and Control
Simulation-Based Research and Development
Advanced Structural Concepts
Adaptive Structures
Computational/Analytical Certification
Multidisciplinary Design and Demonstration
Structural Integrity
Experimental Structures
Weapon Integration
Flow Control/Flow Physics
Low-Speed Aerodynamic Configurations
Multidisciplinary Computational Research
Applied Computational Science
Unmanned Air Vehicle Cooperative Control
Flow Control, Mechanization, and Automation
Multifunctional Structures
Thermal Structures
Structural Health Assessment
Combined Environments (Structures)
Aeroelasticity Analysis Methods
Structural Dynamics

AFRL Technologies

Directed Energy Directorate

Mission Statement: The Directed Energy Directorate develops, integrates, and transitions science and technology for directed energy—including high-power microwaves, lasers, adaptive optics, imaging, and effects—to assure US preeminence in air and space.

Lasers:
Gas/Chemical Lasers
Electric Lasers
Bulk Solid-State Lasers
Fiber Lasers
Semiconductor Lasers, Hybrid Lasers
Laser Vulnerability and Lethality

Modeling and Simulation:
Laser/Optics
Radio Frequency (RF)/Plasma
Systems
Missions

Beam Control:
Atmospheric-Propagation/Adaptive Optics
Acquisition-Tracking and Pointing
Space Situational Awareness

High-Power Microwaves:
Pulsed-Power Plasmas
RF Sources/Antennas
RF Effects

Human Effectiveness Directorate

Mission Statement: The Human Effectiveness Directorate leads revolutionary science and technology development towards superior Airman cognition, readiness, performance, and survival through concentrated efforts focused on (1) Directed Energy Bioeffects, (2) Anticipate and Influence Behavior, (3) Biosciences for Performance Enhancement and Protection, (4) Effective Complex Human Systems, and (5) Mission-Effective Performance.

3-D Audio
Biomechanics
Chemical-Biological Agent Defense
Cognitive Modeling
Continuous Learning and Learning Management Technologies
Cultural Behavior Modeling and Representation
Distributed Mission Operations Training Research
Human-Centered Logistics Research
Immersive Training/Rehearsal Simulation Environments
Live-Virtual-Constructive Integration
Nanotechnology
Nonlethal Technologies
Radio Frequency Radiation Bioeffects
Space
Toxicology
Warfighter/Weapons Systems Integration

Aircrew Performance and Protection
Biotechnology
Cognitive Interface Technologies
Competency-Based Performance Measurement and Tracking
Counterproliferation
Cyberspace
Fatigue Countermeasures
Human-System Interface Design
Laser Eye Protection
Maintenance Job Aiding
Night-Vision, Helmet-Mounted, and Large-Screen Displays
Optical Radiation Bioeffects
Situational Awareness
Speech-Recognition Technologies
Veterinary Sciences

AFRL Technologies

Information Directorate

Mission Statement: The Information Directorate leads the discovery, development, and integration of affordable warfighting information technologies for our air, space, and cyberspace forces.

Information Dominance (and its transition to ground, air, and space systems, especially in the area of command and control)
Information Fusion
Signal Processing
Collaborative Environments
Modeling and Simulation
Information Assurance Intelligent Information Systems Technologies (including intelligent agents, planning/scheduling and decision aids, knowledge bases, and access)
Information Exploitation
Communications and Networking
High-Performance and Adaptive Computing
Advanced Displays and Intelligent Interfaces

Materials and Manufacturing Directorate

Mission Statement: The Materials and Manufacturing Directorate plans and executes the US Air Force program for material and manufacturing in the areas of basic research, exploratory development, advanced development, and industrial preparedness and provides responsive support to Air Force product centers, logistics centers, and operating commands to solve systems- and deployment-related problems and to transfer expertise.

Accelerated Insertion Materials
Advanced Industrial Practices
Advanced Metallics
Airbase Infrastructure Technologies
Amorphous Metals
Atmospheric Threat Protection
Ceramics and Ceramic Matrix Composites
Computational Chemistry
Electronics
Engine Rotor Life Extension
Firefighting Technology
Force Protection Research
High-Cycle Fatigue
High-Resolution Flaw/Feature Imaging
Infrared Sensors and Transparencies
Magnetic and High-Temperature Superconducting Materials Processing
Manufacturing Processing and Fabrication Technology
Materials Behavior and Evaluation
Materials Process Design
Metallic Composites
Metals Processing
Nondestructive Evaluation
Optical Materials
Pollution Prevention Materials
Power and Chemical Processes
Robotics Research
Sensor Technologies
Structural and Electronic Failure Analysis
Surface Phenomena/Interactions
Thermal Protection Materials
Wide-Bandgap Materials
Advanced Composite Processing and Behavior
Advanced Inspection Technologies
Air Mobile Systems Research
Aircraft and Spacecraft Coatings
Analytical Chemistry Research
Biotechnology
Composites Supportability
Corrosion Control
Electrostatic Discharge Research
Environmental Technologies
Fluids, Lubricants, and Tribological Research
Hardened Materials Technology
Hazardous Materials Elimination/Minimization
High-Temperature Superconductor Materials
Laser-Hardened Materials
Manufacturing and Engineering Systems
Materials Affordability Initiatives
Materials Life Prediction and Durability
Materials Supportability
Metal Matrix Composites
Nanotechnology
Nonmetallic Composite Materials
Organic Matrix Composites
Polymeric Materials
Quantitative Defect Characterization
Semiconductor Materials
Solid and Liquid Lubricant Development
Superlattice and Quantum-Well Materials
Systems Support
Virtual Reality Training

AFRL Technologies

Munitions Directorate

Mission Statement: The Munitions Directorate leads the discovery, development, integration, and transition of affordable munitions technologies for US air and space forces.

Ordnance Technologies (warheads, fuzes, and explosives)
Guidance Technologies
Computer Analysis and Modeling Capabilities

Propulsion Directorate

Mission Statement: The Propulsion Directorate plans and executes the Air Force's basic research, exploratory development, and advanced development programs for flight vehicle propulsion and power technology; conducts in-house research and development to exploit new opportunities, maintain technical expertise, and verify contractor findings; provides technical and management assistance in support of studies, analyses, development planning activities, acquisition, test, evaluation, modification, and operation of air, space, and weapons systems and related equipment; provides the principal Air Force interface with scientific, industrial, educational, and other government agencies; and serves as the Air Force Materiel Command focal point in these technical areas.

Turbine Engines
Turbine Engine Augmentors
Turbine Engine Bearings
Combined-Cycle Engines
Subsonic and Supersonic Combustion
Compressors
Turbine Engine Controls
Turbine Engine Diagnostics
Endothermic Fuels
Engine Starting Systems
Engine Health Monitoring Systems
Exhaust Nozzles
Fans
Fuel Pumps and Fuel Systems
Gas Generators
Gears
High-Cycle Fatigue and Its Mitigation
Ignition Prognostics
Lubrication Systems
Oil Specifications, Diagnostics, and Analysis
Oil Monitors
Optical Diagnostics
Pressure-Sensitive Paints
Pulsed-Detonation Engines
Scramjets
Seals
Turboramjets
Turboshaft Engines
V/STOL Propulsion
Air Turborockets
Hybrid Rockets
ICBM Propulsion
Liquid-Fueled Ramjets
Rocket Engine Test Facilities
Solid-Fueled Ramjets
Solid Propellants
Solid Rocket Boosters
Solid Rocket Service Life
Solid Rocket Motors
Carbon Fibers and Composites
Ceramic Processing
Computational Chemistry
Electric Propulsion
High-Energy-Density Matter
Injectors and Spray Measurements
Laser Propulsion
Liquid Rockets and Combustion
Micropropulsion
Monopropellants
Nontoxic Propellants
Plume Phenomenology
Power Conditioning Equipment
Propulsion Fluid Dynamics
Rocket Materials
Rocket-Based Combined-Cycle Engine
Solar Propulsion
Thermal Management
Thermionics
Auxiliary Power Units
Batteries and Fuel Cells
Capacitors
Circuit Breakers
Converters/Inverters
Electric Motors
Conventional, Superconducting Generators

Sensors Directorate

Mission Statement: The Sensors Directorate leads the discovery, development, and integration of affordable sensor and countermeasure technologies for the warfighter.

Radio Frequency
Photonics/Countermeasures
Radar
Reconnaissance
Electro-Optics
Automatic Target Recognition
Sensors
Electronic Warfare

Space Vehicles Directorate

Mission Statement: The Space Vehicles Directorate develops and transitions innovative high-payoff space technologies supporting the warfighter, while leveraging commercial, civil, and other government space capabilities to ensure America's advantage.

Aerospace Environment Warfighting Systems
Revolutionary Space Capabilities for Global Awareness
Vital Developing Military Space Concepts

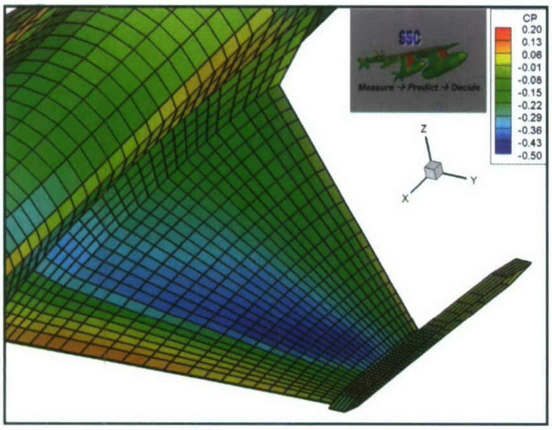
Tab 1 – Support
To The Warfighter

Support to the Warfighter

Page

Air

AFRL-Developed Simulation Tool Improves Aircraft-Stores Carriage Certification Process



AFRL researchers delivered the Medium-Fidelity Flutter Analysis Tool (MEDFFAT) to the Air Force SEEK EAGLE office (AFSEO). The first of three tools designed to enhance AFSEO's simulation and modeling capabilities, MEDFFAT improves the limited, linear capacity of current commercial off-the-shelf (COTS) software by allowing users to more accurately assess the stability of aircraft carrying stores during transonic flight, which occurs in a highly nonlinear aeroelastic environment.

A team of researchers from AFRL, Lockheed Martin Aerodynamics, and ZONA Technology worked with collaborators from the National Aeronautics and Space Administration (NASA) to develop the MEDFFAT software, OVERCAP™. This streamlined aircraft-stores clearance product will improve AFSEO's process for certifying stores carriage safety, ultimately enabling the Air Force to field new weapons more quickly and confidently.

During transonic flight, the interaction between airflow and an aircraft loaded with stores often produces unstable or limited-amplitude, time-periodic wing deformations, which can lead to pilot disorientation, loss of wing fatigue life, or even catastrophic wing failure. Therefore, for each new missile, bomb, or external fuel tank, AFSEO researchers must verify safe carriage (1) at nine different stations along the wingspan, (2) for a large permutation of carriage configuration combinations, and (3) under many different flight conditions and maneuvers.

The linear capability of current COTS software cannot model nonlinear transonic physics or accommodate multibody stores aerodynamics. OVERCAP overcomes these limitations by automatically generating transonic computational grids for the aircraft and its stores based on a single linear panel model, solving the nonlinear aeroelastic equations, and interpolating the solutions between the aircraft and stores grids. The core of the OVERCAP tool is a highly modified version of the NASA Langley Research Center's computational aeroelasticity algorithm for inviscid and viscous flow, known as CAPTSDv. The team's modifications to CAPTSDv include implementation of an overset grid methodology and new boundary conditions. These improvements enable the influence of stores aerodynamics to be modeled. In the MEDFFAT process, OVERCAP first generates a nonlinear steady-state result for a given flight condition. This is followed by several dynamic nonlinear aeroelastic analyses for flight test maneuvers at the steady-state flight condition. The results are then processed to provide information used for assessing safe carriage of the configuration.

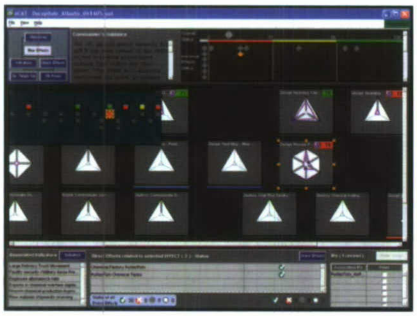
AFRL Researchers Perform C-130 Functional Tip Tank Tests

AFRL worked in conjunction with Snow Aviation to perform tests on a modified C-130E aircraft fitted with functional tip tanks, eight-bladed NP2000 propellers, and extended dorsal and rudder surfaces. During the testing, which involved multiple flights, researchers measured tip tank impact on stall speed, minimum controllable air and ground speeds, cruise ceiling, specific range, wing bending, drag, takeoff and landing distances, and aileron effectiveness. Data collected using Snow Aviation's onboard instrumentation suite, which operated throughout the test activity, indicated that relative to a "stock" C-130E, the modified aircraft offers a 15% improvement in takeoff and landing distances, a 10% improvement in aircraft stall speed, a 5% improvement in minimum controllable speed, a 500 ft increase in ceiling, a 5% increase in specific range, and a 50% reduction in audible range.

The researchers compared their test results to data acquired during C-130 baseline testing conducted in 2006. The purpose of the latest effort was not only to determine the effects of adding tip tanks to aircraft already modified to include improved propellers and extended aerodynamic surfaces, but also to measure the tip tanks' impact on flight characteristics. The transmission of the team's experimental results to the user community—a group that includes Air Force Special Operations Command, Air Mobility Command, and the C-130 System Program Office—will help to raise awareness regarding these technologies.

Tip tanks are fuel tanks mounted at the end (i.e., the tip) of an aircraft's wings. As potential replacements for traditional C-130 fuel tanks, tip tanks could possibly improve aileron effectiveness and also reduce the configuration's drag—increasing both fuel efficiency and capacity. A follow-on project will include further tests conducted using improved fuel measurement and pressure-sensing devices. These precision tests will facilitate a more in-depth look at the impacts of the tip tanks, improved propellers, and extended aerodynamic surfaces. The tip tank effort—just one of Snow Aviation's several C-130 modifications designed to improve the aircraft's short takeoff and landing performance and controllability—has significant potential for improving the aircraft's fuel efficiency.

AFRL Transitions Information Warfare Software Tool to the Operational Community



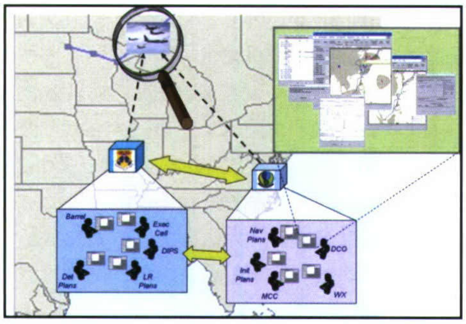
Researchers from AFRL and ManTech International's Cognitive Systems Engineering Center teamed to develop the Information Warfare Combat Assessment Tool (IWCAT), an information warfare air campaign decision and situation awareness aid. Focused on the cognitive work that warfighters perform within their respective domain, IWCAT helps users interpret information and make decisions in the proper context. Essentially, the tool enhances the warfighter's ability to understand, trace, and anticipate the direct and indirect behavioral effects of offensive and defensive, lethal and nonlethal, kinetic and nonkinetic actions directed against adversary information, information-based processes, and information systems.

Over the past 5 years, the program team has successfully deployed several IWCAT prototypes, transitioning and integrating portions of these products into the operational version of the Information Warfare Planning Capability (IWPC). Originally a tool suite used exclusively within the Air Force information operations community, the IWPC—including portions of IWCAT—now extends to users throughout the entire Air Operations Center for planning and assessment purposes.

The IWPC will provide the baseline for another effort involving IWCAT as well. This follow-on work will leverage both the IWPC and its IWCAT components in establishing the Joint Information Operations Planning Capability (IOPC-J), a tool suite ultimately intended to facilitate integrated joint force activity. IWCAT version 5.0 includes specific advancements that show potential in supporting this joint functionality. Accordingly, the successful prototype has prompted further efforts to achieve IWCAT's viable incorporation into future IOPC-J tools.

In designing the IWCAT software, the program team employed a cognitive systems engineering approach. In general, the decision-centered analysis inherent to this design methodology has extended the state of the art for systems development; specifically, the approach has produced powerful decision support system tools and information management applications that reduce volumes of complex data into tailored, domain-specific displays. These representative displays improve battlespace awareness, enhancing the ability of a warfighting staff and commander both to understand the combat effectiveness of a combined air, space, and information campaign and to rapidly grasp the impact of current operational decisions on mission success and future combat capability. As a result, IWCAT has improved the overall assessment capability of the Air Force Information Operations Center and Information Warfare Flights.

AFRL Delivers Distributed Operations Support Concept to Air Operations Centers

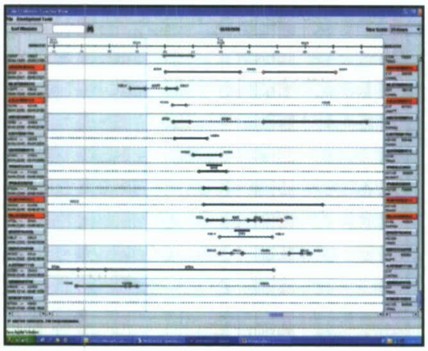


AFRL engineers developed and demonstrated Coronet Awareness and Team Synchronization (CATS) software, subsequently delivering the distributed operations support concept and specifications product to Air Combat Command and Air Mobility Command. AFRL developed CATS using work-centered design, an emerging cognitive-based analytic design approach that optimizes human-computer interaction for individuals and teams engaged in highly complex and dynamic work, including command and control operations. Not only is CATS a visionary concept for supporting synchronized, distributed operations, it also demonstrates potential towards ensuring flight safety.

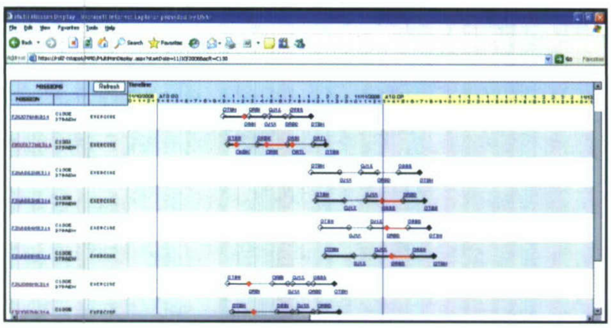
The CATS demonstration product provides continuous and highly efficient work support to ten different users distributed throughout two command centers—namely, the Air Combat Command Air Operations Squadron, Langley Air Force Base (AFB), Virginia, and the 18th Air Force/Tanker Airlift Control Center, Scott AFB, Illinois. "Coronet" refers to missions wherein one or more tanker aircraft escort combat aircraft as they deploy between any bases worldwide. By supporting work that spans early planning through execution, CATS supports a common Coronet mission objective (i.e., successful planning and execution, along with the assurance that all users remain synchronized despite unanticipated replanning tasks that could occur at multiple points in the planning and execution cycle).

The software design centers on the intrinsic, structural elements of the work it supports; however, it is independent of specific work processes and organizational structures and thus remains valid despite any process or organizational changes. This characteristic also enables the CATS framework to be extensible and applicable to similar mission planning and execution domains, where distributed, cross-domain personnel groups need the ability both to work proactively and adaptively and to rapidly replan and self-synchronize.

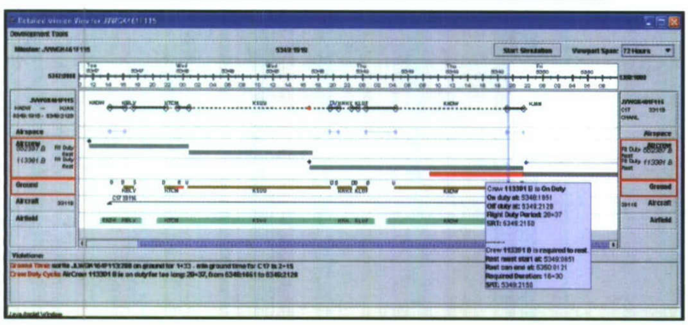
AMC Rapidly Fields AFRL's Command and Control Timeline Visualization Technology



AFRL engineers developed new work-centered interface distributed environment (WIDE) software that provides a timeline visualization capability. Air Mobility Command's (AMC) Tanker Airlift Control Center (TACC) is fielding the advanced technology demonstration software in its operational systems. The timeline visualization tool applies work-centered design principles to map out the operator's decision space—including views of missions and associated resource constraints—on a common timescale, a unique approach that sets the new tool apart from other time-oriented displays.

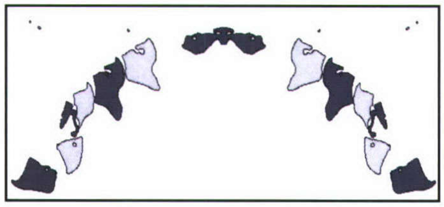


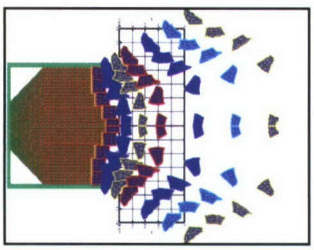
The timeline reflects near-real-time updates to AMC mission data and depicts a given problem in the context of related elements. The visual fusion of relevant information in the display assists operators in rapidly understanding not only the meaning of an alert, but the factors affecting mission viability and possible solutions. Also of significance is the tool's capacity to perform what-if simulations; these hypothetical scenarios facilitate ongoing situation awareness by allowing operators to examine the repercussions of any changes made to the mission itinerary. This unique capability enables a prompt reaction to mission problems—a response based on actionable information and executed in a timely manner.



The new timeline visualization capability transitioned directly into the Consolidated Air Mobility Planning System (CAMPS) version 9.0.2 and deployed within the Air Mobility Division (AMD) of the Al-Udeid Air Force Base (Qatar) Combined Air Operations Center. While the TACC uses this tool to maintain awareness of global mobility assets, the AMD will use it to attain "fleet-at-a-glance" situation awareness of in-theater airlift. As a result of the timeline technology's applicability to all phases of a mission—from initial planning through execution—AMC is integrating the tool into its Mobility Air Forces Command and Control Framework, where all users will have access to the capability. The CAMPS program, an activity involving AMC's primary mission planning system, employed the WIDE demonstration software and specifications to rapidly implement an initial operational capability.

AFRL Enhances Miniature Fragmentation Warhead Design





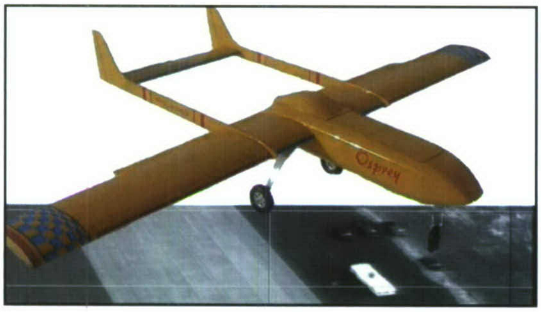
AFRL completed a computational analysis effort supporting the design and evaluation of a miniature fragmentation warhead intended to provide warfighters with a lethal and readily deployable weapon system. AFRL engineers first designed and tested the device, which comprises an array of small fragments launched by an explosive charge. They subsequently provided the computational simulations needed for interpreting test results and improving design characteristics. The analysis has tremendously impacted the warhead design effort, exposing the physics behind the experimental test results and providing a much clearer path towards optimizing the device.

The analysis involved a two-step approach: researchers employed the CTH shock physics code to identify the fragments' deformation mode and then used EPIC shock physics code to simulate the fragments' bulk motion during fly-out. The two-part analysis accurately identified the deformation mode of recovered precut fragments; it also exposed an error in the assumption of precut fragment orientation. The presumed orientation (a result of postmortem fragment inspection) implied that a terraced design was a worthwhile option and, further, that changes in stacking could alleviate shortcomings in pattern uniformity.

However, because the analysis revealed the fragments' true deformation behavior, it became clear that abandoning the terraced design option in favor of a shoulder-to-shoulder stacking configuration was warranted. The team's analysis techniques effectively captured the two stages of fragment fly-out behavior, as follows: (1) the shock wave first causes each individual fragment to expand into any available void (as revealed by the CTH calculations), and (2) the next phase involves the bulk motion of fragment fly-out (as more accurately represented by the EPIC results). The same analysis also explained the mechanism causing the outer rows of fragments to fly well wide of the main pattern. Further computations showed the effects of curvature on fragment fly-out, and analysis of this additional data accurately predicted the problem related to this curvature—specifically, that fragment pattern uniformity decreases as fragment pack assembly curvature increases.

For more information contact
afrlmark@eglin.af.mil • (850)882-3009

AFRL Demonstrates Unmanned Air Vehicle Target Localization Capability

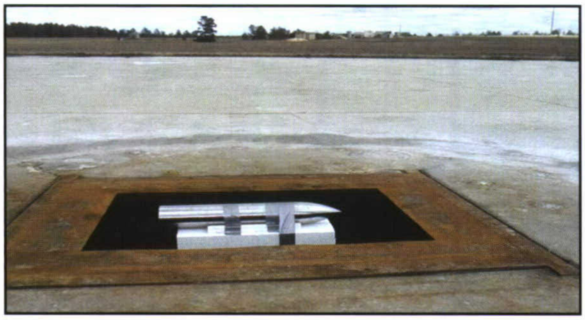


AFRL, in partnership with the Aviation and Missile Research, Development, and Engineering Center (Redstone Arsenal, Alabama), designed and tested a system providing precise ground target coordinates via commercial off-the-shelf (COTS) camera and mapping software. The application utilizes a camera system coordinate frame with basic rotation and geometry matrices to calculate the World Geodetic System 1984 standard earth model position (latitude, longitude, and elevation) of any ground target that appears within an unmanned air vehicle's (UAV) mounted camera field of view. The target localization is relative to the Global Positioning System (GPS) position and attitude values of the UAV, as well as the elevation of the terrain directly below the airborne asset. An operator employs the geolocation application to identify and classify the object of interest before displaying a threat icon on a FalconView-equipped laptop, such as that used by a Tactical Air Control Party.

In a laboratory-controlled environment, AFRL engineers successfully demonstrated the use of an inexpensive COTS video camera for geolocating ground-based objects from a UAV. The ground station receives telemetry data and video information from the UAV and displays the continuous video stream until the operator detects an object of interest. Once detection occurs, the operator depresses a capture key on the ground station, initiating 1 second of video, or 30 frames. The correlated telemetry and video are centered ± 0.5 seconds relative to the time of the capture keystroke, which allows the operator to search through the 30 frames to obtain the one containing the best view of the object.

After selecting the desired object of interest, the operator selects an appropriate object identification and classification from a drop-down menu. The video ground station application computes the GPS position in the video frame in real time and subsequently displays on the FalconView-equipped laptop an icon representing the target track. The results of the target localization algorithms place the object within meters of surveyed "ground truth" position. Engineers are continuing to develop and test the geolocation algorithm and are also working towards providing forward error correction of incoming telemetry, as well as a record and playback feature for the video data.

AFRL Characterizes Airblast of Cased Weapons



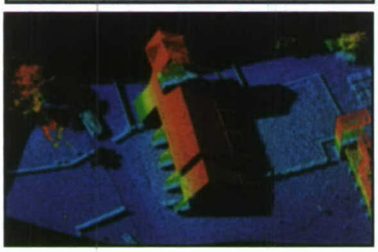
Airblast characterization is vital to fully understanding the performance capability of any existing or concept munitions. AFRL researchers use an instrumented blastpad to characterize airblast. The instrumented blastpad is unique in its design, with the capacity to measure airblast from cased or uncased test items. Researchers redesigned the blastpad to include an exhaust/blast tunnel, adding the capability to measure airblast in a tunnel environment. AFRL uses airblast characterization data in developing weapons effectiveness prediction software. The purpose of this software is to aid the warfighter's efficient selection of munitions for a specific target. It will also assist the design of future experiments for Air Force (AF) and concept munitions.

Cased weapons are particularly difficult to characterize because of fragments produced during detonation; these fragments are hazardous to most measurement devices. The instrumented blastpad design, however, has features that essentially eliminate all hazardous fragments that would interfere with data collection, which occurs via 85 flush-mounted pressure transducers. Positioned at varying distances and azimuths, the transducers create a series of concentric circles and semicircles about the item. Each pressure transducer records pressure-time histories, from which researchers can derive the impulse and peak pressures necessary for developing weapons effectiveness prediction software. Used in conjunction with target models of munitions effectiveness, the prediction software improves AF insight, while reducing costly full-scale weapons testing.

Ultimately, AFRL's instrumented blastpad will assist in providing warfighters the capability to recognize—during the planning stage of AF strike missions—a munition's relative effectiveness against targets. This will facilitate efficient selection of weapons appropriate for given targets, increasing the probability of successful target engagement throughout the mission, minimizing collateral damage, and decreasing munitions costs.

For more information contact
afrlmark@eglin.af.mil • (850)882-3009

AFRL Tests Show LADAR Can Potentially Remedy Helicopter Brownout Problem



Air Force Special Operations Command incurs significant damage to aircraft and—even worse—loss of life as a result of helicopter brownout, a problem wherein dust recirculated by the rotorwash causes pilots to lose visual cues during takeoffs and landings in dry regions. AFRL engineers identified LADAR (laser radar) technology as a sensor technology capable of providing landing zone situational awareness.

AFRL engineers conducted several experiments to assess the potential capability of a LADAR system in helicopter landing scenarios. They collected high-resolution three-dimensional imagery that provides immediate feedback to the pilot for obstacle avoidance and ground slope indication. In addition, while testing in a controlled dust chamber, the engineers demonstrated a see-through imaging capability using a variety of techniques.

Loss of situational awareness puts pilots under extreme stress during brownout conditions. Field test results indicate that LADAR technology can offer an excellent solution to the helicopter brownout problem. Department of Defense rotorcraft pilots are giving the LADAR system a strong endorsement after seeing the test results.

Tab 2 – Sustainment

Sustainment

Page

Support to the Warfighter

Air

Emerging Technologies

Technology Transfer

Awards and Recognition

AFRL Investments Provide High-Tech Cargo Delivery System

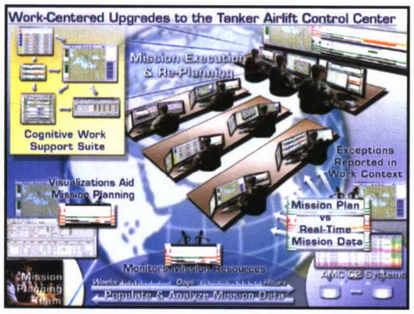
Years of basic research investments have paid off in the successful transition of Joint Precision Airdrop System (JPADS) technology. Conceived and funded by AFRL and the Army, the high-tech cargo delivery system's first deployment to a combat zone was in Afghanistan. JPADS uses the same Global Positioning System (GPS) technology that permits precise target delivery of air-dropped weapons. Its precision enables high-altitude (24,000 ft) airdrop of cargo bundles, facilitating safe cargo delivery at altitudes beyond the reach of many ground threats. JPADS can also eliminate the need for hazardous resupply by ground convoys at risk of attack, to include the ever-increasing threat of improvised explosive devices. This cutting-edge technology thus introduces a new era of more reliably and safely supplying ground troops and more efficiently conducting humanitarian relief missions.

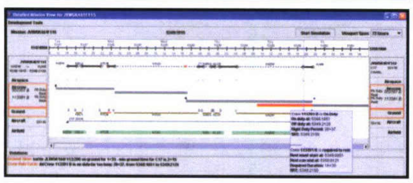
JPADS is the result of successfully integrated Air Force and Army technology. Specifically, it emerged as part of a special projects series prompted by New World Vistas, a comprehensive study initiated in 1995 by then Secretary of the Air Force Sheila Widnall. In 2002, AFRL's investment of approximately $1.5 million began to pay off. At this stage of the effort, researchers successfully demonstrated JPADS as an affordable, reliable means for increasing high-altitude airdrop accuracy. The development and testing phases yielded additional improvements to the system's design in the form of enhanced guidance, navigation, and control algorithms. At the time, however, JPADS was merely one decelerator candidate in the scheme of the overall Joint Precision Aerial Delivery System program.

In subsequent years, the Army worked to develop the physical hardware and mechanisms needed for steering the parachute to a preprogrammed GPS location following the cargo's release from the plane. Meanwhile, the Air Force and Army developed and fine-tuned JPADS-Mission Planner (JPADS-MP), the software that executes precision calculations related to aircraft position, course, and airspeed—as well as a host of other environmental variables capable of influencing airdrop accuracy. JPADS-MP runs on a laptop computer that aircrews use in performing JPADS missions.

JPADS technology allows aircrews to perform airdrops out of harm's way, at higher altitudes and with greater accuracy than previously possible, providing a cost-effective, just-in-time resupply capability that protects aircrews and aircraft alike. To date, the research, development, testing, and evaluation funds invested in the JPADS-MP project total approximately $35 million.

AFRL's Advanced Visualization Displays Enable Superior Operator Performance





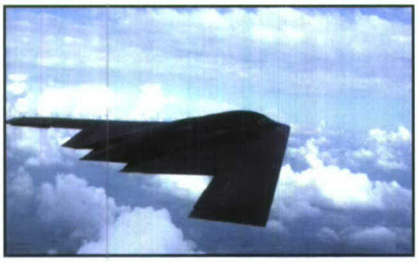
With the aid of Air Mobility Command's (AMC) Tanker Airlift Control Center (TACC) personnel, AFRL researchers demonstrated and evaluated advanced visualization displays depicting global airlift missions and their associated resources. The researchers developed Spiral I of the timeline tool concept, which leverages AFRL's Work-Centered Interface Distributed Environment (WIDE) capability, as the first of a three-phase technology effort focused on demonstrating emergent Work-Centered Support System–based cognitive analysis and user interface design approaches.

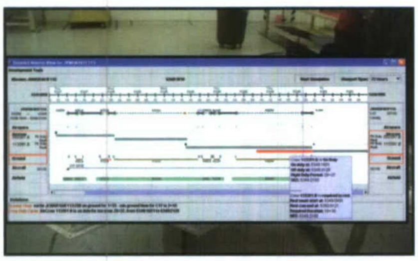
Operationally, the enhanced mission visualization capability will reduce cycle time and increase strategic effectiveness without the cognitive burden currently associated with this work. These improved visualizations enable mission execution personnel to focus on problem solving, decision making, and collaboration, increasing the chances of mission success. The improvements not only translate to less effort expended on system training and usage (including the tasks of locating, retrieving, mentally fusing, and distributing information), but also promote an operator's synchronization with other team members in a dynamic, rapidly changing operational environment.

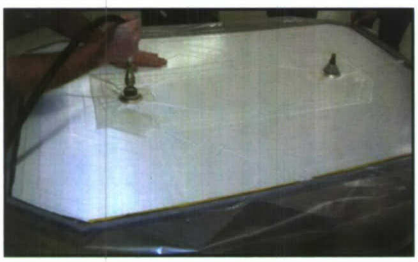
AFRL researchers observed and interviewed TACC personnel, including directors of operation, controllers, and mission planners, to better understand the cognitive work involved with supporting global missions. The WIDE timeline tool visually maps a view of the mission (and related resource constraints) to a common time scale reflecting real-time AMC mission data. This dynamic aspect of the visualization capability helps mission execution personnel readily understand the context of problems to which they are alerted, since they can literally "see" both the factors affecting mission viability and the possible solutions. The timeline tool will also facilitate what-if simulations, promoting better situation awareness of repercussions resulting from any changes to the mission itinerary.

AFRL successfully evaluated the WIDE timeline display with the assistance of various TACC mission execution personnel. They compared personnel performance in realistic work scenarios using the timeline concept and AMC's existing system. With the timeline, operators were able to replan missions significantly faster, with fewer errors and a decreased cognitive workload. They also attained greater situation awareness of repercussions stemming from mission changes. AMC plans to bring these new capabilities to TACC personnel.

AFRL Team Spearheads Redesign of B-2 Nozzle Bay Doors







A team of AFRL engineers successfully resolved a design problem affecting the performance of the B-2 aircraft's nozzle bay doors (NBD). The NBD redesign effort improved mission-capable rates for the B-2 fleet. The Advanced Composites Office worked with the AFRL team and the B-2 Systems Group to identify a timely and cost-effective solution.

The engineering team thoroughly tested the redesigned door in the laboratory and on the aircraft. With full production now under way, about half of the B-2 fleet's NBDs have undergone modification according to the new design. AFRL's modification will generate an estimated savings of more than $20 million. As a result of this success, the B-2 Systems Group has requested further AFRL assistance to adapt the modification to other, similar doors on the aircraft.

Prior to AFRL's redesign and transition effort, B-2 NBD repairs required multiple days and extensive use of costly materials. Focused on improving this situation, the engineering team established procedures for ensuring that the bond between the composite seal and the parent material of the door met all design requirements. In addition, the engineers developed nondestructive inspection standards and procedures for flight testing the new design, designing these standards and procedures into a door section, manufacturing the modification, and subsequently inserting various flaws into the modified product for test purposes. The team then conducted laboratory testing to simulate both thermal- and stress-loaded flight conditions.

The AFRL engineers provided a strong, sustainable capability, as well as a methodology for rapidly resolving complex technical issues and problems while keeping the fleet flying. The team corrected defects found in operational flight systems and played a major role in identifying unexpected problem areas that can benefit from corrective action before major damage occurs. This proactive approach will help minimize future repairs. AFRL provides prompt support for a wide range of potential materials-related problem areas, including metals and composites, electronic material devices, corrosion control, nondestructive evaluation, and failure analysis (a technological approach used to determine a problem's root cause).

AFRL Develops High-Temperature Aircraft Camouflage Coating

Working under a Small Business Innovation Research (SBIR) contract, scientists from AFRL and the Texas Research Institute developed a high-temperature aircraft camouflage coating for use on the titanium slats of C-17 aircraft. This coating will significantly increase the survivability of operational aircraft against the threat of man-portable weapons and provide enhanced thermal performance for future aircraft. The camouflage coating prolongs aircraft survivability by reducing the gloss and reflectance of uncoated high-temperature components.

Current military aircraft require a low-gloss coating for survivability. These coatings are typically polymeric-based products, and they experience severe deterioration with long-term exposure to temperatures above 250°F. Therefore, the areas of the aircraft subject to high temperatures are often left uncoated, leaving the aircraft vulnerable to attack. The C-17's titanium slats are located on the leading edges of the aircraft's wings. During extended ground maneuvers, the slats are subjected to temperatures exceeding 800°F, primarily the result of engine thrust reversal. The heat causes discoloration and flaking of the existing polyurethane-based coating, exposing a highly visible metal surface.

During Phase I of the SBIR effort, scientists developed a low-gloss coating capable of withstanding temperatures of 1200°F; the coating is compatible with titanium or superalloy structures and matches the color standard in place for the C-17 aircraft. Producing and testing sample coatings in laboratory batches, the scientists labored through numerous formulations in order to optimize the coating's thermal stability, processing, and performance. The team's testing included pull-off adhesion, fluid soaks, taber abrasion, and impact. As part of the Phase II SBIR project, scientists refined the coating, evaluated various application methods, and conducted more extensive testing for environmental durability. These Phase II activities resulted in the successful development of a single-component, pigmented polysilazane with ultraviolet, color, and thermal stability.

The coating is easily applied using conventional spray equipment and does not require a postcure process to achieve exceptional thermal performance. Furthermore, the product meets or exceeds many of the existing specification requirements governing the current camouflage coating. AFRL personnel plan to apply the new coating to C-17 aircraft during scheduled program depot maintenance and also intend to flight-test the product on a C-130 aircraft.

AFRL Develops Alternatives for Maritime Control

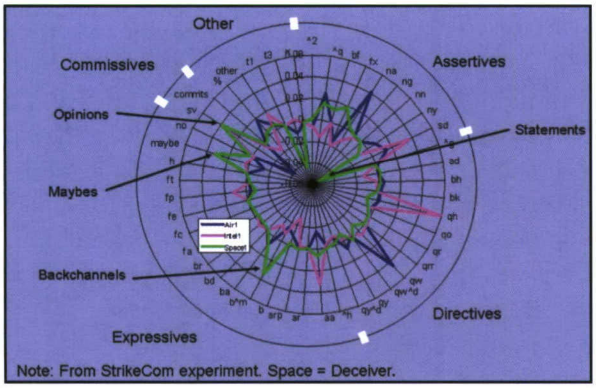
Researchers from AFRL and Mustang Technology Group, a radar technology company based in Allen, Texas, are providing the Air Force (AF) a simple and affordable approach for attacking seaborne threats. The AFRL/industry team developed a low-cost seeker known as the FALCON EYE, a small, all-weather, software-configurable active radar seeker that fits in the forward fuze well of many guided weapons, providing the AF the capability to rapidly engage a variety of surface vessels used by enemy combatants, terrorists, and modern-day pirates.

By employing the form-factor for proximity sensors used in many general-purpose bombs, the team leveraged results from several development and demonstration programs to facilitate the technology's rapid transition into the AF inventory. The team relied exclusively on industrial-grade, commercial off-the-shelf components, as well as commercial electronics fabrication and assembly processes, to develop the low-cost seeker. Researchers will now work to develop a form-factored front end and data collection tests to support algorithm improvements.

Unlike other approaches that require extensive targeting support or weapons that have limited loadouts on few aircraft platforms, the addition of FALCON EYE to a Global Positioning System–guided general-purpose bomb offers the AF a weapons capability for engaging moving or stationary naval combatants from a wide variety of aircraft platforms. These weapons are easily directed to the area of an individual target or to an engagement grid where any motion of the target will be within the seeker's search region. When delivered by long-range aircraft, the FALCON EYE seeker technology provides commanders the capability to conduct agile maritime interdiction worldwide.

For more information contact
afrlmark@eglin.af.mil • (850)882-3009

AFRL-Funded Researchers Conduct Deception Detection Study



AFRL-funded scientists from the University of Arizona used video and audio tools to collect data for interpreting the body movements, voice inflections, and linguistic features of volunteer human subjects during interviews and interrogation sessions. The team used the collected data to develop a software tool suite comprising prototypes for communications analysis, deception detection, and relevant training aids.

One suite component is Agent99, which focuses on deception and its detection—addressing not only the identification of reliable indicators, but also the automation of processes that can help humans make better judgments. Continued research building upon the Agent99 concept will benefit the Air Force (AF) and other armed forces—as well as intelligence agencies—in a variety of ways. For instance, one important application lies in assisting security professionals who work in security screening situations.

The tool's namesake is "Agent 99," a character from the 1960s television series Get Smart. The prototype software suite also contains the Agent99 Trainer, an interactive mentoring/training tool that teaches law enforcers how to detect deception. This trainer was deployed as a training tool for a select group of AF officers. Agent99 evaluates vocalics [articulation], linguistics, and body language based on predefined cues that scientists have developed and programmed into the tool software. The Agent99 Trainer helps trainees understand these cues and also evaluates their level of understanding.

Researchers envision the use of this technology in a futuristic airport where passengers interact with a kiosk capable of detecting deception as their first step in the passenger screening process. While these kiosks would be similar to those currently enabling passengers to obtain boarding passes, they would have the added capacity to triangulate information from multiple databases to determine a specific passenger's risk before that person enters the next phase of security. The envisioned kiosk would covertly communicate any threat to the second security stage without alerting the passenger.

AFRL-Sponsored Researchers Study Sleep Deprivation

AFRL-sponsored researchers at the University of Pennsylvania and Harvard University completed successful studies of sleep-deprived subjects observed to sustain alertness and effective cognitive functioning after taking modafinil. The drug causes wakefulness, using distinct pathways that scientists believe perhaps increase serotonin levels in the brain stem. Though deprived of sleep for 28 hours before being administered modafinil, the test subjects afterwards performed far better on cognitive tests than members of another group, who received a placebo. Specifically, when shown a symbol and asked to type a specific number for that symbol, the test subjects' error rate was much lower than the rate of those individuals given a placebo.

These findings will benefit a number of Air Force career fields wherein personnel must maintain periods of sustained wakefulness. The scientists' next step is to explore how modafinil may be able to help subjects maintain an interminable state of poise and productive alertness.

AFRL-Funded Researchers Develop New Software Model to Improve Aircraft Mission Control Systems

AFRL-funded researchers from Kansas State University (KSU) developed a new software model that could potentially reduce software development time and costs while improving aircraft mission control systems. The model is called Cadena, and the work is happening at KSU's Laboratory for Specification, Analysis, and Transformation of Software, a facility also known as SAnToS.

SAnToS aids the invention of tools that help people construct and develop, in a systematic and rapid way, reliable software that conforms to its specification. The KSU research involves the combination of software models to drive development of component-based systems and lightweight domain-specific specification and verification technology.

Highly reliable, distributed, real-time, and embedded computer systems are imperatives for the operational platforms needed to achieve the Department of Defense objectives of network-centric collaboration and information supremacy. By emphasizing use of reusable components, the Cadena model reduces development time, production time, and overall costs. It also helps ensure that design and integration errors are caught early in the development process.

Defense industry engineers used the SAnToS Cadena model to develop the avionics environment for the software flown on the Scan Eagle unmanned air vehicle platform at White Sands Missile Range, New Mexico. The engineers employed Cadena software for the Scan Eagle platform because it enabled rapid assembly of reusable components having a high degree of automation and greater capability with respect to providing streaming video to the command site. Cadena's success has attracted the attention of major private-sector research companies, one of which is now working with and providing additional support to the Cadena research team.

AFRL Develops Portable Covert Airfield Lighting System

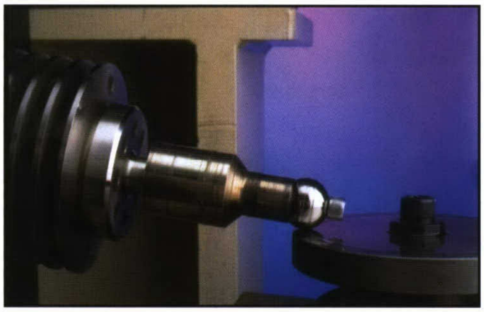
AFRL engineers worked under a Small Business Innovation Research grant with Optical Research Associates to design and develop a portable covert airfield lighting system (PCALS) based on light-emitting diode (LED) technology rather than conventional incandescent bulbs. The dual-mode runway edge lights are easily activated in a visible light mode or switched to an infrared mode, which is visible only through night-vision equipment. The covert mode would guide heavy military cargo aircraft operating in austere environments, such as Afghanistan and Iraq, where quickly established runways may be short, unpaved, and located in hostile territory. The difference between covert and visible mode is the wavelength of light that the LEDs emit.

PCALS operates with a lightweight 4 kW generator, and the LED's lifetime can range up to 100,000 hours. Aerial shipment of a well-packaged production version will require only one C-130 aircraft pallet, as opposed to the three pallets needed for air-transporting other systems. Engineers leveraged LED advances to design a system that is much smaller and lighter, more portable, and less power-hungry than existing portable lighting systems. At the 2005 Team Patriot military mobility exercises, PCALS successfully demonstrated its airfield lighting capacity on a severe, unimproved 5,000 ft airstrip, as well as on the paved, 10,000 ft Volk Field Air National Guard Base (Wisconsin).

Utilizing PCALS during the exercises were a C-130 special operations Air National Guard unit, which used night-vision goggles to fly five approaches to the covert lighting at the unimproved airstrip, and a UH-1 Huey Army National Guard unit, which navigated approaches at both the unimproved and the paved airfields. Pilots from both aircraft reported that they had observed the runway lights from a distance about 25 miles from the respective airfields. Additionally, they indicated that they would have seen the lights from a greater distance in the absence of local cultural lighting.

To help transition the lights to civilian airfields, engineers designed PCALS' visible mode to comply with Federal Aviation Administration requirements governing the medium-intensity visible lighting commonly used for commercial runways. A commercial airfield in Tampa, Florida, purchased the blue, omnidirectional taxiway lights that operate in visible mode only and are observable primarily from the ground. These lights—designed and manufactured by Cooper Crouse-Hinds under subcontract to Optical Research Associates—are less costly for commercial airports to operate and maintain.

AFRL Develops Additives to Improve Aircraft Engine Bearings



AFRL fluids and lubricants experts managed three Small Business Innovation Research (SBIR) contracts to develop additives for the fully formulated gas turbine engine oils used with new aircraft engine bearings. These additives will improve the characteristics of the corrosion-resistant steel bearings to be used in engines of advanced aircraft such as the Joint Strike Fighter.

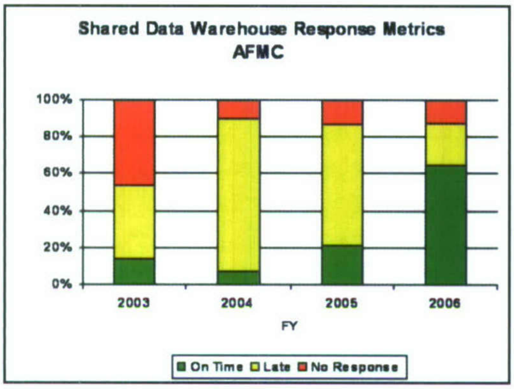
The development and testing of these additives involved collaboration among military and commercial institutions and showcased the technical expertise and leadership skills of AFRL's scientists and engineers. This research will provide a more suitable gas turbine engine oil for aircraft engines, which will aid in prolonging the life and enhancing the performance of advanced aircraft engines.

The Air Force operational environment requires aircraft to fly faster and carry more weight than currently qualified oils permit. Pursuing higher speeds and heavier loads results in increased temperatures and fatigue for aircraft engines. In addition, higher speeds and increased weight require engines to produce more thrust, increasing the amount of stress typical for steel bearings in the engines. The new additives are totally soluble and react with iron surfaces to create the necessary lubrication, allowing engine bearings to be designed for maximum load-carrying capacity and minimum friction.

AFRL researchers received funding for three Phase I SBIR contracts. All three companies—METSS Corporation; UES, Inc.; and Wedeven Associates, Inc.—received tasking to develop and screen a number of additives for antiwear properties, as well as critical characteristics such as thermal stability and coking.

AFRL experts closely guided the effort, interfacing with the three SBIR companies; commercial oil companies NYCO S. A., ExxonMobil, AirBP, and Hatco; and engine companies Pratt & Whitney, General Electric, and Rolls Royce to open the lines of communication and information sharing among the involved parties. NYCO S. A. agreed to provide its oil for suitability testing and assessment with the additive candidates. The results of this effort demonstrate a ~2x improvement in wear using corrosion-resistant steel and candidate formulations compared to currently used steel with current gas turbine engine oils. Both Wedeven Associates and METSS Corporation subsequently received Phase II SBIR contracts.

AFRL Enhances Diminishing Manufacturing Sources Analysis



The AFRL-managed Air Force Materiel Command Diminishing Manufacturing Sources and Material Shortages (DMSMS) program office recently demonstrated the Web-based Air Force Module's (AFM) value in linking the service to the Diminishing Manufacturing Sources (DMS) Shared Data Warehouse (SDW). The DMS SDW initiative focuses on improving sustainability and cost efficiency across all Air Force (AF)—and potentially all Department of Defense (DoD)—weapon systems.

The AFM enhances oversight and tracking, expedites case processing, and simplifies AF DMS trend analysis reporting. These capabilities not only improve DMSMS management processes, but also contribute to the long-term DMS SDW vision of consolidating all DoD data sources to better manage issues of obsolescence. The AFM, officially the D400, is part of the Office of the Secretary of Defense–sponsored, DoD-wide SDW effort, which includes stakeholders from the Army, Navy, AF, Government–Industry Data Exchange Program, and Defense Logistics Agency (DLA). Since the AFM's implementation, on-time response has increased from 8% to 64%, nonresponse has dropped from 46% to 12%, and average response time has decreased from 127 to 25 days.

The AFM is a Web-based application developed to automate standard AF DMSMS discontinuance notification, case management, and case response practices. It maintains online case history data dating back to Fiscal Year 2000 and generates standard reports for use at all levels.

Accessible to all program managers, systems engineers, item managers, and equipment specialists with AF DMSMS management responsibility, the AFM enables distribution of case information to every DMSMS-impacted weapons system in the AF inventory in less than 24 hours. The system currently receives and sends case information electronically to the DLA. Upon receipt of a new case, the system automatically queries the AF's D200F database. This application creates worksheets and sends e-mail notifications to program managers, item managers, and equipment specialists impacted by the discontinuance.

Sharing the AFM source code with the Navy accelerated development of the Navy's DMS SDW module. The common core application allows both services to collaborate on joint development and share independent improvements, while maximizing the use of limited resources and meeting the specific needs of each service.

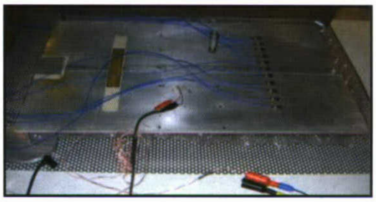
Researchers Improve Capability to Detect Cryogenic Tank Damage


Al-Li Friction-Stir-Welded Tanks

Researchers from AFRL, the University of Dayton Research Institute, and Purdue University's School of Mechanical Engineering made significant progress in developing an improved capability for monitoring the structural health of cryogenic tanks used for space missions. The researchers conducted high-resolution nondestructive evaluation (NDE) and structural health monitoring (SHM) experiments using elastic wave propagation (in the form of surface and guided waves) and were able to quantify microstructure and mechanical damage in friction-stir-welded aluminum-lithium (Al-Li) alloys, which are prominent candidates for cryogenic tank construction. The research is not only essential to ensuring the reusability of cryogenic tanks across hundreds of missions, but is applicable to other types of unitized structures as well.

The improved capacity to detect incipient damage in cryogenic tanks enhances safety, speeds turnaround time, and reduces operating and material costs. Therefore, AFRL's NDE and SHM research benefits the Air Force, future space programs, and industry alike.

Researchers examined the dynamic behavior of the Al-Li alloy plates and determined nodal and antinodal points. They then applied both high-frequency (elastic wave propagation) and low-frequency (vibration) acoustic waves to interrogate the damage in the plates. The team initiated high frequencies using piezoelectric patches/transducers and low frequencies using a dynamic shaker system. The researchers also used burst and swept waveforms for the high frequencies. Next, the team simulated different forms of damage, using either localized temperature gradients or mass placement along and away from the weld. The team's effort also involved damage studies conducted by introducing cracks in the plates at various locations. Sensors placed at different locations enabled researchers to understand sensor effectiveness in capturing the damage data.



To analyze the time-domain data obtained from the sensors, researchers used signal processing methods such as conversion to frequency-domain data, time-frequency analysis, and harmonic wavelet analysis (with each wavelet level corresponding to an octave band of traveling plate wave modes). Additionally, they assessed statistically significant features for damage detection and identified damage locations using beam-forming methods. The researchers' numerous experiments were able to show that the vibroacoustic (combined low- and high-frequency) method is an effective and appropriate way to interrogate damage in both welded and nonwelded test plates.

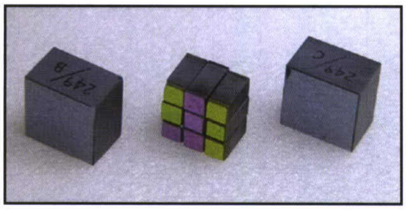
AFRL Technology Improves Firefighting Vehicles

AFRL engineers developed a revolutionary new firefighting technology that will pave the way for a new generation of smaller, leaner, air-transportable fire trucks. The basis of the technology is a system for delivering ultra-high-pressure (UHP) agents to combat aircraft fuel fires—a capability that reduces the amount of water and foam needed to fight fires, which, in turn, also reduces the size of the vehicle itself. The compact size improves the efficiency of air-transporting vehicles to the site—a C-130 can hold a pair of the new trucks versus just one (partially dismantled) P-19 fire truck. Despite reductions in both size and water-carrying capacity (decreased from 1,000 to 730 gal), firefighting effectiveness is actually improved. Engineers envision that the new deployable vehicles will be at least twice as effective as the current P-19 fire truck, essentially matching the capabilities of three large, 1,000 gal vehicles with two smaller, 750 gal vehicles.

For the effort, the AFRL Fire Research Group (Tyndall Air Force Base, Florida) modified an existing P-19 firefighting vehicle to incorporate three different agent application technologies: UHP water, compressed air foam, and dry chemical. Major technological breakthroughs include the design of a bumper turret capable of supporting both UHP and combined-agent nozzles, along with separate UHP and combined-agent handlines. Researchers have since removed the vehicle's roof turret as well, because qualitative fire testing—as well as quantitative flow characterization—ultimately revealed the effectiveness of the 300 gal/min UHP bumper turret as equal to that of the standard 500 gal/min roof turret. Air Force (AF) firefighter feedback supporting this decision indicates that the bumper turret is more efficient, permitting improved visibility of both the agent stream and the fire from the cab of the vehicle.

Since the modified P-19's elevation to full operational capacity, the test bed has shown that the UHP-equipped vehicle significantly increases firefighting effectiveness over standard P-19 capabilities, while discharging only 60% as much firefighting agent. Armed with these promising results and the endorsement of the AF major commands, researchers recommended the creation of guidelines addressing aircraft rescue and firefighting vehicles of the future. Accordingly, AFRL is leading a $2.4 million effort with the Air Force Civil Engineering Support Agency (AFCESA) to modify five additional P-19s with UHP technology for additional field testing and evaluation. The next-generation UHP P-19s will employ a smaller, lighter-weight centrifugal pump that will cost 75% less than the first-generation, 300 gal/min pump system. AFCESA will use the experience gained from these five vehicles to develop specifications for the new military-deployable fire truck.

Improved Crystals Transition for Laser Technology Demonstration



AFRL researchers managed an innovative research and development (R&D) effort conducted with BAE Systems, Inc., that achieved a tenfold increase in the energy-per-pulse performance of zinc germanium diphosphide ($ZnGeP_2$) crystals—important components in the construction of high-power (and now, high-energy) laser systems. Due to the significant performance increase, the technology transitioned to AFRL's Directed Energy Directorate prior to the conclusion of the R&D effort; there, it will see immediate application as an enabling technology in a planned infrared (IR) laser technology demonstration. The development brings the Air Force a key capability for achieving high-energy IR pulses and thus marks an important step in establishing IR laser sources for military applications.

The AFRL-industry R&D effort improved the damage hardness of the nonlinear optical $ZnGeP_2$ crystal by a factor of two and increased the surface area of the aperture by a factor of nine. The researchers increased the crystal's level of damage hardness by polishing it using an innovative technique. Whereas the process has typically involved moving a crystal back and forth atop an abrasive surface and using a stream of water to wash away waste, the new technique submerses the entire crystal in a water bath and positions the abrasive surface above—rather than beneath—the crystal. This method allows waste to float away in the bath rather than being dragged across the crystal, thus eliminating the scratch defects (known as sleeks) inherent to the former method.

Researchers successfully widened the aperture by growing the crystal boule to larger dimensions—a difficult task requiring that three problems be overcome. First, the larger quantity of phosphor needed for creating a larger boule resulted in increased pressures and greater danger of ruptures. Designing the ampoule (sealed quartz tube) with thicker glass solved this problem. Secondly, the weight increase stemming from both the thicker glass and the greater amount of material caused sagging and furnace failure. The researchers resolved this issue by redesigning the ampoule support rods. Lastly, the larger container, or boat, used to grow the larger crystals produced crystals exhibiting spurious nucleation and grain boundaries. To address this final obstacle, the team incorporated a graphite support to stabilize the thin stem of the boat, which contains the oriented starting material from which the growth of the entire boule is initiated.

AFRL Develops Partial Solution to Helicopter Brownout

At the request of Air Force Special Operations Command (AFSOC), an AFRL rapid reaction team successfully integrated and tested a science and technology (S&T) solution to helicopter brownout, a problem that occurs during takeoffs and landings performed in the dry, dusty conditions of the desert and similarly arid environments. The blowing sand and dirt (i.e., brownout event) dramatically reduces pilot visibility, and AFSOC has attributed the loss of more than 30 rotary-wing aircraft—and 60 servicemember lives—to the critical problem. AFRL scientists and engineers worked with Applied Minds, Inc., to develop a short-term, "see and remember" prototype system for reducing aircraft accidents caused by the loss of visual cues during takeoff and landing operations. Less than 5 months after receiving the AFSOC request, the AFRL team began flying the prototype system on a commercial helicopter.

This S&T solution—known as the Photographic Landing Augmentation System for Helicopters, or PhLASH for short—employs an electro-optical sensor and infrared strobe lights to image and georegister the ground (i.e., match the image to a coordinate on the earth's surface) prior to the pilot's landing attempt (i.e., before the brownout condition ensues).

During the helicopter's final approach, but before the aircraft triggers brownout, PhLASH captures a series of high-resolution digital still images of the landing area. The system transforms these images in real time based on the vehicle's subsequent flight path, resulting in a video-like display of the landing area and nearby obstacles, along with symbology indicating the vehicle's current position. The display will not reflect any changes to the landing zone from the point that PhLASH captures its most recent image (the last taken before brownout begins) until the aircraft's landing; however, this time span is typically less than 20 seconds.

AFRL recently completed developmental and operational testing of the system on an MH-53 helicopter. The next phase of the program involves the integration of PhLASH on operational helicopters. The Office of the Secretary of Defense selected the PhLASH program for $1.75 million of quick-reaction funding towards development of a ruggedized system suitable for permanent installation.

AFRL Develops Lighter-Weight Battlefield Power System

AFRL engineers advanced and deployed a battlefield power system that reduces the carrying loads of Air Force forward battlefield operators by 24%. In the past, operators carried up to 35 lbs of batteries into the field. AFRL developed the lighter-weight power technology over the past 3 years, completing both developmental and operational testing. This new technology incorporates a lithium-ion (Li-ion) rechargeable battery, a zinc air battery, and a handheld power manager that hybridizes the energy sources and provides power to the operator's equipment.

Battlefield operators previously used a number of Li sulfur dioxide batteries (BA-5590s) to power their equipment. This battery has considerable weight and a relatively low specific energy density; further, it has no means to provide information regarding its current state of charge. These and other factors contributed to limited use of BA-5590s during the origins of Operation IRAQI FREEDOM. AFRL engineers responded to the challenge of improving the availability and reducing the weight of the battlefield power system; they also incorporated additional capabilities, such as information on the system's state of charge.

AFRL first took advantage of existing zinc air battery technology by leveraging the BA-8180 product. Originally developed by Electric Fuel Battery Corporation under contract to the Army, BA-8180 is now available as a commercial off-the-shelf item. This battery is relatively lightweight and has a high specific energy density compared to BA-5590. The engineers used BA-8180 in their developmental system to provide a constant trickle charge to a primary Li-ion rechargeable battery.

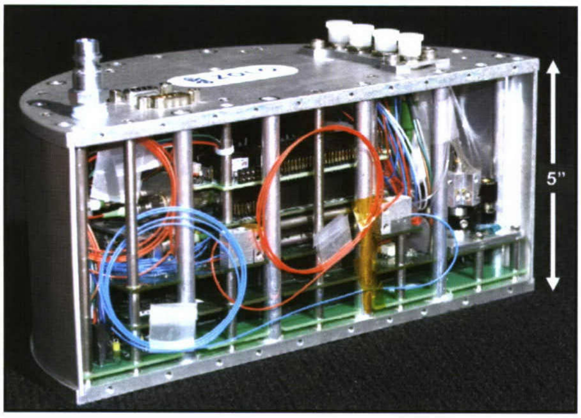
MediPak Energy Systems developed the Li-ion battery under contract to AFRL. The technology provides a reduced-weight battery capable both of being recharged from any 30 VDC power source and of providing high current under heavy load. By hybridizing this battery technology with the BA-8180 product, the AFRL team increased the system's overall energy density while decreasing the weight of the operator's carried load.

Smart Fuel Cell, Inc.—also under contract to AFRL—developed the power manager used in the new battery system. The product acts as the interface between the power sources and the equipment. It is capable of efficiently selecting and converting power from variable battery source options and delivering optimum power to the equipment at the correct voltages. The power manager also indicates the Li-ion battery's state of charge, providing the operator greater situational awareness of his or her battlefield power system's status.

AFRL's 1-Megawatt Superconducting Generator Successfully Completes Demonstration

AFRL scientists and engineers successfully demonstrated the Multimegawatt Electric Power System (MEPS) 1-megawatt (MW) superconducting generator. The demonstration tested the generator's load up to 1.3 MW at over 10,000 rpm. The line-line voltages were 266 V-rms, and the currents were 1460 A-rms. The new MEPS generator achieved 97% efficiency, using input power from the torque meter and output power from the electrical data, while also accounting for cryocooler losses. All test results indicate that the generator has a significant margin over the test points and that its performance is consistent with program design specifications. This 1 MW superconducting generator demonstration is the first successful full-power test of a superconducting generator for the Air Force.

AFRL Scientists Develop Miniaturized Laser-Based Measurement Capabilities for Scramjet Engine Performance Analysis



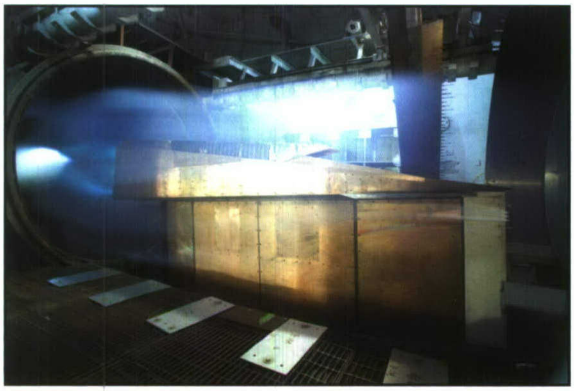
AFRL scientists are working with Small Business Innovation Research (SBIR) partner Zolo Technologies, Inc., to prepare for the first flight test of a diode-laser-based measurement platform. The test is part of the Hypersonic International Flight Research and Experimentation (HIFiRE) program. The team has adapted and miniaturized laser-based telecommunications technologies to develop a unique measurement platform employing tunable diode laser absorption spectroscopy (TDLAS).

The TDLAS platform provides a novel approach for measuring flow properties (e.g., species concentration, velocity, combustion efficiency) in flight. The method employs kilohertz frequency sampling rates in order to gain maximum information from flight experiments. This effort marks the first time that the technology has undergone miniaturization for use at scales suitable for sounding rocket flight experiments (which involve mass on the order of 3 kg and power on the order of 20 W).

HIFiRE represents a 7-year bilateral agreement with Australia to conduct research in the exploration and development of fundamental hypersonic aerospace technologies. TDLAS experiments are scheduled for three of the HIFiRE sounding rocket flights. These activities will focus on developing new, flight-qualified, nonintrusive techniques capable of measuring core flow properties in real time in order to characterize critical vehicle/engine parameters, such as air mass capture, stability limits, and combustion progress.

Scientists have qualified the diode-laser flight hardware to operate over unprecedented temperature and vibration conditions. The TDLAS experiments will transition the SBIR technology from Technology Readiness Level (TRL) 2 (i.e., technology concept and/or application formulation) to TRL 4 (i.e., component and/or breadboard validation in laboratory environment) in the initial flight, scheduled for 2008. Two additional flights are slated for 2009 and 2010, respectively. The team expects that the TDLAS measurement platform will achieve TRL 6 status (i.e., system/subsystem model or prototype demonstration in relevant environment, ground or space) at HIFiRE's culminating exercise, a Mach 8 scramjet [supersonic combustion ramjet] propulsion flight.

X-51A Completes Low-Mach Test Series

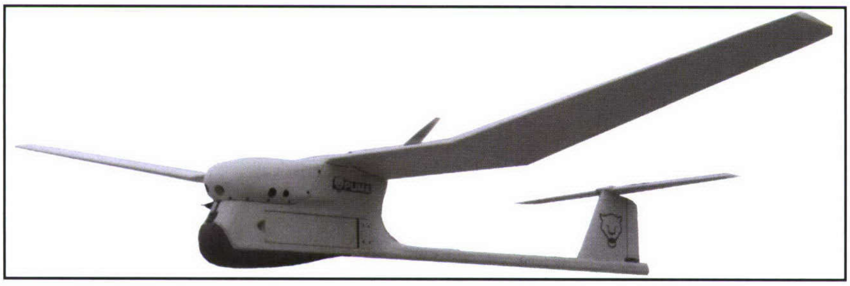


AFRL engineers completed low-Mach tests on the SJX61-1 engine using the National Aeronautics and Space Administration (NASA) Langley Research Center's 8-foot high-temperature tunnel. The Pratt & Whitney Rocketdyne SJX61-1 (or X-1) is a hydrocarbon-fueled scramjet [supersonic combustion ramjet] engine featuring full X-51A flight hardware: flowpath with forebody and nozzle, F-119 full-authority digital engine control/fuel control, and closed-loop thermal management system.

The X-1 successfully completed low-Mach testing, demonstrating JP-7 operation at flight-simulated Mach 4.6 and 5.0 conditions. Early estimates indicate measured performance and operability meet or exceed pretest predictions. To date, the X-1 has logged over 900 seconds of combustion time, more than the previous AFRL HyTech ground demonstration engines 1 and 2 combined. Despite enduring over 35 hot cycles, engine hardware remains in excellent condition. Completion of this test series is a critical step in the development of the X-51A integrated propulsion system and has provided the data necessary to support the X-51A Critical Design Review.

The X-51A Flight Test program plans to demonstrate the AFRL HyTech scramjet [supersonic combustion ramjet] engine within the Mach 4.5 to 6.5 range with four flight tests, beginning in Fiscal Year 2009. The X-51A program is a collaborative effort between the Air Force, the Defense Advanced Research Projects Agency, Boeing, NASA, and X-1 builder Pratt & Whitney Rocketdyne. The dedication of the joint NASA/Pratt & Whitney Rocketdyne test team made the successful test a reality. Subsequent tests will characterize the closed-loop thermal management system at Mach 6.5 conditions. The X-1 is the first of two ground engines planned in the X-51A Flight Test program.

Small Unmanned Air Vehicle Achieves Record Flight Time Using Hybrid Fuel Cell/ Battery Energy Storage System



AFRL engineers, in conjunction with Small Business Innovation Research partners AeroVironment (AV), Protonex Technology (PTX) Corporation, and Millennium Cell (MCEL), successfully flight-demonstrated Puma, AV's hand-launched small unmanned air vehicle (SUAV) that gets its power from a hybrid fuel cell/battery energy storage system. Puma flew for 7+ continuous hours on power supplied by PTX Corporation's PTX.L fuel cell system. The hybridized proton exchange membrane fuel cell employs a lithium-ion battery to provide peak power during takeoff and dash maneuvers; the fuel cell recharges the battery and provides continuous steady-state power for the plane and payload during cruise flight. MCEL provided a fuel cartridge of sodium borohydride (chemical hydride), which provided the fuel necessary for the fuel cell system's 7-hour, 3-minute flight.

The duration of Puma's flight represents a substantial increase in flight time for this class of SUAV. The standard Puma has a flight time of 2.5 hours on rechargeable batteries, while other electric SUAVs used by the military have flight times ranging from 45 minutes to 1.5 hours. The Puma SUAV delivers advanced flexibility and endurance, with an adaptable design that permits the addition of custom payloads in lieu of the air vehicle's standard configuration of color and infrared cameras. In addition to being easy to deploy and use, Puma allows operators to view both stationary targets and moving targets. The platform provides real-time intelligence via persistent low-altitude reconnaissance with a low noise signature.

The hand-launched Puma weighed 14 lbs, including its onboard fuel cell system and single onboard camera. Future flight demonstrations will seek to extend the plane's flight time, reduce its weight, and provide room for a full payload.

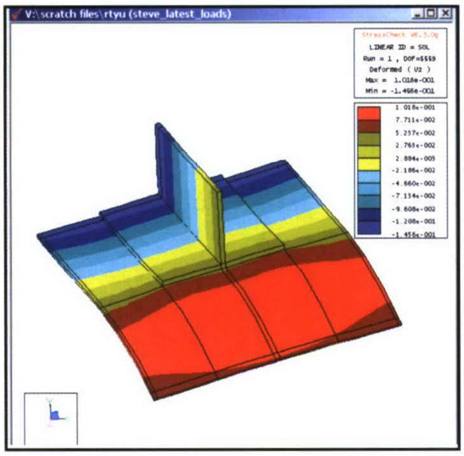
Lab-Developed F-22 Nose Landing Gear Door Reduces Production and Maintenance Costs

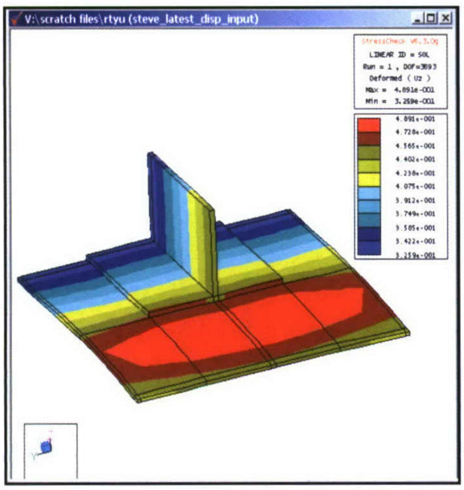
Working under AFRL's Advanced Aluminum Aerostructures Initiative (AAAI), researchers developed an innovative nose landing gear door (NLGD) that will be a part of all newly produced F-22 aircraft. The new door is less costly to produce than the original door structure; further, it will significantly reduce maintenance time and expense. Already installed on two vehicles, the redesigned NLGD is a unitized structure, eliminating the parts and fasteners typically required to hold traditional door components together. This single-unit construction makes the door a more aerodynamically efficient and easily maintained structure.

The door's constituent parts (a lower grid section and a top skin) fasten in place with snap-fit technology, meaning that they snap together without the need for drilled holes. The elimination of holes translates to less potential for cracking. The structure's one-piece construction will substantially reduce maintenance and associated costs.

AAAI is an AFRL-managed, congressionally funded advanced development program with the ultimate goal of reducing the installed cost of aluminum aerospace structures, while also reducing maintenance requirements, improving performance, and decreasing life-cycle costs. As such, AAAI represents a new approach to design—one that streamlines the design process by involving both the material manufacturer and the airframe manufacturer throughout all phases of product development.

Advanced Structural Analysis Tool Is a Collaborative Success





An advanced modeling and analysis tool for complex composite structures, StressCheck™, is generating benefits across the aerospace industrial base. Industry innovation and a collaborative effort involving AFRL Small Business Technology Transfer, Navy Small Business Innovation Research, and Air Force/Navy Manufacturing Technology resources have enabled the development, maturity, validation, and subsequent transition of the tool to the F-35 and other advanced weapon systems and development programs.

StressCheck and its associated handbooks are saving substantial cost and time across the aerospace industry. By reusing existing finite element models, engineers can accomplish a typical joint analysis in seconds instead of hours, and the tool's automation—including automated error checking and application of the best failure criteria for each possible failure mode—substantially reduces the potential for errors. The StressCheck handbook models reflect expertise captured from experienced composite analysts; the tool therefore facilitates the ongoing, automatic application of this captured knowledge towards future joint designs of advanced weapon systems.

StressCheck's handbook functionality allows skilled engineers to develop reusable models of typical joints, including single lap shear, double lap shear, scarfed lap shear, and step lap joints for in-plane loading, as well as blade and clevis "pi" joints and back-to-back angle joints for out-of-plane loading. StressCheck requires that the user simply input the joint information, including materials and joint dimensions. Based on the information entered, the tool then automatically adjusts the model, calculates the results, checks for problems in the new joint configuration, and even prepares files for additional analyses.

Initially, the F-35 program evaluated the use of this software tool for analyzing inlet duct bonded assembly joints. StressCheck's success in this area raised awareness regarding the tool's value in performing stress analysis of complex composite structural details and effectively expanded its use throughout the F-35 program. Already a standard tool at Boeing, StressCheck is currently aiding Lockheed Martin's F-35 efforts and is also undergoing evaluation for use on the Global Hawk.

AFRL Helps Identify Intelligent Communication and Hearing Protection System

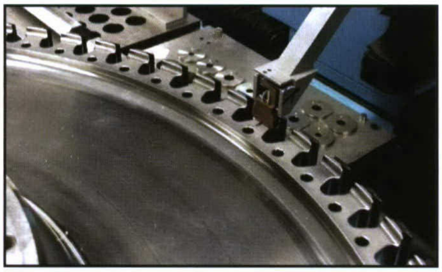
AFRL researchers assisted the US Army's Rapid Equipping Force (REF) in identifying an adaptive intelligent communication and hearing protection system designed to enhance military operations and make hostile environments less dangerous for US ground forces. The new, lightweight technology—known as QuietPro™—protects against acoustic trauma, an injury to inner-ear hearing mechanisms caused by excessively loud noise. Technical evaluations and demonstrations, combined with performance and production quality assessments, indicate the new system is a high-quality product, comparable to high-quality hearing aids and noise reduction headphones.

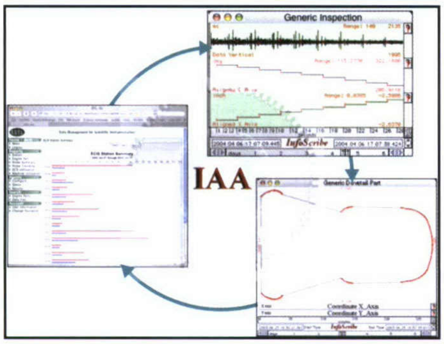
Tests show the device not only safeguards soldiers from sizable acoustic events, but also improves field communications and ambient noise detection. The QuietPro technology provides active noise reduction, peak noise limits, blast protection, and improved field communications in one package. The Marine Corps and Special Operations Command plan to purchase units based on the positive evaluation results.

Based on data acquired both from AFRL's developmental test and evaluation efforts and from other competing systems, the REF determined that QuietPro is an effective and promising technology solution. Testing included blast overpressure protection, noise reduction in a high-noise environment, and auditory direction perception accuracy, with future tests planned for the Marine Corps program. The test activity also leveraged AFRL facilities that serve as the national standard for measuring the speech intelligibility of communications systems. All QuietPro test results are positive, and the equipment is ready for large-quantity production.

QuietPro developer and manufacturer Nacre AS (Trondheim, Norway) produced several versions of the device to address military, aviation, and industrial customer applications. The system comes with earplugs, a noise attenuation mechanism with adjustable volume settings that can easily be attached to a soldier's vest, and connection cords that can interface with most military radios. The earplug is equipped with a miniaturized computer chip that isolates and eliminates the damaging elements of noise, reducing the risk of acoustic trauma. The plug also has a sensitive inner microphone that records the user's voice and transmits it via radio or wired systems, significantly improving field communications.

AFRL Initiates Transfer of Engine Data Mining Software



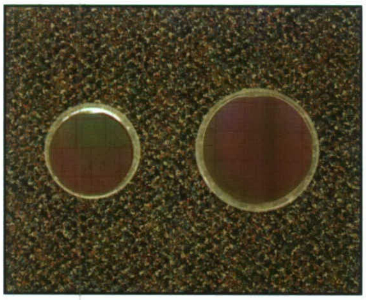


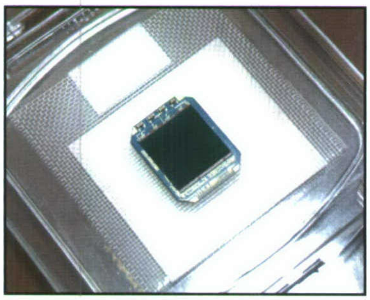
AFRL engineers collaborated with data management company Info Scribe Technology Laboratory (ISTL), Inc., to acquire a software package for assisting the management of inspection data. The Oklahoma City Air Logistics Center (OC-ALC), Tinker Air Force Base, Oklahoma, purchased the intelligent agent architecture (IAA) software to gain the capability to develop database search tools and reports for eddy current inspection system (ECIS) data.

With the software acquisition, OC-ALC now has the capacity to develop database search tools and reports related to the increasing amount of ECIS data collected daily. Prior to this purchase, the availability of tools and reports was limited to products developed under Small Business Innovation Research contracts, with the development of new tools being dependent on additional, follow-on contracts. The purchase of the IAA software license enables OC-ALC engineers to develop tools and reports for evaluating inspection times, testing restarts and failures, and verifying probe performance and eddy current machine utilization—all of which are tasks that aid overall inspection and maintenance of turbine engines on Air Force (AF) aircraft.

ISTL produced a data mining system that provides AF engineers, researchers, and maintenance personnel an efficient resource for searching through aircraft turbine engine inspection data and performing automated analysis on that data. IAA, a fully developed and demonstrated search capability, enables users to search ECIS data (stored at a rate of hundreds of gigabytes per year) and generate electronic reports within minutes. In addition, it allows the integration of all data sources so that users can conduct comprehensive searches for various trends, such as those pertaining to engine inspection processes or those related to a given engine's remaining life.

AFRL Program Helps Reduce Cost of Focal Plane Arrays





AFRL researchers completed their involvement in the F-35 Infrared Focal Plane Array (FPA) program, contributing expertise that led to a decrease in cluster defects and the insertion of larger-scale indium (In) antimonide (Sb) wafers into the arrays. The FPA is a significant component of infrared sensor systems and accounts for 75% of the total cost of the F-35 infrared detector assembly (IDA). By implementing manufacturing technology (ManTech) improvements, the researchers reduced the cost of the aircraft's IDA and achieved the desired savings. The success of this ManTech initiative represents a key cost savings for the Air Force and Department of Defense. The two companies awarded contracts under the FPA program, Flir Indigo Operations and L3 Communications Cincinnati Electronics, have identified the previous failures in producing InSb wafers for the FPA and are taking the necessary steps to correct the problem.

Wafers are small, thin, circular slices of a semiconducting material cut into square die. An FPA comprises a single die combined with an optical silicon wafer, a silicon readout integrated circuit, and a ceramic substrate, a unique—and patented—design. The Joint Strike Fighter Electro-Optical Distributed Aperture System (EODAS) is a sensor suite that provides the F-35 aircraft with a spherical view for threat warning and navigation. The IDA inside the EODAS contains the FPA, which provides the image data when appropriately mounted and connected into a higher-level camera assembly.

The EODAS consists of six IDAs, each with 90° field-of-view optics pointed in the different cardinal directions. A seventh unit resides in the Electro-Optic Targeting System (EOTS), a high-resolution gimbaled targeting system positioned under the nose of the aircraft. Researchers have identified several key roles for the EODAS and EOTS, including missile threat warning, infrared search and track, target detection and recognition/identification, battle damage assessment, and piloting and navigation, in all weather situations, both day and night.

The AFRL ManTech program achieved its goals of inserting the necessary technology to enable processing of 4-inch InSb wafers. This technology insertion will assist the F-35 program in meeting IDA-related goals and will result in a direct cost avoidance of approximately $400 million.

AFRL Research Team Awarded for International Collaborative Effort

Members of an AFRL-led cooperative program team that developed the Next-Generation Active Buffeting Induced-Stress Suppression System earned The Technical Cooperation Program (TTCP) Team Achievement Award for their efforts towards creating a vibration suppression system with the potential for extending the fatigue life of high-performance aircraft components. The team included researchers from AFRL's Air Vehicles Directorate, as well as participants from the National Aeronautics and Space Administration, Boeing, and various research teams from Canada and Australia.

The AFRL team's objective was to demonstrate an active control approach to the shared, technically challenging problem of structural life extension. The researchers chose to investigate the application of an active buffeting alleviation system for reducing the oscillations—or buffeting—endured by the vertical fin of F/A-18 aircraft flown at high angles of attack. The team sought to counter the harmful buffeting by applying active suppression through surface-bonded piezoelectric actuators and incorporating the existing rudder hardware.

Researchers tested the hybrid buffet suppression system on a full-scale F/A-18 vertical fin and fuselage structure at the Defence Science and Technology Office's International Follow-On Structural Test Project facility (Melbourne, Australia). Results showed significant reduction of buffeting and demonstrated that the hybrid suppression system, as well as each actuator system, individually offers a viable solution to buffeting or other vibration-related problems. For their efforts, the team members received the prestigious TTCP Team Achievement Award, an honor presented annually for projects that best exemplify the intent of cooperative programs. TTCP is an international organization that collaborates in defense scientific and technical information exchange. Member nations include the US, the United Kingdom, Canada, Australia, and New Zealand.

Lieutenant Colonel Tammy M. Savoie Wins Flemming Award

Lieutenant Colonel Tammy M. Savoie, of AFRL's Human Effectiveness Directorate, was named a recipient of the 58th Annual Arthur S. Flemming Award in the Administrative category. Lt Col Savoie is chief both of AFRL's Fatigue Countermeasures Branch, located at Brooks City-Base, Texas, and of AFRL's Aircrew and Protection Branch, Wright-Patterson Air Force Base, Ohio. She was honored for contributions in developing a suite of automated medical system solutions and coordinating with multiple government contractors to support warfighters in Iraq, Kuwait, and Afghanistan.

Lt Col Savoie deployed to Iraq to collect patient medical information in the field and make it electronically available to medical providers anywhere that a patient might be transferred. She executed Army and Air Force (AF) operational tests from start to finish, resulting in worldwide deployment of the system for use by expeditionary medical forces in Iraq and Afghanistan. Thirty AF, Army, and Navy units are deploying the software to collect combat medical data. Lt Col Savoie's efforts resulted in the flow of 500,000 health records from Iraq to an electronic watch board for medical surveillance.

The federal government established the Flemming Awards in 1948 to recognize exceptional employees who have at least 3, but no more than 15, years of government service. Nominees are acknowledged for their work contributions, educational achievements, and local community involvement.

Mr. Steve Szaruga Receives Air Force Outstanding Scientist Award

Mr. Steve Szaruga, of AFRL's Materials and Manufacturing Directorate, earned the 2006 Air Force Outstanding Scientist Award in the Senior Civilian category for his exceptional accomplishments and contributions to the Air Force (AF) and national defense. This award recognizes the top AF scientists who have made important technology contributions or have solved technical problems in the areas of sustainment, testing, training, or advancement. Throughout his career, Mr. Szaruga has demonstrated expertise and dedication towards the development and transition of technologies related to vital corrosion protection and low-observable materials for critical AF platforms. His selection exemplifies the highest level of technical expertise, professionalism, and dedication.

Mr. Szaruga led a team in the development of a nonchromated primer for aluminum aircraft surfaces and structures, marking the first time that a non-chromium-based primer proved capable of offering corrosion protection equaling that of chromium-based options. The primer, which was approved for use by the F-15 Systems Group, resulted in a a cost savings of $5,000 per F-15 aircraft per depot cycle. The primer also generated interest within the KC-135 and F-35 fleets, as well as the Brazilian AF.

Mr. Szaruga also initiated two important programs for evaluating polyurethane-based thermoplastic conductive sealants for advanced aircraft. These programs successfully identified a polyurethane-based thermoplastic product suitable for this purpose. Ready for use minutes after application and heating, this thermoplastic offers dramatically reduced processing time compared to the hours required for a traditional thermoset polymer to cure.

In addition to his work solving technology challenges related to AF aircraft fleets, Mr. Szaruga has also modified procedures for flight line repair of legacy aircraft conductive paint and radar-absorbing materials to incorporate objective test procedures for paint quality. This work provided more consistent operational performance, while increasing aircraft reliability and safety.

First Lieutenant Mark Mallory Receives Junior Military Engineer of the Year Award

First Lieutenant Mark Mallory, a lead engineer at AFRL's Materials and Manufacturing Directorate, received Air Force Materiel Command's Junior Military Engineer of 2006 Award. This award recognizes technical contributions to the sustainment, testing, and advancement of Air Force (AF) weapons systems. Lt Mallory was chosen for his hard work, expertise, and dedication to protecting the warfighter and using sound business skills to reduce unnecessary delays and spending. His selection is an example of AFRL's commitment to excellence in performance and aid to the warfighter and exemplifies the highest level of technical expertise, professionalism, and dedication.

Lt Mallory received his Bachelor of Science Degree in Chemical and Environmental Engineering from the University of Toledo. Lt Mallory's strong leadership abilities have contributed to reductions in AF spending. After expressing concern with the commercial body armor that the AF was purchasing, he pushed for the armor to undergo additional testing in order to verify commercial company claims. His efforts prevented the AF from purchasing $4 million worth of armor that did not meet AF requirements. He then advocated for the creation of a new Department of Defense standard for body armor. Under Lt Mallory's leadership, the new standard will list the requirements that commercial armor must meet before it can be purchased by the AF, Army, Marines, or Navy.

Lt Mallory also led an effort to identify issues with airfield matting designs. His careful attention to the issue led to the consideration of several different designs, prompted an overall cost savings of $65,000, and reduced the project work time by 5 months. In addition, he was responsible for deploying a new combat identification system into the field, and he also developed a new body armor inspection technique enabling simpler verification of the armor's integrity.

Tab 3 – Demonstration Exercises

Demonstration Exercises

Page

AFRL's Cooperative Operations in Urban Terrain Program Participates in US-Australia Combined Exercise

AFRL's Cooperative Operations in Urban Terrain (COUNTER) program recently participated in Talisman Saber 2007, the largest joint warfighting exercise in the Pacific. During the exercise, the COUNTER team integrated with Australian Defense Forces, Pacific Command (PACOM), and the 3rd US Marine Expeditionary Forces to fill the requisite Opposition Forces (OPFOR) role.

The COUNTER team deployed three unmanned air vehicles (UAV) for performing intelligence, surveillance, and reconnaissance (ISR) tasks. In flying more than 40 sorties in support of the OPFOR, the COUNTER UAVs frequently flew alongside manned vehicles, which presented unique challenges in sortie planning and execution. The COUNTER system performed all tasks successfully, demonstrating the technology's effective use in an actual combat scenario.

The COUNTER project represents an effort to provide situational awareness to special operations forces working in urban environments. The COUNTER team uses small and micro UAVs to perform ISR activities and collect video telemetry for detecting possible threat targets in the urban terrain. The COUNTER technology enables a single operator to manage multiple UAVs in low-altitude tactical (urban) environments. The team's participation in the combined exercise expanded the system's operational envelope by demonstrating the successful use of COUNTER components to fulfill mission requirements surpassing original design specifications.

The Talisman Saber exercise is designed both to train Australian and US combined forces in mid- to high-intensity combat operations and to ensure the cooperative readiness of the forces. PACOM was particularly interested in assessing the COUNTER system's capacity to help close gaps related to UAVs in urban operations. Talisman Saber 2007 marked AFRL's first major participation with PACOM. The lab's participation directly demonstrates the three Air Force core competencies: developing Airmen, adapting technology to warfighting, and integrating operations. COUNTER was one of four AFRL technologies to participate in Talisman Saber 2007.

Tab 4 – Emerging Technologies

Emerging Technologies

Page

Continued on next page

Emerging Technologies

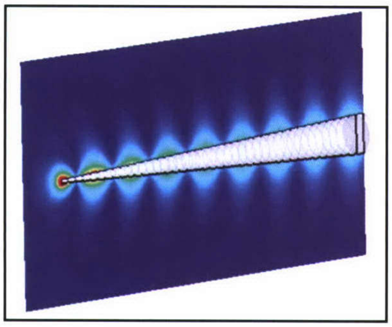
Page

AFRL and Argonne National Lab Team Up to Leverage Resources

Major General Ted F. Bowlds, former commander of AFRL, signed a memorandum of understanding (MOU) with officials from the US Department of Energy's Argonne National Laboratory that promises to save taxpayer dollars and speed the delivery of technological advances to American military forces. The new relationship between AFRL and Argonne will provide an opportunity to establish a common and consistent path into the respective technology bases of each facility.

The MOU will not only promote cooperative exchange of technical requirements and science and technology information, but will also result in mutually leveraged program development resources between the two labs. Officials expect the agreement will improve the cost, schedule, and performance goals associated with developing critical technologies for the nation through the coordination of related efforts and information exchanges. AFRL and Argonne are already working to evaluate material properties for titanium alloys, nanoparticles, and polymers. This collaborative research effort will leverage some of the top research scientists and facilities in the country, helping to meet the needs and requirements of emerging national and homeland security challenges.

AFRL-Funded Researchers Combine Terahertz Radiation and Metamaterial Technology to Detect Explosives



AFRL-funded researchers from the University of Bath, England, have developed wire structures that combine terahertz (THz) radiation with metamaterial technology to provide a straightforward explosives detection capability. The metawires guide THz wavelengths into narrow spaces or holes, where hidden explosives or other flaws and impurities readily absorb the THz radiation and are detected as a result of this absorption. This combination of THz radiation and metamaterial technology is useful because it provides the Air Force a portable means for investigating materials suspected of having flaws, impurities, hidden compartments, or similar features visible through the use of THz radiation.

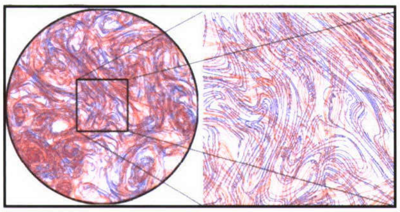
Factors such as strong atmospheric absorption, coupled with a lack of compact sources, detectors, and associated components, have caused scientists to debate the usefulness of THz radiation, which occupies a region of the electromagnetic spectrum somewhere between long-wave infrared and microwave radiation. The researchers were able to accomplish this particular investigation by passing THz waves through a wire with periodic grooves cut along its length. The grooves cause the radiation to adhere closely to the wire. Theoretically, a grooved wire that is also tapered will concentrate the THz radiation at the wire's tip, creating an intense source of THz radiation for insertion inside other structures as a probe.

Physicists Convert Light Pulses Into Matter for Quantum Communications

AFRL-sponsored physicists at Harvard University have—for the first time—halted a light pulse and regenerated it in a new location. This research is of consequence to the future of the Air Force because it could provide a powerful technique for fiber-optic communication and quantum information processing, which are important to encryption.

Researchers accomplished the conversion by stopping a light pulse in a supercooled sodium cloud, a Bose-Einstein Condensate (BEC), and then storing the pulse's data before extinguishing it. In the next phase of the technique, the information associated with the original optical pulse transforms into a matter wave traveling at 200 meters per hour. This matter wave travels to a second BEC, transferring the information between the two supercooled clouds. By illuminating the second cloud with a control laser, researchers revived the light pulse, which subsequently sped up and traveled out of the second BEC.

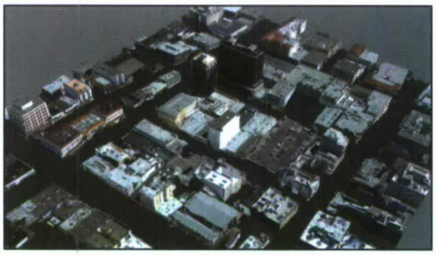
AFRL-Funded Researchers Identify Coherent Structures in Turbulent Airflow



An AFRL-funded team at the Massachusetts Institute of Technology is working to detect and predict structures that create clear-air turbulence. The team's objective is to understand and forecast the atmospheric structures that underlie the airflow associated with the phenomenon. The researchers use nonlinear mathematical and visualization methods as a systematic means of identifying the components of the turbulence. They are also exploring the identification of important, but otherwise hidden, structures in Air Force (AF) weather forecasting models as another focus area.

The work is of importance to the safety of high-altitude AF operations and the stable pointing of onboard laser weapons. Eventually, the work may assist engineers in designing better planes, cars, submarines, and engines. Using weather forecast data, the researchers were able to accurately identify the locations of optical turbulence having the potential to affect laser beams. The team would also like to investigate the use of coherent structures in locating sources of atmospheric pollution or contamination.

AFRL-Funded Researchers Aid Military Efforts With 3-D Models of Urban Environments



An AFRL-funded research team at the University of California at Berkeley devised a novel methodology for building three-dimensional (3-D) models of urban environments in a fast, scalable, and automated way. The new approach involves creating a digital surface model out of airborne laser scans (with complementary roof and terrain shape) and texture-mapping the scans with aerial imagery. The scans provide photorealistic renderings that enable virtual walk-, drive-, and fly-throughs.

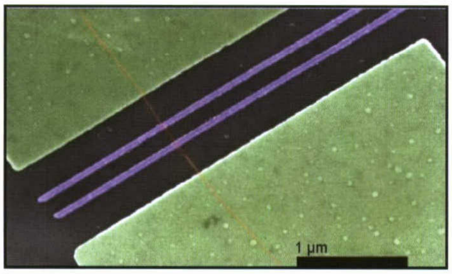
The availability of 3-D models representing major metropolitan areas allows the Air Force to execute its missions—both domestic and international—with more efficiency and precision. Having the exact 3-D map of a city is useful in counterterrorism activities, mission planning, and disaster management.

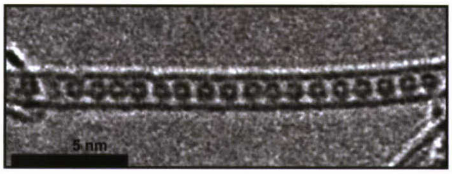
Previous 3-D modeling methods required that data acquisition (i.e., scanning) equipment be parked near a particular object (i.e., building or structure) for an extended period of time. The new technology's continuous-mode scanning capability cuts this acquisition window to approximately 25 minutes. The end result is a detailed model of the building or structure.

The new 3-D modeling approach permits automated generation of textured 3-D city models that supply both high-level detail at ground level and low-detail, complete coverage of aerial views. Acquiring a close-range facade model at ground level is as simple as driving a vehicle equipped with laser scanners and digital cameras through a downtown area under normal traffic conditions. Negotiating the street in a continuous—rather than stop-and-go—fashion affords extremely fast data acquisition times.

Following completion and transition of the ongoing 3-D modeling effort, the team would like to extend its work to the indoor environment and consider the problem of incremental model updating after a building has been demolished. The researchers would also like to examine the suburban landscape, where trees and other natural objects are intermingled with buildings.

Lab-Sponsored Research Investigates Electronic Properties of Carbon Nanotubes



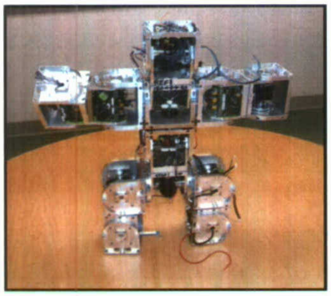


An AFRL-funded research team at Stanford University is creating transistors based on carbon nanotubes, ultrathin tubes of carbon a few atoms wide that will play a prominent role in the future of electronics due to their exceptionally high electrical conductivity. The new transistors contain several ultrafine metal wires placed atop a carbon nanotube for the purpose of locally depleting electrons and creating barriers to electron flow. The subsequent measurement of electron flow across these barriers reveals important information about the nature of electronic transport in one dimension.

The researchers are employing chemical vapor deposition, electron beam lithography, and atomic force microscopy to create the nanotube-based devices. They collect measurements at very low temperatures (less than two-hundredths of a degree above absolute zero). The team's research focuses on understanding the role of quantum mechanics in shaping electron flow in carbon nanotubes. Such a knowledge base will be essential in extending the capabilities of device miniaturization. In addition to allowing manufacturers to pack increasingly more switches onto a single chip, device miniaturization via carbon nanotubes may help reduce device power consumption and heat dissipation, which are critical issues for Air Force platforms ranging from manned fighter planes to autonomous drones.

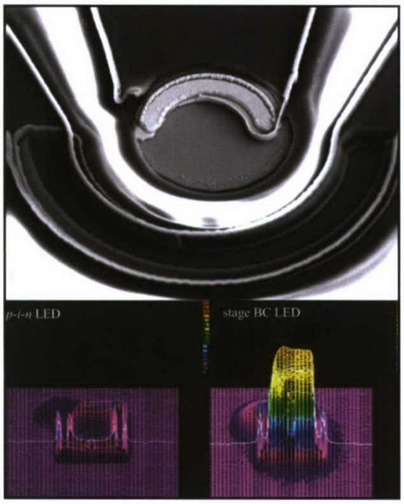
The research team's next step is to study the ways in which electrons react to a possible barrier in a one-dimensional wire—a topic of widespread speculation but, until now, very few experimental results.

AFRL Funds Development of Self-Reconfigurable SuperBots



An AFRL-sponsored research team from the University of Southern California is creating "SuperBots," self-reconfigurable robots capable not only of changing their logical or physical configurations (i.e., shapes, sizes, formations), but of altering their locomotion and manipulation to suit the mission and the environment. This research directly supports the Air Force vision of information dominance and the development of "anywhere, anytime" operational readiness by enhancing the warfighter's ability to quickly assimilate new information. The researchers will next focus on developing more adaptive behaviors for the SuperBot, as well as exploring task-triggered self-reconfigurations for the device.

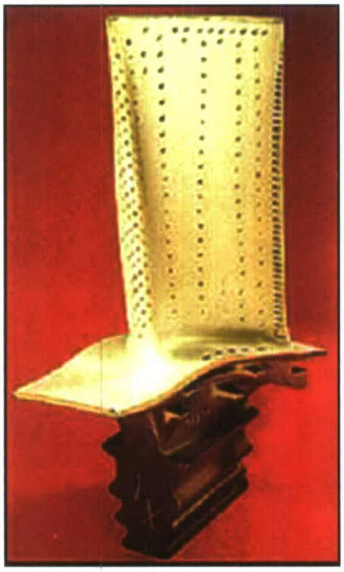
AFRL Research Advances Light-Emitting Diodes for Laser Applications



In-house sponsorship of an AFRL optoelectronics team is advancing Air Force combat systems through research into high-brightness/high-efficiency emission sources (e.g., light-emitting diodes and lasers) for laser radar and infrared countermeasures applications. In one effort, the team of AFRL sensors scientists utilized a novel thin film as an electrical interconnection between monolithically grown stacks of laser diodes for higher-slope-efficiency lasers. The outcome of this effort revealed that use of this technique produces much greater laser light output power with no significant loss of modulation speed in the output. In a separate effort, the team utilized state-of-the-art heat sinking and advanced designs to construct a surface-emitting laser with the capacity to achieve higher powers while maintaining single-mode emissions.

The researchers are also working on a laser that emits light without modulation (external modulator design) in the 50-60 GHz range. Light instead passes through a separate device—an optical modulator—that puts a high-speed signal on the carrier. The team is now investigating the possibility of small-signal modulation in three-stage, surface-emitting lasers at a speed greater than 9 GHz (with 10 GHz speeds on the horizon and 15-20 GHz representing the cutting edge of the technology).

AFRL-Funded Research Identifies New Material Properties

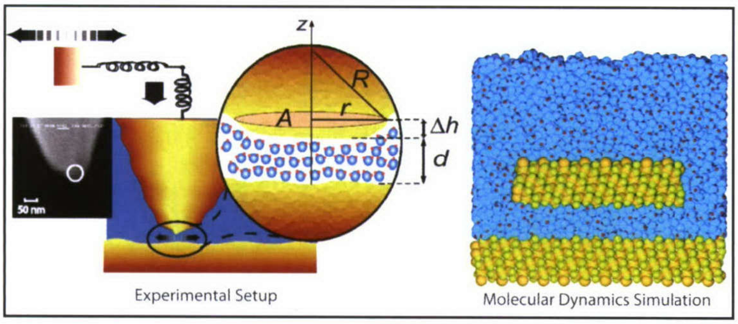


AFRL-sponsored researchers from the University of Wisconsin's Department of Materials Science and Engineering have identified new properties in molybdenum-silicon-boron (Mo-Si-B) alloys. The researchers discovered that the alloys exhibit melting temperatures more than 800°C higher than those of today's state-of-the-art nickel-based alloys, good oxidation and resistance, and useful mechanical properties. In order to provide the fundamental understanding needed for further development and application of Mo-Si-B alloys, the research focuses on basic studies of thermodynamic stability, diffusion kinetics, and microstructure control. Preliminary tests involving elevated-temperature mechanical properties have demonstrated that alloys based on this new microstructure are 50% stronger than current alloys, which are constrained by their melting temperatures.

By applying modern electronic structure computational analysis, in conjunction with considering atomic size factors and conducting critical experimental tests, the researchers are establishing guidelines for evaluating alloy phase stability and microstructure control. They have identified a key alloy phase that spans a wide range of compositions and are also examining the atomic arrangements necessary for achieving novel compositions. To obtain accurate information regarding defect structure, the researchers are employing several structural and modeling analysis methods—one of which entails use of the Intense Pulsed Neutron Source at Argonne National Laboratory—to obtain neutron diffraction measurements.

Increases in aeroengine operating temperatures exceed the limits of current, nickel-based superalloys; however, the higher-temperature environment equates to greater engine power and efficiency. Thus, the Mo-Si-B alloys' enhanced capacity for elevated-temperature operations is critical for future applications in hypersonic flight.

Researchers Discover Viscous Properties of Water



Experimental Setup

Molecular Dynamics Simulation

An AFRL-sponsored team at the Georgia Tech Center for Computational Materials Science discovered, via modeling and simulation methodologies, that water in layers 1 nm thick has viscous properties. This discovery will benefit the Air Force by encouraging researchers to use the same methods to reveal the novel properties of other materials used in advanced technological applications. The premise of this approach is for scientists to conduct their research by formulating and then applying classical and quantum-mechanical simulations via high-power computer platforms. The resulting data enables them to analyze, explain, and predict the properties of matter under varying conditions.

Researchers Attempt to Overcome Signal Interference in Free-Space Laser Communications

An AFRL-funded research team from the Klipsch School of Electrical and Computer Engineering at New Mexico State University is working to reduce atmospheric interference in free-space laser communications. The team of scientists has demonstrated new ways to deal with the fading effects that occur when light interferes with itself as it propagates through atmospheric turbulence. The researchers have developed a wave optics simulation that is the first to accurately model a "partially coherent beam." Their work uses fiber-optics technology to produce partially coherent beams from laser light (which is initially both time- and space-coherent).

The researchers proposed that light might better propagate through patches of atmospheric turbulence if reduced from its natural state of perfect coherence. Laser beams are potential tools for free-space communications, as well as for optical tracking, targeting, and other Air Force applications.

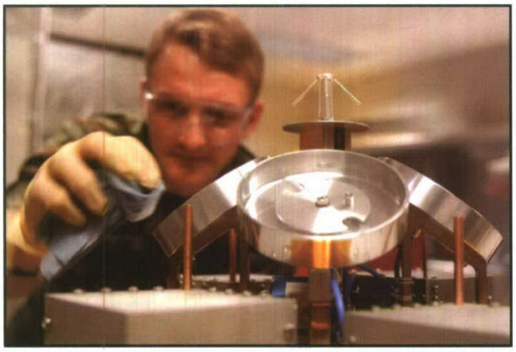
Air Force Officer Helps Build Clean Drinking Water Infrastructure for Iraqis

Lieutenant Colonel Joseph J. Fraundorfer, a senior reservist with AFRL, worked as deputy chief of the Water Sector for the Gulf Region Division in Iraq during his recent deployment. He worked alongside Air Force (AF), civilian, and Iraqi civil engineers as part of a construction crew working to reconstruct the water system in Iraq, improve water treatment processes, and otherwise make positive changes in the lives of Iraqis.

The team worked on potable water projects, along with improvements to dams and irrigation capabilities, in order to boost the country's agricultural output. The State Department identified and prioritized projects, which involved managing a budget of approximately $2 billion to construct 400 water projects. Lt Col Fraundorfer's group worked with Joint Contracting Command to get the jobs under contract and manage them programmatically to completion. While both Lt Col Fraundorfer's civilian experience as a program manager for a large defense and aerospace systems supplier and his AF role as a civil engineer working in foreign countries helped in completing the tasks of balancing cost, schedule, and technical issues, he found construction in an active combat environment to be a great deal more challenging.

By the end of his deployment, Lt Col Fraundorfer and his team had helped bring clean running water to more than 5 million Iraqis who had previously relied on untreated or boiled water for drinking purposes. This is not the 23-year AF veteran's first challenging overseas assignment. He served with the military as a test engineer for a space shuttle group, as a civil engineer during the Bosnian War, and as an air operations and logistics officer in Kosovo. He also did counterdrug work in Panama; civil engineering in Aviano, Italy; and air operations and logistics (as an officer) in Stuttgart, Germany, during the war in Bosnia. In May 2006, he deployed to Iraq for a 4-month tour of duty, becoming so enthused about the mission that he subsequently volunteered for a second, 4-month tour.

AFRL Funds Academy Satellite Program



AFRL is funding a research program at the US Air Force Academy (USAFA) that directly involves cadets in satellite design, construction, and launch. The most recent cadet-created satellite is FalconSat-3, which launched in the spring of 2007 from Cape Canaveral, Florida, and is currently conducting weather and spacecraft experiments 562 km above the earth.

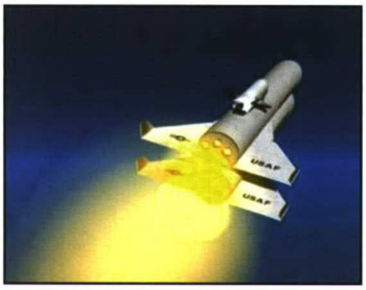
AFRL began funding the FalconSat program 6 years ago. USAFA's Space Systems Research Center provides program oversight, running the multidisciplinary, two-semester astronautical engineering course that asks cadets to put theory into practice. The purpose of the FalconSat program is to educate cadets in fields related to space and acquaint future Air Force leaders with the excitement and challenges related to satellites and space access. In addition to studying the requisite engineering and physics, cadets learn to deal with the real-life requirements and regulations that must be satisfied in order to build and launch a satellite.

FalconSat-3 houses five scientific experiments expected to support a number of Department of Defense (DoD) research initiatives. These experiments characterize the plasma turbulence in the environment surrounding the satellite, suppress the vibration caused by the stresses of launch, and investigate the satellite's shape and structural stability throughout its exposure to the rigors of launch and space.

USAFA's first nanosatellite/microsatellite was FalconGold, a 15 kg satellite that incorporated a Global Positioning System (GPS) signal experiment and launched aboard an Atlas Centaur rocket in 1997. FalconGold relayed GPS data for 15 days, demonstrating the viable use of GPS signals for orbital determination above the constellation. USAFA next launched FalconSat-1 (2000), followed by FalconSat-2 (2005), another satellite that successfully relayed GPS data.

Since the FalconSat-3 launch, cadets have operated the satellite from USAFA's ground station. Expected to remain in orbit for at least a year, FalconSat-3 will provide valuable data to the USAFA Physics Department, AFRL, and other DoD agencies.

AFRL Supports Research of Materials for Use in Extreme Environments



AFRL supports leading-edge scientific research that precipitates new performance capabilities for materials used in extreme environments—materials having the potential to impact the future of hypersonics. AFRL-funded researchers are making significant headway in advancing this critical area of materials investigation. Recent successes include the discovery of novel compounds; the development of a new process known as "melt texturing"; and the observation of important microstructural phenomena that provide insight as to how materials interact, both with one another and with their operating environment.

Researchers at the Naval Surface Warfare Center's ceramics laboratory are exploring a class of materials called cermets, ceramic-metal composites that exhibit the high-temperature properties inherent to ceramic materials but compensate for the intrinsic brittleness of ceramics at room temperature. Researchers discovered a new compound while attempting to prepare a cermet containing tantalum as the metal component and zirconium diboride as the ceramic component. Each material has a very high melting point. The strength of the new compound is substantially greater than that of zirconium diboride, a material already demonstrating significant potential for ultra-high-temperature applications and excellent resistance to oxidation and corrosion. These characteristics suggest that the new material may be capable of withstanding thermal shock and, thus, have potential use in reentry vehicles and nozzle components.

AFRL funds provided to the National Aeronautics and Space Administration (NASA) Glenn Research Center over the past 7 years—along with NASA's collaboration with the Frantsevich Institute for Problems of Materials Sciences—led to the development of melt texturing. This new process creates highly ordered microstructures in ceramic composites, enabling their use in multifunctional aerospace applications. For instance, melt texturing facilitates the use of ceramic actuators throughout a variety of high-temperature structural applications in propulsion technology—especially for rockets and hypersonic aircraft, wherein extreme thermal environments pose a significant challenge to current materials. Melt-textured materials could also find use in electron emitter applications for the electric propulsion of satellites.

AFRL's Materials and Engineering for Affordable New Systems (MEANS) program is a unique new medium for teaming colleagues from academia and industry in a way that permits them to tackle highly complex problems and derive fundamental physics-based models. The MEANS team is developing a mathematical model to describe the complicated mechanisms involved in the catastrophic failure of thermal barrier coatings (TBC) in turbine engines. The availability of this new model will permit engine designers not only to identify key material and structural parameters, but to probe the design space for improved TBCs. The team has already developed a new thermocycle test that will provide industrial colleagues a useful diagnostic technique for testing the efficacy of future coatings.

AFRL Funds Research for High-Power Airborne Laser Systems

AFRL is funding research at the University of Notre Dame to advance the knowledge of near-field aero-optic deviations and their effect on directed energy. A team at the university is researching the effect of aero-optics and its implication to laser communication applications and other optical research initiatives. Successful development of airborne laser weapons and communications systems will entail the development of adaptive optic or aerodynamic solutions to the corrupting effects of aero-optics.

Aerodynamic flows around aircraft structures induce density variations in the boundary layer flows and slipstream. The interaction of these density variations with a laser beam (i.e., the phenomenon of aero-optics) can severely alter the beam's characteristics, making it difficult or impossible to focus laser power on distant objects or transmit laser communications signals from a flight vehicle. To conduct the computational analysis, the team plans to employ an advanced large-eddy simulation code that can capture the density fluctuations and, thus, the changing index of refraction, which is important for accurate predictions regarding the effect of flow control on aero-optical deviations.

In order to complete wind tunnel experimentation prior to flight test, engineers at the university are building a new closed-loop wind tunnel with a 3-foot-square test section providing high-optical-quality access and low-intensity turbulence. The team will conduct flight tests in two Cessna Citations flying in formation. These aircraft are capable of achieving Mach 0.5 (380.7 mph, or half the speed of sound) in straight, level flight and Mach 0.71 (532.5 mph) in a descent.

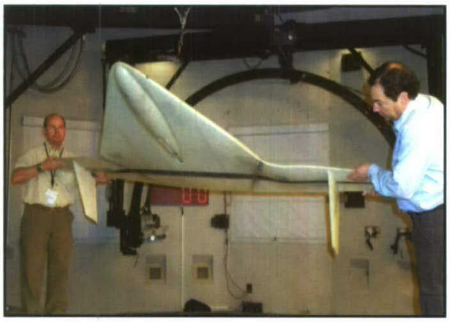
This research culminates decades of investigation into the relationship between fluid dynamic mechanisms (e.g., density gradients) existing in the presence of pressure wells and the refraction index of fluid media. When evaluation of these phenomena was first introduced over two decades ago, scientists considered it trivial. The scientific community now views research of these dynamic interactions as crucial to assuring the success of Air Force directed energy and laser communication technologies.

AFRL Provides Research Funding for Signal Processing Expert

AFRL-funded scientist Dr. Wil Myrick is conducting research that could ultimately provide the military with advanced remote sensing capabilities. Dr. Myrick is investigating the use of software-defined radio (SDR) technology in flexible adaptive signal processing architectures. First receiving AFRL support as a student attending Purdue University, Dr. Myrick completed work that established a great foundation in the area of reduced-rank signal processing. He also received the 2006 Black Engineer of the Year Award for his research in signal processing as related to solving some of the nation's most challenging signal processing problems.

Now a senior signal processing analyst at Science Applications International Corporation, Dr. Myrick is a nationally recognized expert in advanced adaptive signal processing. He also conducts related research that could eventually provide innovative plug-and-play signal processing algorithms that would further extend SDR capabilities, as well as new software interfaces that would support current and future clients in using reconfigurable signal processing architecture throughout their own infrastructures. Dr. Myrick's research will dramatically enhance communication and collection systems of critical importance to saving the lives of warfighters.

AFRL Researchers Test Mars Flyer Concept



AFRL research continues to play a critical role in the future of Mars exploration. Using the laboratory's Vertical Wind Tunnel (one of only two such facilities in the country), scientists from AFRL, the National Aeronautics and Space Administration's Ames Research Center, and the Naval Research Laboratory performed tests on a Mars Flyer model known as MATADOR—the Mars Advanced Technology Airplane for Deployment, Operations, and Recovery. MATADOR is a versatile, folding-delta-wing vehicle designed for deployment high above the Mars surface; the delta (i.e., triangular-shaped) wings fold in and out, enabling the vehicle's transition from vertical descent to horizontal flight.

The wind tunnel tests simulated low-speed flight similar to what would be encountered within the Mars atmosphere. The tests not only assisted the researchers in developing flight control algorithms for transitioning the vehicle from vertical descent to horizontal flight, but also allowed them to make key adjustments to the craft and verify computer-simulated data gathered from previous tests.

Throughout testing, the MATADOR model was suspended in the Vertical Wind Tunnel and subjected to upward-blowing winds reaching 14 to 17 mph, an environment which accurately simulated the vehicle's path through the Mars atmosphere during the critical first 30 seconds following the craft's emergence from its aeroshell. As an unmanned air vehicle concept, MATADOR would fly over the surface of Mars, collecting vital data about the planet's surface and atmosphere. MATADOR would then transmit this information—which might include evidence of water or ice just below the planetary surface, evidence of methane-related processes in the atmosphere, or data pertaining to the structure and turbulent behavior of the atmosphere itself—back to researchers on Earth.

Its sturdy, folding-wing design allows MATADOR to deploy safely through the thin Mars atmosphere with the assistance of thrusters. Furthermore, the design facilitates a relatively controlled landing on the Mars surface for the vehicle once it has completed its flight, circumventing the need for riskier crash landings. In addition, because the design alleviates the need for heavier vehicle packaging, it enables the craft to carry more fuel or payload.

AFRL Researchers Conduct Baseline C-130 Tip Tank Flight Demonstrations

AFRL, in conjunction with Snow Aviation, completed baseline flight demonstrations of a C-130 aircraft. To determine the aircraft's flight characteristics under various conditions, the researchers gathered data as the C-130 completed exercises such as maximum-performance takeoff, roll mode at half aileron deflection, banked turns, and power-off and power-on stalls. The research team also used the demonstrations to determine the aircraft's minimum controllable airspeed.

The collaborative effort supports Snow Aviation's plans to modify the C-130 by replacing the aircraft's traditional fuel tanks, which are located under the vehicle's wing, with functional tip tanks. The use of tip tanks may help improve aileron effectiveness and reduce the drag associated with the current configuration, affording better fuel efficiency. The company will employ the data collected during the initial flight demonstrations as a baseline for comparison with future results.

Tip tank modification marks one of several updates that Snow Aviation plans to pursue for improving the C-130's short-takeoff-and-landing performance, increasing the aircraft's controllability, and possibly reducing its drag. AFRL will continue to play an integral role throughout the tip tank demonstrations. During the next demonstration, researchers will fly a C-130 equipped with tip tanks. To ensure proper comparison of results, the team will employ methods similar to those used for collecting baseline data. AFRL will then independently assess the data to determine the benefits of the modifications.

Active Aeroelastic Wing Flight Research Vehicle Receives X-53 Designation

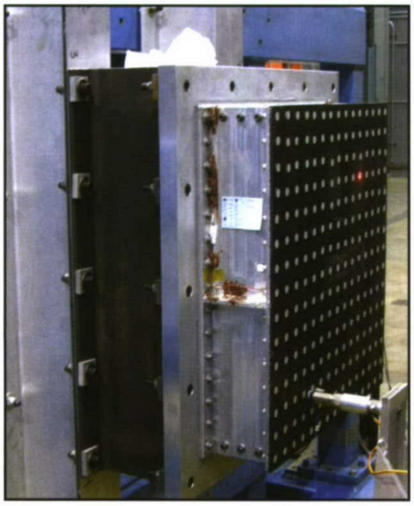
AFRL researchers received word regarding the Active Aeroelastic Wing (AAW) flight demonstrator's assignment to mission design series number X-53. The designation makes the vehicle AFRL's first successfully initiated X plane since the X-24 lifting body concept, which was later employed on the space shuttle.

Receiving X-53 designation marks an important step forward in AAW technology. The X-53 moniker affords the vehicle a higher recognition factor and will likely generate greater interest in the concept from a technology transition perspective. The AAW concept may play a crucial role in future aircraft, including strike unmanned air vehicles and global engagement bombers.

The AAW flight demonstrator, a joint effort between AFRL, the National Aeronautics and Space Administration, and Boeing, is a highly modified F/A-18 fitted with AAW technology. AAW refers to a novel wing concept that integrates aerodynamics, active controls, and structures to maximize air vehicle performance. AAW technology seeks to leverage aeroelastic effects—which are normally detrimental to aircraft performance—to benefit the vehicle instead.

Traditional air vehicle designs commonly employ stiff geometries to minimize aeroelastic instabilities such as aeroelastic control effectiveness. Alternatively, the AAW concept turns aeroelastic flexibility into a net benefit by exploiting the wings' aeroelastic twist. AAW control surfaces control the wings' aeroelastic shape at high speeds and maneuver loads to provide significant amounts of control power under conditions of high wing strain or to minimize aerodynamic drag under conditions of low wing strain.

AFRL Supports F-35 JSF With Acoustic and Impact Testing



AFRL signed a commercial test agreement with Northrop Grumman to conduct acoustic fatigue and impact testing of a thin-gauge composite material with a SynCore™ center structure. This material system is intended for use on the interior walls of the F-35 Joint Strike Fighter's (JSF) inlet duct.

Researchers subjected the test article to sonic fatigue loading in order to simulate pressure fluctuations resulting from engine noise and airflow through the inlet duct. The impact testing simulated the effects of small-impact loads (e.g., a tool drop or a bird strike). Engineers will use the test results to evaluate the material system's durability and damage tolerance capabilities as applicable to the construction of inlet duct walls. The completed tests, which contributed to fulfilling the certification requirements for F-35 inlet duct assembly, represent a significant step towards fielding this material system on the future operational JSF. Northrop Grumman will also use this data to validate its analytical models.

The test article, constructed of a minimum-gauge composite material with a stiffened SynCore center structure, was representative of a short-takeoff and vertical-landing version of the JSF inlet duct interior walls. Researchers mounted the article to an aluminum box structure to simulate the proper boundary conditions of the airframe.

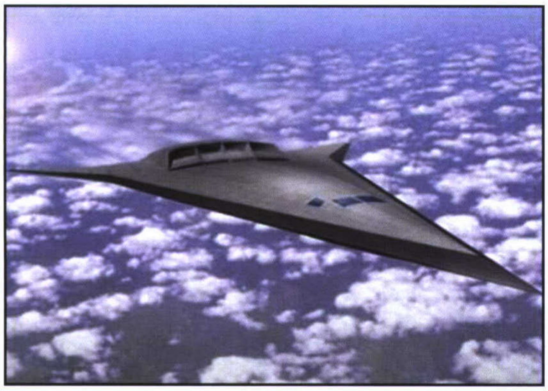
Researchers then subjected the test article to an accelerated acoustic level at a maximum 166 dB overall sound pressure for four entire lifetimes, each consisting of simulated ground run-up and flight operations. After the first lifetime, the research team executed a 6 ft-lb impact test that produced an impact damage zone slightly larger than the impactor, as detected by ultrasonic and thermographic inspections. Completion of the second and third lifetimes yielded no further increase to the impact damage zone, as verified by additional nondestructive inspections. The damage tolerance portion of the test effort included a larger impact load of 40 ft-lbs. At this load, the impactor only slightly deformed the test panel and precipitated no catastrophic failure—demonstrating better performance than analytical models had predicted. With the completion of one additional lifetime of acoustic fatigue, the damage initiated by the two previous impacts began to increase at the impact damage zone; however, the additional lifetime ended without catastrophic failure.

AFRL Researchers Support UAV Tests

AFRL researchers provided technical and operational support to The Ohio State University's Collaborative Center of Control Science (CCCS) during unmanned air vehicle (UAV) flight tests. The CCCS UAV flight tests will aid efforts to determine the usefulness of UAVs for future intelligence, surveillance, and reconnaissance missions, as well as the most effective use of UAV resources in a cooperative environment.

The battlefield air targeting (BAT)-III UAV completed five successful flights during testing conducted at Camp Atterbury, Indiana. BAT-III is a small, low-cost, autonomous UAV capable of delivering high-quality video telemetry to a ground station. The test effort enabled researchers to gather flight data for UAV modeling, while providing UAV operators the opportunity to gain experience in autonomous and manual landings. Operators also gathered imaging data of test targets and tested the experimental ground station. AFRL scientists provided safety and management oversight; the emergency remote control pilot; general assistance with the overall test activity; and technical development of the algorithms needed for UAV cooperation, which is yet to be tested. Additional testing is scheduled and will include flight tests of multiple UAVs.

AFRL Assists Northrop Grumman With Supersonic Tailless Air Vehicle Tests



AFRL provided a full-motion flight simulation environment to test candidate control systems for Northrop Grumman's Supersonic Tailless Air Vehicle (STAV) concept. The testing, conducted in the lab's Large-Amplitude Multimode Aerospace Research Simulator (LAMARS), incorporated design improvements based on new wind tunnel data and reflecting two additional controllers, various ground effects, and modified landing gear.

Throughout the testing, three Northrop Grumman test pilots evaluated aircraft performance during takeoff, landing, and subsonic and supersonic tracking tasks. The pilots used the Cooper-Harper rating scale, a method that assigns quantitative scores according to desired and adequate performance criteria, to evaluate aircraft handling qualities. Compared to the results of earlier tests, performed in May 2006, the aircraft's tracking and landing tasks received significantly higher ratings, due primarily to the incorporated design modifications. The study allowed Northrop Grumman engineers to collect data on over 100 different parameters throughout more than 300 test runs. They were also able to observe the effects of autothrottle on the STAV concept. This evaluation and data collection effort will facilitate further improvements to the concept. Once Northrop Grumman has incorporated the necessary design modifications, the research team plans to return to AFRL's LAMARS facility for additional testing.

The STAV concept entails an effort to reduce the weight and drag associated with traditional supersonic aircraft designs. This reduction is achievable by eliminating the tail and replacing conventional tail control surfaces with more innovative control effectors.

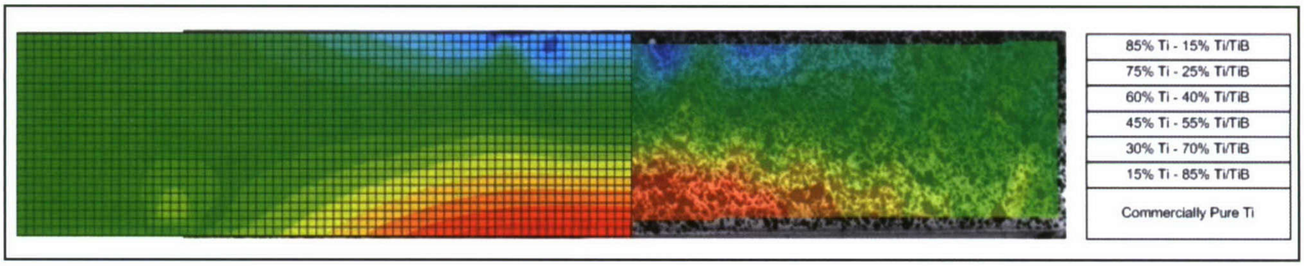
AFRL Researchers Test Sense-and-Avoid Technology

In an effort to improve the safety and expand the reach of unmanned air vehicles (UAV), AFRL scientists conducted a series of Sense-and-Avoid Flight Tests (SAAFT) in Niagara Falls, New York. AFRL established the SAAFT program to demonstrate autonomous collision avoidance capabilities in both cooperative and noncooperative air traffic. The intent of the parent Sense-and-Avoid (SAA) program is to equip UAVs such as the Global Hawk and Predator with collision avoidance capabilities and thus allow them the same access to national and international airspace that manned aircraft have. AFRL researchers are developing electro-optical (EO)-based "sense" (i.e., detection sensor) technology for noncooperative traffic detection. They are developing autonomous "avoid" (i.e., maneuvering) technology—and also using information from the Traffic Collision Avoidance System (TCAS)—to detect cooperative, conflicting traffic.

In order to evaluate the performance of the systems, AFRL engineers installed the SAA hardware and software in a Calspan Learjet (LJ) acting as a surrogate Global Hawk–like UAV. The LJ flew in various one-on-one encounter scenarios, with a Federal Aviation Administration (FAA) Beechcraft King Air and Convair 580 alternately acting as intruder aircraft on a collision course. The SAA system successfully controlled the entire sequence of open- and closed-loop flight tests, from detection through avoidance and return-to-course activity. The researchers first tested the individual capacity of the EO system, as well as that of the TCAS, to detect the intruder aircraft; they then employed the systems together. The team's objective was to predictably and reliably control the UAV in the same manner as a normally piloted aircraft. Pilots reported positive, humanlike system performance. Future scheduled flights will evaluate avoidance algorithm capabilities during collision scenarios involving multiple and maneuvering intruders.

AFRL also plans to conduct additional flights to investigate the use of autonomous dependent surveillance broadcast for cooperative traffic detection and long-wave infrared cameras for noncooperative traffic detection. The SAAFT team consists of personnel from Northrop Grumman-Integrated Systems; Calspan Corporation; Bihrle Applied Research; C2Projex; Defense Research Associates; AFRL; and, through a memorandum of agreement with the FAA, pilots and engineers from the Hughes Aircraft Flight Test Center (Atlantic City, New Jersey).

AFRL Researchers Perform Functionally Graded Material Bending Tests



AFRL researchers completed quasi-static bending tests of functionally graded titanium/titanium boride test specimens. The twofold purpose of this test effort was to gain a better understanding of the material-structure interactions and to evaluate laboratory testing tools and techniques. Functionally graded materials (FGM) such as the titanium/titanium boride composite have the potential to reduce or eliminate the need for parasitic thermal protection systems in hypersonic and other extreme environment aerospace vehicles. These FGMs are another tool designers can use to help maximize structural response and minimize weight in high-temperature aeronautical applications.

The testing involved 6" x 1" x 1" specimens—some of the thickest titanium/titanium boride bend specimens ever produced. During the testing, the research team loaded each specimen in a four-point bending fixture in order to determine the specimen's stress, strain, and displacement fields. To measure these quantities, the researchers employed experimental techniques such as differential thermography, digital image correlation, fiber-optic strain gauging, and conventional-resistance strain gauging. The testing validated the theory that FGMs can be tailored to improve the structural bending response. Furthermore, it gave AFRL researchers the opportunity to assess some of their more unique experimental tools as applied to work involving complex material-structural geometries.

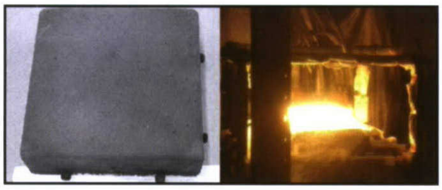
Structural Health Monitoring Tests May Aid Access to Space

AFRL recently tested a Structural Health Monitoring (SHM) system that may help improve rapid access to space. The test activity leaves researchers just one step away from developing an Operationally Responsive Space (ORS) vehicle, a craft capable of launching quickly, returning to earth, and launching again within a few hours.

The SHM tests involved a thermal protection system (TPS) test panel equipped with thermocouples and piezoelectric, acoustic emissions, and fiber-optic sensors. The various sensors monitored the structural integrity of the TPS panel as it endured simulated space launch conditions, including temperatures up to 2100°F and acoustic loads up to 165 dB. The research team conducted the tests in AFRL's Combined-Environment Acoustic Chamber, the only facility capable of simulating such extreme environments. The test results showed that all sensors not only survived the harsh environment to which they were subjected, but accurately detected the damage to the TPS panel.

By monitoring and reporting any potential structural damage incurred by the TPS during launch, spaceflight, and reentry, the SHM system could potentially reduce turnaround time for vehicles such as the space shuttle and other reentry aircraft. While SHM can likely benefit the ORS program, it can also be incorporated into high-speed vehicles such as the F-16 to help monitor in-flight damage and assist anticipation of emerging structural problems.

AFRL Tests Aerogel-Filled Carbon Foam TPS Concept

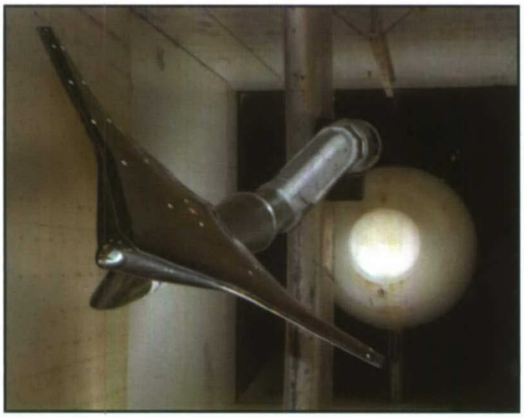


AFRL researchers recently used the lab's Structural Test Facility to complete successful testing of an advanced aerogel-filled carbon foam and oxidation-resistant composite structural shell thermal protection system (TPS) component. AFRL is completing this interdisciplinary development effort under contract to Ultramet Corporation.

The combination of aerogel-filled carbon foam with a refractory composite outer shell has the potential to structurally enhance a TPS outer surface, while providing the necessary thermal insulation to maintain the substructure at safe operating temperatures. The state-of-the-art TPS employed on the space shuttle orbiter comprises lightweight silica-based tiles that provide no benefit to the structural performance of the airframe. AFRL's new concepts are pushing the technology towards the more structurally and thermally efficient designs that the Air Force must have in order to meet the rapid-turnaround requirements of future military systems.

During the testing, researchers used graphite resistance heating elements to heat the face of the TPS component to 3500°F for three, 5-minute cycles. The tests demonstrated concept effectiveness, with the aerogel-filled carbon foam successfully decreasing the cool-side temperature of the TPS component by ~2400°F over a material thickness of <1.5 inches. The successful testing proved the capacity of the TPS component to maintain its integrity under high-temperature conditions while demonstrating very effective insulative capabilities. This material has potential application as part of a scramjet [supersonic combustion ramjet] engine flowpath liner, for protecting the vehicle's lower-temperature components from engine heat.

AFRL Researchers Complete Blended Wing Body Wind Tunnel Tests



AFRL researchers completed tests of a blended wing body (BWB) model in a 16-foot transonic wind tunnel at the Arnold Engineering Development Center (AEDC). The BWB model is a follow-on to previous wind tunnel tests conducted in the National Transonic Facility (NTF). The AEDC wind tunnel's larger cross section enabled researchers to gather a broader range of data, including measurements of the model taken at higher Mach numbers than the earlier tests had allowed.

During testing, researchers investigated both Mach tuck and Mach buffet on the configuration. Mach tuck is a condition wherein the nose of the aircraft tends to pitch downward as the airflow around the wing reaches supersonic speeds. Mach buffet is a condition in which the wings begin to vibrate at supersonic speeds. The research team observed neither condition during the testing, which involved more than 250 data runs, covering 23 configurations and spanning a Mach number range of 0.5 to 0.97.

To permit a direct comparison of data, the researchers conducted the initial portion of this test under conditions mirroring those of the NTF tests. The team then performed the remainder of the testing at a lower tunnel air pressure, which is less expensive and thus allows more configurations to be tested.

The BWB airframe merges wings and a wind-airfoil-shaped body, thereby generating lift and minimizing drag. In addition, it promises greater passenger or cargo capacity. Its potential may extend to various commercial and military applications as well, including tanker or transport aircraft.

X-48B Blended Wing Body Test Vehicle Takes Flight

The AFRL, Boeing, and National Aeronautics and Space Administration (NASA) jointly developed X-48B blended wing body (BWB) research vehicle made a successful maiden flight at the NASA Dryden Flight Research Center (Edwards Air Force Base, California). The test aircraft—an 8.5% scale, remotely piloted vehicle—successfully completed a 31-minute flight that tested the revolutionary aircraft's handling and flying capabilities.

The BWB test vehicle climbed to an altitude of 7,500 ft during the inaugural flight, completing a number of successful tests (e.g., initial stability checks, autothrottle checks, and practice landing and approach at altitude). Researchers compared the data acquired from this test flight to the extensive wind tunnel data collected during numerous tests at NASA's Langley Research Center (Hampton, Virginia).

All tests completed during the flight were successful, and the aircraft passed a postflight inspection with no parts damaged. The remote pilot reported that the aircraft handled and flew well. After initial evaluation and associated adjustments, the aircraft will make additional test flights. Future plans include up to 25 test flights at the low-speed flight regime for the purpose of gathering additional data and further evaluating the configuration.

The BWB design is similar to a flying wing, but the BWB aircraft's fuselage is triangular-shaped. The triangular construction gives the aircraft increased lift and less drag over the traditional tube-shaped fuselages of most military and commercial aircraft. The BWB concept provides greater fuel efficiency and increased cargo or passenger capacity. It may also prove to be quieter, since the engines are mounted on the back of the aircraft, away from the fuselage. Because of its unique shape and cargo capacity, the BWB concept has many potential commercial and military applications, including use as a tanker or transport aircraft.

AFRL Captures Real-Time Video for Ballistic Missile Test

AFRL engineers tracked and collected data on a successful missile defense intercept test at the Navy's Pacific Missile Range Facility (PMRF), located off the Hawaiian island of Kauai. They fed real-time video to the control center, successfully capturing the intercept of a Scud-type ballistic missile launched from a mobile platform positioned in the Pacific Ocean off Kauai. The "hit to kill" interceptor launched from the Terminal High-Altitude Area Defense (THAAD) launch complex at the PMRF, which is the world's largest instrumented multienvironment range capable of supporting surface, subsurface, air, and space operations simultaneously.

This THAAD interceptor mission marks a significant accomplishment for both the Missile Defense Agency THAAD program and the AFRL Maui Space Surveillance Site (MSSS) activity—it is the first such mission considered a test of the Ballistic Missile Defense System (BMDS), given that more than one element of the BMDS program participated in the test activity. Test elements included net-centric command and control communication links, missile/interceptor launches from the PMRF site, target identification, target interception, radar tracking, and hit assessment algorithms.

AFRL collected images of the intercept and debris cloud, providing critical information on both kill assessment and lethality. These resolved images verify the target and kill vehicle impact point. The data and analysis improve real-time kill assessment algorithms for the BMDS. Once fully developed, tested, and deployed, the BMDS will serve the US homeland and its deployed force, friends, and allies as a layered defense against ballistic missiles of all ranges, in all phases of flight.

AFRL's MSSS is a state-of-the-art electro-optical facility combining operational satellite tracking capabilities with a research and development program; the site also houses several telescopes—one of which is the largest within the Department of Defense. Space object tracking occurs via telescopes, low-light-level video cameras, and computers. The midwave adaptive optics system was the primary electro-optic sensor for the THAAD test because it captures images at a very high frame rate.

AFRL Tests Next-Generation NASA Communications System

AFRL engineers are testing a next-generation hearing protection and communications system for astronauts. The new system is designed for use inside the National Aeronautics and Space Administration's (NASA) advanced crew escape suit (ACES) during the remaining space shuttle missions. During liftoff, astronauts in the shuttle crew compartment experience noise levels of approximately 115 dB SPL (sound pressure level) for less than 1 minute. AFRL engineers used the lab's 50,000 W microphone-in-real-ear facility to perform tests reproducing shuttle launch sound levels. While the test data will help NASA determine whether astronauts are exposed to potentially harmful noise levels during missions, it will also aid researchers focused on ensuring that communications remain as clear as possible throughout the all-important launch period.

ACES is a fully pressurized system that includes a bright orange full-body suit; a launch/entry helmet that attaches to the suit with locking rings; and a communication carrier assembly (also known as the "Snoopy cap"), which is worn under the helmet and contains protective ear caps and microphone boom assemblies. While the suit's primary use is for shuttle launch and entry, astronauts also wear ACES during any on-orbit emergency situations to protect themselves from exposure to the elements and contain themselves within a safe atmosphere.

NASA's upgraded technology and AFRL's related assessment techniques could also help guide the design of a helmet and communications system for NASA's Constellation program, a recently initiated space exploration mission geared towards returning humans to the moon and then pursuing Mars and other solar system destinations. To improve astronaut comfort, NASA plans to incorporate a dual-microphone system with a shorter boom that can adjust to accommodate a range of head shapes and sizes. With the current, fixed-position boom, the microphone is sometimes too far away from smaller crew members.

AFRL and FAA Engineers Work to Keep Aircrews Safe From Lasers

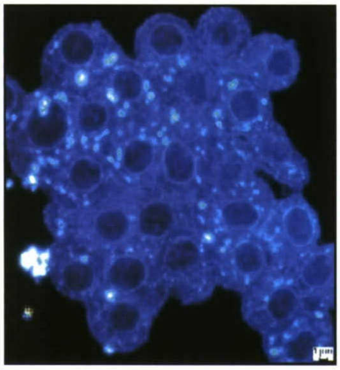
Engineers from AFRL and the Federal Aviation Administration (FAA) are collaborating to improve aircrew safety in situations where lasers are carelessly or maliciously pointed at aircraft. A team of optics, human factors, and computer specialists is quietly laying the groundwork for this unique research project. The fruit of their efforts is a one-of-a-kind laser positioning system integrated with a Boeing 737 flight simulator at the FAA's Mike Monroney Aeronautical Center (Oklahoma City, Oklahoma).

The system realistically mimics the effects of a laser flashed at an aircraft cockpit from the ground. While such concentrated beams of low-power laser light are not physically harmful, they can distract or temporarily incapacitate aircrew. The 4-axes-of-motion system uses fiber-optic cables to transport a laser beam from its source to the simulator. A computer tracks the simulator's flight path and correlates it with the ground-based laser's simulated position so that from the pilot's perspective, the laser maintains a constant ground location.

A handheld laser pointer directed at an approaching aircraft from 2 miles away can cause windshield glare, after-images, and flash blindness (i.e., temporarily impaired vision caused by an intense flash of light)—leaving a pilot unable to see an airport's runway and surrounding landscape. The effects are similar to those caused by a camera flash or the bright headlights of an oncoming vehicle. The integration of eye-safe lasers into a flight simulator enables researchers to monitor pilot reactions and recommend appropriate countermeasures.

A congressional report issued in January 2005 cites laser-specific laws, eye protection for pilots, laser-free zones near airports, and public education as ways of reducing the laser threat to aviation safety. Thanks to the input of AFRL and FAA experts, congressional legislation has been introduced to make it a federal offense to point a laser at an aircraft. AFRL and the FAA are teamed via a $10 million memorandum of understanding that allows the organizations to share personnel, funds, and resources, including the FAA's state-of-the-art simulator.

AFRL Researchers Study Biological Interaction of Nanomaterials to Enhance Force Protection



Thanks to in-house funding, AFRL scientists are accomplishing a multitude of nanotechnology research projects geared towards investigating the biological interactions of engineered nanomaterials, including potential toxicities arising from the physicochemical properties uniquely associated with nanoscale structures. This research will assist in acquiring the fundamental knowledge needed to facilitate a better understanding of nano-bio interaction mechanisms, provide in-depth analyses of corresponding effects on biological systems, and enable the theoretical development of predictive bioresponse models. Not only will such knowledge help to improve nanomaterial safety strategies for the protection of human and environmental health, it will also aid the application of advanced nanobiotechnologies to the development of future weapon systems.

Under certain conditions of exposure, every chemical is toxic. While the Air Force is working to minimize issues concerning the production, handling, and disposal of nanomaterials as they relate to future mission requirements, a significant knowledge gap remains with respect to the human and environmental health implications of increasing nanomaterial usage. There is a need to understand the potential sources and effects of exposure to nanomaterials throughout their cycles of production and use. Further, it is critical to understand the transport—and evolution—of nanomaterials channeled through the environment and the human body, including their significant avenues of access and potentially adverse effects.

Two key areas of immediate military relevance include propulsion and munitions systems, which employ nanomaterials not only in tuning systems for greater insensitivity to ignition during storage and delivery, but in generating more energetic propulsion/explosions and ensuring long-term storage stability. Consequently, there is a growing need for nanoenergetics and other novel technologies to satisfy the increasing performance demands of propulsion and munitions systems.

AFRL CRADA Improves Safety Standards for US Firefighters

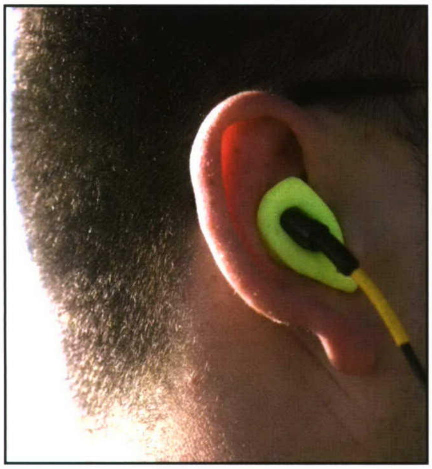
A study taking place at AFRL's Computerized Anthropometric Research and Design Laboratory under a Cooperative Research and Development Agreement (CRADA) could lead to improved safety standards—and, consequently, fewer deaths—for the nation's firefighters and rescuers. The National Fallen Firefighters Foundation approached an anthropometry surface scanning company, Total Contact, Inc., to study the body size and shape of firefighters. The outcome of this inquiry was an AFRL/industry CRADA enabling the use of the lab's three-dimensional anthropometric body scanner to aid the study. The data will facilitate development of new industry guidelines towards improving the fit and function of firefighter/rescuer safety equipment, clothing, and vehicles. This data will also become part of the Air Force (AF) anthropometry program database.

Statistics from the International Association of Fire Chiefs reveal that outdated manufacturing guidelines related to the large size and bulk of turnout gear, along with inadequate fire engine seat design, prevent 25% of US firefighters from buckling their seatbelts while riding in a fire engine. Since 2000, 52 firefighters have died as a result of traffic accidents involving fire engines; of these individuals, 36 were not wearing seatbelts at the time of the accident. In fact, motor-vehicle-related incidents—including vehicle rollovers—represent the second-leading cause of line-of-duty fatalities among firefighters.

Valid sampling requires a total of 120 firefighters, including females and minorities, in order to fully represent the firefighter population. Currently, 30 firefighters—mostly white males—have volunteered as test subjects. The study will dovetail with a comprehensive, separately funded project conducted by the National Institute of Occupational Safety and Health (NIOSH) to collect anthropometric data from about 1,000 firefighters nationwide. The AF plans to broker a formal agreement with NIOSH to share information.

A firefighter's bulky turnout gear may weigh upwards of 20-40 lbs, with bulging pockets of equipment further hindering mobility. When sitting three or four abreast in a fire engine seat, firefighters often cannot buckle seatbelts properly or must use seatbelt extensions. Even when seatbelts are fastened, they may not work as intended because of improper fit when extended over the firefighters' gear. While anthropometry studies targeting other professions (e.g., police officers, nurses, agricultural workers, and truck drivers) have occurred, this effort marks the first-ever study involving firefighters.

Airmen Obtain Better Access to AFRL-Developed Hearing Protection



AFRL developed a unique hearing protection and communications system known as the Attenuating Custom Communications Earpiece System, or ACCES®, under a Cooperative Research and Development Agreement with Westone Laboratories, Inc. The innovative technology improves hearing protection and communications not only for military maintainers and pilots, but for industrial workers such as construction crews, heavy equipment operators, and commercial aircrews and ground crews. Air Combat Command (ACC) aircrew members have gained better access to this high-tech device since the flight medicine office became responsible for creating custom ear impressions and performing initial fit and comfort testing of ACCES.

This formal support from ACC streamlines the process for aircrew who want to experience the superb noise reduction and clear radio communications ACCES offers crew members in the cockpit and maintainers on the ground. Before the policy change, Airmen who wanted ACCES had to find a qualified professional trained in creating impressions for the custom-molded earpieces. Often this meant contacting researchers at AFRL.

With hundreds of sets of this product already in the air, the Air Force (AF) needed trained medical professionals dedicated to meeting the growing demand for custom-molded impressions of the flyers' ears. By integrating specialized electronics into custom-molded earpieces, ACCES allows wearers to experience clear audio communications, while protecting their ears from the damaging noise common in aerospace environments.

ACCES has received the safe-to-fly approval necessary for use in AF fighter and bomber aircraft. The AF envisions that, over time, improved hearing protection will help minimize health care costs; since 1977, the Veterans Administration has spent more than $7 billion on the treatment of hearing loss.

AFRL Scientists Identify Method for Applying EMI Shielding Materials

AFRL scientists discovered a suitable method for applying a polymer nanocomposite solution to serve as electromagnetic interference (EMI) shielding material. These materials protect ground-based structures, as well as aircraft, spacecraft, and satellites, from internal and external EMI effects.

Replacing conventional aluminum systems with polymer nanocomposites for EMI shielding will reduce weight and eliminate corrosion originating in the hardware needed to keep the aluminum in place. The new method is also well suited as a retrofit technology, since it is quickly and easily adaptable to systems that are currently unshielded.

Many current systems rely on EMI shielding techniques involving the addition of aluminum foils to the composite structure. Such techniques require that the foils be glued parasitically to each individual panel before assembly. They also require the use of conductive grounding straps with fasteners to achieve a complete enclosure. Consequently, these existing methods add unnecessary weight, increase manufacturing time, and initiate galvanic corrosion (a problem that occurs when bolts are used to connect structural elements with dissimilar electrochemical properties).

AFRL's development of a polymer nanocomposite material that can be integrated directly onto structures eliminates the need for such problematic fasteners, at the same time decreasing the amount of excess weight associated with aluminum systems. The research team also improved the mixing techniques needed for preserving adequate dispersion of particles throughout the application process. The newly developed method uses the Thinky® planetary mixer (model ARE 250) to disperse the nanofibers evenly without damaging them.

In addition, the researchers devised a method for spraying the mixed solution directly onto the structure; their approach uses a setup very similar to that of an automotive paint sprayer. Provided the solution is mixed to the proper viscosity and concentration, this direct application method not only provides an even coating but also preserves the uniform mixture of the nanoparticles required for sufficient shielding.

Fabrication Processes Developed for 3-D Polymeric Photonic Crystals

As part of an AFRL Small Business Innovation Research (SBIR) Phase I effort, Omega Optics, Inc., and EM Photonics, Inc., successfully developed fabrication processes for constructing three-dimensional (3-D) polymeric photonic crystals. Having now proceeded to SBIR Phase II activities, the researchers are developing a polymeric photonic crystal superprism, a material structure that magnifies small changes in incident beam angles to produce large changes in a laser beam's propagation direction. This new material has many applications, including sensing, electro-optics, lasing, and light-emitting diodes. One example of such usage would be as the enabling material for high-speed laser beam steering.

Photonic crystals represent a powerful means for fabricating new, artificially structured materials with optical properties engineered to address specific applications. The fusing of these two technologies represents an innovative platform for high-performance photonics. This technology may benefit a range of important applications, such as laser beam steering, biological and chemical sensing, materials for integrated photonics devices, and optical detector arrays.

Photonic crystals are part of a truly revolutionary approach to optical engineering. The great power and flexibility achieved by engineering photonic crystal nanostructures has prompted an explosion of interest towards applying the technology to numerous areas within optical engineering. Because photonic crystal engineering enables researchers to tailor the optical properties of a material using nanostructuring, it bypasses the typical constraints associated with the given properties of a specific chemical species.

Deployed Engineers Provide Mine Clearing Support

Two materials engineers from AFRL's Airbase Technologies Division deployed to Operation ENDURING FREEDOM to provide robotic system support and training. Air Combat Command and US Central Command Air Forces requested this in-country support for the Mine Area Clearance Equipment (MACE) prototype, a robotic mine clearing system based on Danish heavy equipment manufacturer Hydrema's 910 MCV-2 mine flail system. The AFRL engineers provided system support and training for 3 weeks at Bagram Air Base, Afghanistan.

AFRL engineers converted a man-in-the-seat vehicle to a remotely controlled configuration that removes military personnel from dangerous mine clearing situations and improves driving and position accuracy. The system incorporates a high-end differential Global Positioning System (GPS) that provides operators more precise vehicle control and enables them to receive positioning feedback, ensuring more accurate area coverage and higher confidence in clearing affected locations.

AFRL's Advanced Robotics Team employed the Joint Architecture for Unmanned Systems to develop MACE, which operates via radio frequency using an AFRL-developed joystick controller, a laptop computer, and an operator control station that houses the Ethernet and power for the system. Engineers completed the programming necessary for sending and receiving the required signals and messages over a 9-month period.

AFRL's engineers spent 3 weeks in the field teaching military personnel how to operate the successfully converted system. They performed their initial operational demonstration in an area from which Army mine clearance vehicles had previously cleared 117 explosives. The demonstration team used MACE and its GPS grid-plotting capabilities to detonate 17 additional land mines in a 50 x 100 ft area. After the initial demonstration, the engineers enhanced the system's GPS capabilities by configuring the waypoints for the area to be cleared. They then conducted another MACE demonstration, clearing 44,380 sq ft in 4 hours and successfully detonating 37 additional mines (for a total of 54) in an area that had already been cleared, but not proofed. The vehicle allowed Bagram personnel to reduce the time spent clearing areas and, more importantly, removed vehicle operators from life-threatening circumstances.

Real-Time Measurements Improve High-Energy Laser Optical Coatings

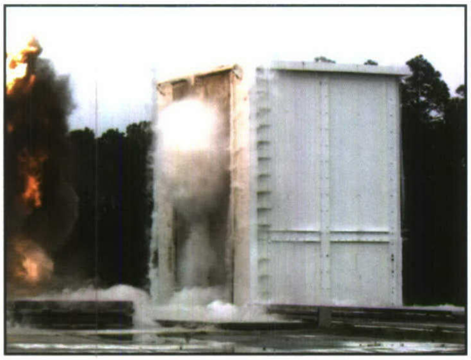
As part of an AFRL Small Business Innovation Research effort, MetaStable Instruments, Inc., reduced the time and expense required to optimize optical coating processes for aircraft and space components. This effort resulted in the successful development of a dynamic new technique that enables coating technicians to measure light absorption and scattering losses of less than one part per million—in real time, as the coating process is under way inside a vacuum chamber. The measurements collected for this effort, which represent the most sensitive ever achieved in vacuum conditions, could prove instrumental for ongoing development of high-energy lasers. By providing technicians a means to optimize materials processing and coating parameters on a routine basis, the new method enables very-low-absorption (VLA) optical thin film coatings to be produced in less time and at reduced cost to the Air Force.

Highly reflective multilayer optical coatings are essential to high-power laser systems, such as the airborne laser. Because these lasers are so powerful, even small amounts of incident laser energy absorption can result in damage to the optical coatings. Since damaged steering optics produce distorted laser beams, VLA coatings—as well as accurate and timely nondestructive VLA measurements—are necessary to efficiently and cost-effectively optimize the optical thin film deposition process.

MetaStable Instruments' new technique uses attenuated total internal reflection altered by evanescent coupling of light into a waveguide mode in the thin film. The fraction of light no longer reflected once the waveguide condition exists is a measure of the thin film's extinction coefficient. Researchers employed this technique outside the vacuum chamber, with an air gap between the measuring instrument and the film of interest, as well as inside the chamber, with a low-refractive-index solid layer (or layers) separating the instrument from the film. Consequently, coating technicians can now quickly and routinely optimize materials processing and coating parameters in order to minimize coating absorption.

The new method causes light that is undergoing total internal reflection at the surface being coated to be evanescently coupled into a waveguide within the thin film. Absorption or scattering losses in the waveguide reduce the total internal reflection of the light. Therefore, measuring the reduction in internal reflection can determine the extinction coefficient of the thin film.

AFRL Investigates Blast Response of Insulated Concrete



AFRL researchers entered into a Cooperative Research and Development Agreement (CRADA) with the Portland Cement Association to research the response of insulated concrete products to explosive blasts. Under the CRADA, the Portland Cement Association will provide AFRL with insulated concrete products from several different trade associations, representing a wide range of product designs. AFRL will investigate material behavior and structural response to blast pressure loads. This research will provide valuable information concerning each product's ability to withstand explosive blasts; it will also help engineers accurately predict material behavior in the face of threats often included in the design criteria for government facilities.

During Phase I of the agreement, engineers began investigating 13 mature products already in wide use throughout the commercial market, including two precast, prestressed sandwich panel products; four concrete masonry products; two tilt-up products; and five insulated, stay-in-place concrete forms. AFRL engineers constructed a three-story reaction structure to conduct the full-scale explosive experiments necessary for validating the engineering models developed to predict blast response for each insulated concrete product. Once validated, the models will facilitate the development of tools (e.g., range-to-effect charts) that engineers can use to determine whether a particular product can protect against a specified blast threat.

In Phase II, engineers will focus on insulated concrete products that are recent additions to the market, using the same process of developing predictive models and conducting full-scale validation experiments. Determining validity is primarily a matter of measuring wall deflection and reflective pressures during the full-scale experiments. The goal is to achieve a 5%-15% over-prediction of deflection by the models, along with a good timing match between model response and gauges measuring peak deflection during the experiments. This overpredicted model deflection then yields engineering tools with inherent factors of safety desirable in all structural design decisions.

Once the engineers are able to deem a model as an accurate predictor of blast response, they will begin Phase III of the CRADA. This phase will involve materials testing in the lab, combined with parametric studies that use Phase I and Phase II computer models to identify material or design modifications capable of delivering improved blast protection. To validate model predictions, Phase III will also include essential full-scale experiments conducted on products manufactured according to any specified modifications.

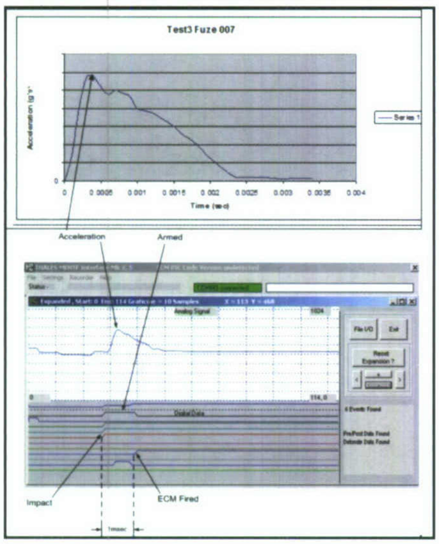
AFRL Designs and Constructs Double-Deck Aircraft Mockup for Fire Research

AFRL collaborated with the Federal Aviation Administration (FAA) to design, fabricate, and install a 60 ft section mockup of a double-deck aircraft, facilitating new large aircraft (NLA) fire research that is unachievable with smaller-scale mockups. Both agencies gain the capability to conduct research trials on a full-scale mockup similar in size and shape to the Boeing 747, Airbus A380, and military C-5 aircraft. They also acquire a fire scenario differing from that of AFRL's existing C-130 mockup, which has seen extensive use in military and civilian firefighting and rescue evaluations since its installation in the early 1990s. Whereas engineers built the NLA mockup 10 ft off the ground (simulating fire impingement on the fuselage belly), the C-130 mockup rests on the ground (simulating a landing with the wheels up).

The FAA requested that AFRL engineers design and build a double-deck aircraft mockup to serve as the focal point for fire research programs. NLA, such as the Airbus A380 and Boeing 747-8, present new challenges to current aircraft rescue and firefighting principles, practices, theories, training methods, and equipment. In turn, airport firefighters face greater risks as commercial aviation increases the number of passengers aboard aircraft, incorporates the use of composite materials in aircraft structures, and expands aircraft fuel storage capacity.

The resulting NLA mockup is constructed of 1/4 in. plate steel, erected on 12 in. diameter support legs. The fuselage section measures over 27 ft in diameter and encompasses the cargo, main, and upper passenger decks, along with the first three passenger doors, which are located directly behind the cockpit. The wing is designed to represent the first 10 ft of the leading edge and possesses three-dimensional characteristics to emulate a realistic firefighting platform. A 20 ft section of the inner engine nacelle is suspended from the wing. Engineers have fabricated a set of three plate steel, high-temperature evacuation slides that can be used on either the wet side (for live fire evaluations) or the dry side (for vehicle and other non-fire-related evaluations). The entire mockup is instrumented with over 75 thermocouples, which monitor the thermal loading of the mockup and provide critical data on temperature and fire behavior.

AFRL Tests Fuze Survivability



AFRL teamed with Alliant Techsystems to conduct cannon testing of the Survivable Thermostable Robust Intelligent Fuze (STRIFE). STRIFE is an intelligent fuze capable of making active decisions during penetration. The device can sense voids, layers, and distance traveled; it also has a built-in data recorder that records its decisions, along with the penetration event itself.

The test team executed subscale penetration events to evaluate fuze survivability and function under extremely-high-impulse shock loads. Success criteria included firing the fuze's inert detonator at the programmed event and recording penetration deceleration and fuze performance data. Testing involved subjecting the fuze to a high-g shock environment by firing a subscale projectile into a concrete target using AFRL's howitzer cannon. The team tested four fuzes in subscale projectiles moving at high velocity into concrete targets. In all four tests, the fuzes functioned as programmed and recorded rigid body decelerations greater than 15 kg. These tests represent the most rigorous high-impulse shock testing the fuzes have undergone to date.

The drive towards faster, more accurate, and capable weapons has created the need for intelligent fuzes capable of surviving high-impact conditions and thus increasing the capacity of penetrating weapons to defeat hardened and deeply buried targets. STRIFE provides an accurate fuzing solution for hard-target defeat. The results also signify STRIFE's potential for surviving the harsh environments associated with higher-impact velocities.

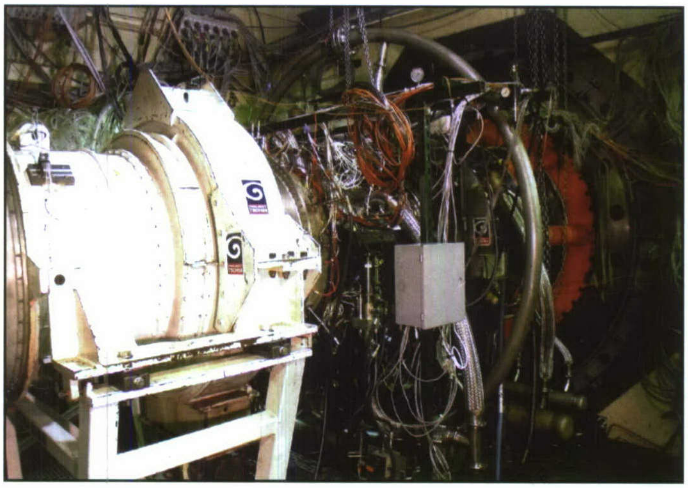
Infrared Thermography Technique Patent Granted

Drs. Shichuan Ou and Richard B. Rivir, of AFRL's Propulsion Directorate, along with of Louisiana State University's Dr. Srinath V. Ekkad, earned a patent titled "Method of Infrared Thermography." The patent describes an invention that uses a high-resolution infrared thermography system to determine heat transfer coefficients and film effectiveness values from a single test.

The newly patented method quickly and accurately provides film-cooled heat transfer coefficients and film effectiveness values from a single test, which reduces costs and alleviates the inaccuracies and uncertainties associated with conducting multiple tests. Furthermore, the method avoids the use of expensive thermographic liquid crystals for obtaining temperature values.

Turbine engine designers routinely use film cooling to cool engine components in the hot-gas flowpath. Film cooling is the process of injecting coolant fluid at one or more discrete locations (holes or slots) along a surface exposed to a harsh, high-temperature environment. As high-performance turbine engine technologies advance, turbine inlet temperatures must increase in order to achieve higher thermal efficiency. These higher temperatures necessitate effective film cooling to protect the turbine components. The capability to obtain film-cooled heat transfer coefficients and film effectiveness values with a single test aids engine designers and eliminates the expense of running separate—but related—experiments to determine those values.

AFRL Commences GE VAATE Core Compressor Testing

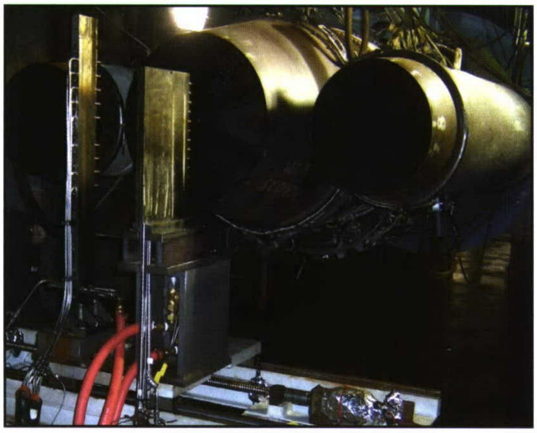


AFRL engineers began testing General Electric's (GE) long-range strike (LRS) Versatile Affordable Advanced Turbine Engines (VAATE) core compressor at the laboratory's Compressor Research Facility (CRF). These tests will further develop the front three stages of the dual-use core compressor to increase part-speed efficiency, investigate concepts that mitigate blade row interaction losses without requiring large-axial spacing, and validate and improve time-accurate computational fluid dynamics design tools.

AFRL engineers obtained 70%-80% corrected speeds at all throttle conditions, while maintaining the low-power stall margin. The test data also demonstrated that at high power, similar levels of flow, efficiency, and stall margin were maintainable with respect to the baseline. These improvements help the GE LRS engine meet thrust-to-weight ratio, thrust-specific fuel consumption, and development cost goals.

Completing this effort will require testing of five different builds. Engineers completed the first build tests for mechanical checkout, stator optimization, and aeromapping. The data collected at AFRL's CRF demonstrates a significant efficiency improvement over previous tests conducted at GE's Lynn, Massachusetts, facility.

Alternative Jet Fuel Reduces Aircraft Engine Emissions



AFRL researchers completed successful engine emissions tests to support the Department of Defense Assured Fuels Initiative, an effort geared towards securing domestic fuel sources to meet the military's energy needs. To assess the performance of a manned Air Force aircraft running on alternative jet fuel, the research team measured the particulate and gaseous emissions of a TF33 PW-103 engine, comparing the results of burning conventional JP-8 fuel versus an alternative, 50/50 blend of JP-8 and Fischer-Tropsch (F-T) synthetic fuel.

The tests showed that using the fuel blend produced significantly reduced particulate emissions for all engine conditions. Specifically, the researchers observed a ~20%-40% decrease in particle concentration and smoke number and a ~30%-60% reduction in particulate mass. Furthermore, the alternative fuel's effect on most gaseous combustion products was negligible, suggesting that it had no adverse impact on TF33 engine emissions.

Developed in Germany during the early 1920s, the F-T process provides a method for producing alternative jet fuels from domestically available hydrocarbon products such as natural gas, coal, and shale. To support ground testing of the F-T–derived fuel product, researchers working at Tinker Air Force Base, Oklahoma, used AFRL's Turbine Engine Research Transportable Emissions Lab to evaluate TF33 emissions over a wide range of engine operating conditions, from idle to maximum power. Following completion of these ground tests, researchers flight-tested the alternative fuel aboard the B-52 bomber, evaluating it alongside conventional fuel (i.e., burning the fuel blend in two of the aircraft's TF33 engines and JP-8 in its remaining six TF33s). During a future flight test, the B-52 aircraft will burn the alternative fuel in all eight of its TF33 engines.

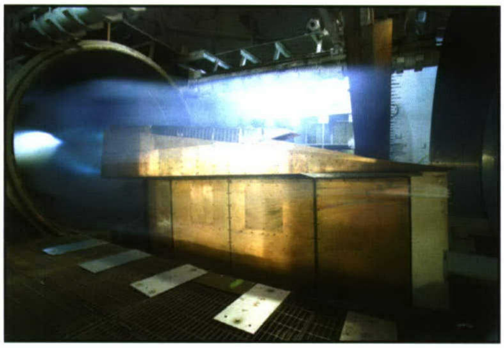
AFRL Develops One-of-a-Kind Bearing Test Rig

AFRL high-speed turbine experts developed a one-of-a-kind test facility to demonstrate the Revolutionary Approach to Time-Critical Long-Range Strike (RATTLRS) forward-thrust bearing technology. RATTLRS is a high-Mach air vehicle program funded by the Office of Naval Research. AFRL's new research test facility enables evaluation of the RATTLRS forward-thrust bearing from initial concept to flight mission testing.

The new facility is the most complex and thorough ever constructed in terms of its capacity to accurately simulate high-Mach, expendable engine conditions for bearing testing. While the facility's bearing load, speed, and temperature capabilities match those typical of most test rigs, it can also achieve engine bearing compartment airflow, temperature, and pressure conditions needed for simulating vapor delivery and "cooling" air as separate and controllable air circuits. All test parameters are independently controllable to allow precise replication of the RATTLRS high-Mach engine operating conditions.

In addition to addressing the overall complexity required to meet engine flight conditions, AFRL propulsion engineers completed this work under an extremely aggressive schedule in order to meet the RATTLRS flight demonstration planned for December 2007. Construction of the facility was a team effort involving multiple disciplines, including mechanical design and drafting, heat transfer analysis, rotordynamic analysis, bearing analysis, gas flow analysis, instrumentation, computer programming in LabVIEW™, plumbing and electrical design and installation, and vibration analysis. As a result of the collaborative efforts performed to bring the RATTLRS bearing test facility online, a team of government and contractor researchers received the AFRL Propulsion Directorate's In-House Project of the Quarter award for third quarter 2006 activity.

X-51A Achieves Successful Combustion on JP-7

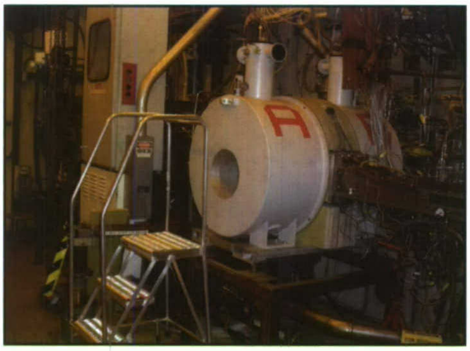


AFRL engineers began tests on the SJX61-1 engine using the National Aeronautics and Space Administration (NASA) Langley Research Center's 8-foot high-temperature tunnel. The Pratt & Whitney Rocketdyne SJX61-1 (or X-1) is a hydrocarbon-fueled scramjet [supersonic combustion ramjet] engine featuring full X-51A flight hardware: flowpath, F-119 full-authority digital engine control/fuel control, and closed-loop thermal management system. The X-1 successfully completed its first ignition on ethylene fuel and transition to JP-7-only operation at Mach 5 simulated flight conditions. This successful effort is a critical step in the development of the X-51A integrated propulsion system and marks the first time the AFRL HyTech scramjet engine has been tested in a simulated "full flight" integrated propulsion configuration (which includes both a full vehicle forebody/inlet and nozzle).

The X-51A Flight Test program plans to demonstrate the AFRL HyTech scramjet engine within the Mach 4.5 to 6.5 range with four flight tests, beginning in Fiscal Year 2009. The X-51A program is a collaborative effort between the Air Force, the Defense Advanced Research Projects Agency, Boeing, and X-1 builder Pratt & Whitney Rocketdyne. The flexibility of the X-1 control system and the hard work of the joint NASA/Pratt & Whitney Rocketdyne test team made the successful test a reality. Subsequent tests will verify engine performance and operability across the X-51A flight envelope and characterize the closed-loop thermal management system. The X-1 is the first of two ground engines planned in the X-51A Flight Test program.

For more information contact
afrl.rz.techinfo@wpafb.af.mil • (937)255-3428

Scramjet MHD System Generates Electrical Power

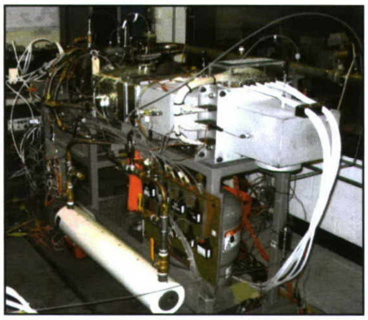


An inherent limitation of scramjets [supersonic combustion ramjets] is their inability to provide air vehicle systems—especially future air vehicles that use high-power directed energy weapon systems—with electrical power using conventional generators. Conventional gas turbine engines produce electrical power via mechanically rotating generators, but scramjets have no rotating parts to provide this function. AFRL sponsored the Hypersonic Vehicle Electric Power Systems program to develop a solution to this problem. Through this effort, AFRL researchers worked with partners in industry and academia to demonstrate that magnetohydrodynamic (MHD) generators can extract electrical power directly from scramjets and generate it on demand and nearly instantaneously (within a response time of milliseconds).

Researchers modified a scramjet ground demonstrator by installing an MHD generator downstream of the combustor. The principal components of the MHD generator consist of an electrode-lined channel inside a superconducting magnet. For this demonstration, the system employed a helium-cooled superconducting magnet borrowed from the National Aeronautics and Space Administration's Marshall Space Flight Center. The interaction of the magnetic fields with the scramjet's electrically conducting exhaust gas flow creates the ability to produce electrical power. The concept demonstrated simulated speeds of Mach 8 and produced 2-10 kW of electrical power. The power output was limited only by the mass flow rate of the scramjet test rig.

For more information contact
afrl.rz.techinfo@wpafb.af.mil • (937)255-3428

AFRL Incorporates Turbogenerator Into Integrated Cooling and Power System

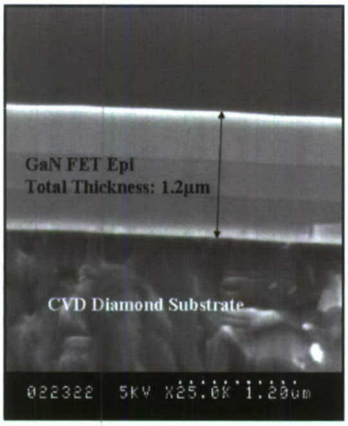


Engineers from AFRL and industry partner Smiths Aerospace successfully demonstrated the use of a turbogenerator in an integrated cooling and power system (ICPS) to provide extra power and cooling. This generator supplies additional power and cooling for aircraft that have no remaining margin for new electronics. Driven by engine bleed air, the turbogenerator simultaneously delivers dedicated high-frequency alternating current (AC) or direct current (DC) electrical power and cooling for electronic hardware such as radar. Its use of engine bleed is actually less than (or comparable to) that of existing secondary systems. The turbogenerator is magnetically levitated, providing improved performance and reliability over traditional bearing technology for both the turbine and the generator. Since magnetic bearings enable the use of a high-speed, permanent-magnet generator, they also facilitate a reduction in turbogenerator size.

AFRL testing demonstrated that upon starting, the ICPS operates independently of the main aircraft bus. The system isolates high-energy requirements, along with the associated detrimental impact on electric power quality, from the main aircraft electrical bus. The ICPS extracts bleed air energy to provide electrical power, as well as necessary cooling, to the dedicated avionic device.

The turbogenerator also demonstrated the capacity to reduce thermal loading. Engineers used an AFRL-developed power converter to transfer the excess electric power produced by the ICPS back to the main aircraft bus, with no detriment to power quality. Excess electric power is occasionally produced when the application requires more cooling than power. Previous systems dissipated this excess as heat. The technological capability to convert high-frequency AC or 270-volt DC power and divert it back to an electrical aircraft bus enables the ICPS to unload the main generator and, in some cases, provide the main aircraft power. This technology offers the flexibility to isolate a radar from the main aircraft bus or optimize the energy balance for integration with the main bus.

AFRL Demonstration Leads to World's First Gallium Nitride-on-Diamond Transistor



Working under a cooperative agreement and with support from the Defense Advanced Research Projects Agency, engineers from AFRL, Emcore Corporation, and Group4 Labs successfully demonstrated the world's first gallium nitride (GaN)-on-diamond, high-electron-mobility transistor. Applications of this technology, which will dramatically improve the thermal handling properties of GaN-based devices and thus enable efficient and effective heat management of high-power devices, include very-high-power radar and communications. The demonstration proved that functional device layers can survive the atomic attachment process, making these materials a viable solution.

GaN is a compound semiconductor expected to make miniaturized, high-power wireless transmitters a possibility. GaN is the key material for next-generation high-frequency, high-power transistors capable of operating at high temperatures. The advantages of GaN-based devices include high output power with minimal physical volume and high-efficiency power amplification at ultrahigh and microwave radio frequencies. Diamond represents the ideal material on which to base high-power transistors due to its very high thermal conductivity.

Nitride semiconductors are candidates for many applications, including solar blind photodetectors, blue-light-emitting and laser diodes, and high-temperature and high-power electronics. The Al [aluminum] GaN-GaN structure has attracted special interest as a result of its potential application to the development of high-mobility transistors capable of operating at high powers and temperatures. AFRL conducts basic research and exploratory development programs in the areas of high-speed digital devices, microwave- and millimeter-wave power devices, and wide-bandwidth amplifiers to meet unique Air Force needs for aerospace radar, electronic warfare, and communication systems.

Air Force Competition Demonstrates Groundbreaking Vehicle-Halting Prototypes

Servicemen and women fighting the Global War on Terrorism have seen in-theater vehicle checkpoints turn deadly due to uncooperative drivers. Two six-person teams comprising junior scientists and engineers from AFRL entered a competition focused on resolving this chronic, dangerous problem. The teams worked in a rapid-prototyping environment over a 5-month period to devise innovative, nonlethal vehicle-halting methods. The teams subsequently demonstrated their groundbreaking, rapid-prototype solutions, which could eventually deploy for the use of military commanders overseas.

Major General Ted Bowlds initiated the AFRL Commander's Junior Workforce Challenge to innovatively construct, evaluate, and prove options for US and coalition force use in resolving, without deadly force, the perilous problem of uncooperative vehicles at checkpoints. The twofold intent of the competition was to establish novel solutions addressing urgent warfighter needs while providing junior officers experience in developing those solutions. Supplemented by $60,000 in funding, each team created affordable, versatile, and portable working prototypes that met the needs of the end user.

The AFRL Commander's Junior Workforce Challenge enables participants to receive practical training on rapid product design and development, as well as mission and requirements analysis. Such activities represent an unprecedented, invaluable opportunity that not only broadens early career experience but continues to impact the individual throughout his or her Air Force career. The need for such programs and missions has increased since the September 11 terrorist attacks. Consequently, AFRL has teams working towards other urgent solutions for deployed troops as well, addressing critical capabilities ranging from the identification of friendly forces on the ground to the alleviation of brownouts, a condition that occurs when a helicopter landing (typically in a desert environment) creates a cloud of dirt that engulfs the aircraft.

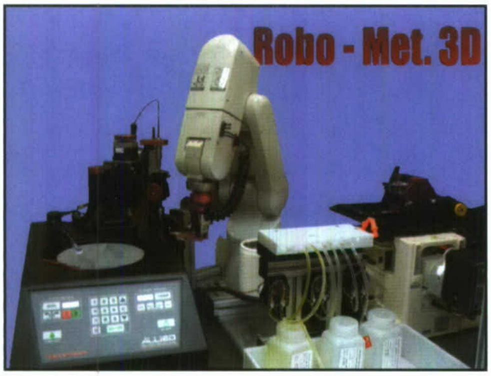
For more information contact
afrl.rv.publicaffairs@wpafb.af.mil • (505)846-4704

Tab 5 – Technology Transfer

Technology Transfer

Page

AFRL Transfers Fully Automated 3-D Microstructure Characterization Technology to Industry



AFRL researchers developed a fully automated three-dimensional (3-D) microstructure characterization device, known as Robo-Met.3D. The custom-built robotic device enables 3-D characterization of advanced metallic and composite materials. AFRL subsequently transferred the technology to UES, Inc., and since the time of that successful transfer, UES has licensed the technology and built two units—one for use at the company's Beavercreek, Ohio, facility and a second for The Ohio State University. There are also four Air Force (AF) patent applications pending.

The Robo-Met.3D technology decreases the time researchers must wait to receive important information regarding the 3-D microstructures of advanced materials, reducing the typical waiting period from months to days. The set of tools the device provides for characterizing microstructural specimens is both more complete than previously available tool sets and more conducive to probing more deeply into areas of growing interest, such as 3-D microstructure-based finite element modeling and multiscalar microstructural characterization.

AFRL scientists initially created Robo-Met.3D to quantify the spatial distribution of silicon carbide in aluminum. Scientists use silicon carbide (a ceramic particle) to reinforce a number of aluminum components used in current AF aircraft systems (e.g., the F-16 and B-1), a usage that significantly increases the material's specific stiffness over that of an unreinforced alloy. Through research, scientists discovered that the silicon carbide's spatial distribution within the aluminum determined both the ductility and the strength of the material. However, because the process of measuring spatial distribution in two-dimensional sections made exact answers difficult to obtain, researchers conceived and built the fully automated Robo-Met.3D device to achieve both higher efficiency and higher precision.

The Robo-Met.3D system comprises several integrated components: a precision polisher, a washing station, an optical microscope, and a robot. The robot represents the premiere breakthrough in the system. It moves the specimen from station to station and allows the scientists to run the process continuously. Using AFRL-developed custom software, the system produces 3-D micrographs of the material specimen, providing scientists a complete picture of the chosen material's spatial distribution and condensing the time spent awaiting results from months to mere days. From conceiving the technology to performing material specimen polishing trials, AFRL scientists completed the initial Robo-Met.3D development effort in just 18 months.

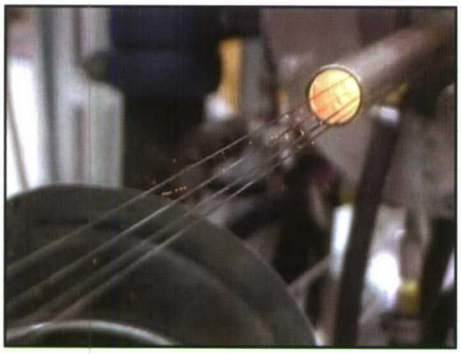
AFRL Donates Advanced Materials Analysis System to Academia

Under an Educational Partnership Agreement (EPA), AFRL donated a surplus advanced materials analysis system to the Howard University Nanoscale Science and Engineering Facility (HNF). Capable of analyzing the surface and in-depth composition of materials with precision accuracy, the Secondary Ion Mass Spectrometry (SIMS) system enables students, faculty, and other researchers using the facility to identify and quantify various types of materials, including impurities, contaminants, and dopants (materials added to crystals to alter their physical properties). AFRL's advanced SIMS technology thus greatly enhances the university's capacity to analyze materials; increases the institution's research and development potential; and expands educational opportunities in science, mathematics, and engineering.

SIMS is a highly sophisticated analytical technique that employs a focused primary ion beam to bombard a material sample, along with a mass spectrometer to identify and measure the secondary ions ejected from the sample. The technology's high sensitivity and high elemental selectivity provide the materials and manufacturing research community with the much-needed capability for performing three-dimensional, elemental analysis of a material's structure. The technology has several aerospace applications, including the identification and quantification of semiconductors, metals (including aircraft corrosion samples), dielectrics, coatings, thin films, and a number of other materials. Other applications of the SIMS technology include education and research, chemical analysis of surfaces and distribution mapping of species, contamination analysis of thin films and surfaces, surface coating continuity monitoring, failure analysis of thin film devices, and bioactive surfaces development. These application areas are important to the Air Force, industry, and academia.

The SIMS system donated to Howard University comprises a surface analysis and materials characterization instrument that combines Dynamic SIMS with Auger Electron Spectroscopy (AES) and depth profiling capabilities. The ultra-high-vacuum instrument is for analyzing surface and in-depth compositional impurities (via SIMS), as well as determining the major elements in solid samples (via AES). This instrumentation's conception and development occurred under the leadership of Mr. Jim Solomon, who used it to support AFRL's mission for more than two decades. The EPA transpired through the leadership of AFRL's senior technologist in electronic materials, Dr. William C. Mitchel, and onsite SIMS expert, Dr. Howard E. Smith, and the involvement of Professor Gary L. Harris, HNF director.

AFRL Commercializes Advanced Silicon Carbide Fibers



Working under contract with ATK-COI Ceramics, Inc. (ATK-COIC), and in collaboration with the National Aeronautics and Space Administration (NASA), AFRL engineers commercially established an advanced silicon carbide (SiC) fiber technology for use in gas turbine engine components and other high-temperature applications.

AFRL and NASA have identified Sylramic™ SiC fiber and its derivative Sylramic-iBN [*in situ* boron nitride] SiC fiber as having superior performance capabilities over other commercially available SiC fibers. The use of these fibers, which are not only capable of withstanding temperatures >2600°F but also exhibit high thermal conductivity, will extend to a range of engine components that must endure extremely harsh service environments.

Phase I contract activity included initial processing runs of the Sylramic fiber in ATK-COIC's new facility, mechanical testing of the fiber, and subsequent transfer of the Sylramic-iBN process from NASA to ATK-COIC. Efforts conducted at the conclusion of Phase I determined that the ATK-COIC–manufactured Sylramic fiber was equivalent to the original Dow Corning fiber, thus validating the manufacturing process at the company's new facility. The successful transfer of the Sylramic-iBN process from NASA to ATK-COIC also entailed the demonstration of equivalent properties for fibers produced at NASA and ATK-COIC facilities.

Phase II objectives targeted both the collection of additional data on ATK-COIC's Sylramic fiber and the performance evaluation of Sylramic and Sylramic-iBN fibers in several ceramic matrix composite (CMC) materials. Overall, Phase II efforts demonstrated the viable reestablishment of Sylramic fiber processing capability, which was the primary goal. Ceramic composites reinforced with ATK-COIC–produced Sylramic and Sylramic-iBN fibers were also shown to have properties equivalent to legacy composites reinforced with the fibers produced by Dow Corning.

As a result of this collaborative AFRL/NASA/industry effort, Sylramic fiber is again available for purchase and Sylramic-iBN fiber is commercially available for the first time. ATK-COIC is currently supplying these fibers for use in Air Force and NASA programs that seek to improve the temperature capability and durability of CMCs for application in advanced aircraft turbine engines.

Tab 6 – Awards/
Recognition

Awards and Recognition

Page

AFRL Names Seven New Fellows for 2007

The AFRL Fellows program annually honors the laboratory's most outstanding scientists and engineers for their achievements and technical excellence that support our nation's air and space forces. The 2007 honorees, all of whom are nationally and internationally recognized experts in their respective fields, are Mr. Harold Vernon Baker (pictured top left), Space Vehicles; Dr. Timothy J. Bunning (pictured top middle), Materials and Manufacturing; Mr. Edward Duff (pictured top right), Directed Energy; Dr. Datta V. Gaitonde (pictured middle left), Air Vehicles; Mr. William E. Harrison III (pictured middle right), Propulsion; Dr. Kathleen M. Robinette (pictured bottom left), Human Effectiveness; and Dr. Stephen W. Schneider (pictured bottom right), Sensors.

For more information contact
milestones@wpafb.af.mil • (937)656-4227

Dr. Lee Semiatin Selected for Society Awards

Dr. Lee Semiatin, a senior scientist in AFRL's Materials and Manufacturing Directorate and lab task manager for metals processing/fundamental mechanisms and modeling, received both The Minerals, Metals, and Materials Society Award and The Materials Information Society Award. Dr. Semiatin's basic materials processing research resulted in the development of the scientific foundation now used for the manufacture of titanium- and nickel-based products throughout the Air Force.

For more information contact
publicaffairs@afosr.af.mil • (703)696-7797

Two AFRL-Funded Scientists Awarded National Medals of Science

In a ceremony held at the White House, President George W. Bush honored two AFRL-funded scientists from Northwestern University with the National Medal of Science. Dr. Tobin Marks (pictured top) received the Medal of Science award for his pioneering work in homogeneous and heterogeneous catalysis, organo-f-element chemistry, new electronic and photonic materials, and coordination and solid-state chemistry. Dr. Jan D. Achenbach (pictured bottom), founder and current director of the Center for Quality Engineering and Failure Prevention at the university, was honored for his seminal contributions to engineering research and education in the area of wave propagation in solids, as well as his pioneering work in the field of quantitative nondestructive evaluation.

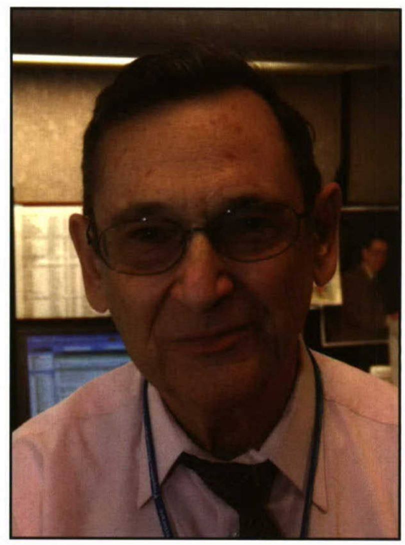
For more information contact
publicaffairs@afosr.af.mil • (703)696-7797

Optical Society of America Honors AFRL-Sponsored Researcher

Dr. J. Gary Eden, AFRL-funded University of Illinois researcher and director of the Laboratory for Optical Physics and Engineering, received the Mees Medal from the Optical Society of America. The award honors Dr. Eden's contributions to ultraviolet lasers, photochemical vapor deposition, ultrafast spectroscopy, and microplasma devices, as well as his efforts to improve international teamwork in the areas of optics and photonics. The honor also recognizes Dr. Eden's many years of research centered on the discovery and application of new lasers in the ultraviolet, visible, and near-infrared spectral regions. It was one of Dr. Eden's students who discovered ultraviolet and violet-emitting fiber lasers; further, his team has created large numbers of microcavity devices in common aluminum foil by using inexpensive wet chemical processing.

For more information contact
publicaffairs@afosr.af.mil • (703)696-7797

Dr. Harold Weinstock Selected as IEEE Fellow



The Institute of Electrical and Electronics Engineers (IEEE) selected AFRL's Dr. Harold Weinstock, a quantum electronic solids research program manager, as a 2007 Fellow. The honor recognizes Dr. Weinstock's leadership and research contributions in the field of superconducting magnetometry, a vital tool for analyzing metallic structural integrity.

For more information contact
publicaffairs@afosr.af.mil • (703)696-7797

AFRL-Sponsored Professor Earns Theoretical Computer Science Honor

AFRL-supported professor Dr. Nancy Lynch received the 2007 Knuth Prize for Theoretical Computer Science for creative and influential contributions to the theory of distributed computing. Dr. Lynch is the eighth awardee and the first female to be honored. She is the national executive committee professor of software science and engineering at the Massachusetts Institute of Technology's Electrical Engineering and Computer Science Department.

For more information contact
publicaffairs@afosr.af.mil • (703)696-7797

AFRL-Funded Scientists Earn Young Innovators 2007 Award

The editors of *Technology Review* magazine honored Dr. Ju Li (pictured left) and Dr. Mung Chiang (pictured right) as 2007 Young Innovators for their breakthrough research. The two AFRL-funded scientists were among the individuals included in the journal's annual list of top innovators under the age of 35 who are working in the field of science and technology. The editors cited the pair's work as being "so cutting-edge [that] it is changing our world."

For more information contact
publicaffairs@afosr.af.mil • (703)696-7797

Dr. Corey Schumacher Chosen for NAE 2006 Frontiers of Engineering

Dr. Corey Schumacher, a senior research aerospace engineer at AFRL's Air Vehicles Directorate, was chosen to participate in the National Academy of Engineering's (NAE) 2006 Frontiers of Engineering Symposium, held in Dearborn, Michigan. Dr. Schumacher is one of only 80 scientists honored with this selection.

For more information contact
afrl.rb.marketing@wpafb.af.mil • (937)255-2074

Four AFRL Engineers Earn AIAA Associate Fellow Status

Four engineers from AFRL's Air Vehicles Directorate became Associate Fellows within the American Institute of Aeronautics and Astronautics (AIAA). Peer-nominated and elected for the honor based on their outstanding contributions to the arts, sciences, or technology of aeronautics and astronautics, the 2007 AIAA Associate Fellows are Dr. Michael Ol (pictured top left), a senior research aerospace engineer in the Aerodynamic Configuration Branch; Dr. Corey Schumacher (pictured top right), a senior research aerospace engineer in the Control Design and Analysis Branch; Dr. James Myatt (pictured bottom left), a senior research aerospace engineer and team lead for feedback flow control in the Control Design and Analysis Branch; and Dr. Richard Snyder (pictured bottom right), a research aerospace engineer in the Structural Design and Development Branch.

For more information contact
afrl.rb.marketing@wpafb.af.mil • (937)255-2074

Dr. Deborah Grismer Receives Science and Technology Role Model Award

Dr. Deborah Grismer, of AFRL's Air Vehicles Directorate, received the 2007 Federal Women's History Month Science, Technology, Engineering, and Math Role Model Award. The award is presented annually, in conjunction with Women's History Month, to military and civilian women in the Department of Defense who epitomize the core values of their respective organizations by providing exceptional leadership and seeking to create opportunities for other women and minorities in their field.

For more information contact
afrl.rb.marketing@wpafb.af.mil • (937)255-2074

AFRL Researchers Earn Perkins Award

Dr. Michael Bolender (pictured right) and Dr. Michael Oppenheimer (pictured left), research engineers with AFRL's Air Vehicles Directorate, received the Courtland D. Perkins In-House Engineering Award for their research in hypersonic vehicle dynamics and control modeling. The researchers developed a new modeling capability addressing some of the challenges controls engineers face when designing a hypersonic vehicle. Their goal is to give engineers a tool they can use to analyze different hypersonic vehicle configurations and determine the controllability of each design.

For more information contact
afrl.rb.marketing@wpafb.af.mil • (937)255-2074

Michigan State University Honors Dr. Paul With 2007 Mechanical Engineering Distinguished Alumni Award

Michigan State University's Mechanical Engineering Department honored Dr. Donald Paul, chief scientist of AFRL's Air Vehicles Directorate, with the 2007 Distinguished Alumni Award. Dr. Paul (pictured right), a 1968 graduate of the university, received the honor based on his professional and personal accomplishments and his ongoing support of the university.

For more information contact
afrl.rb.marketing@wpafb.af.mil • (937)255-2074

Dr. Kathleen Robinette Selected as Honorary Human Factors and Ergonomics Society Fellow

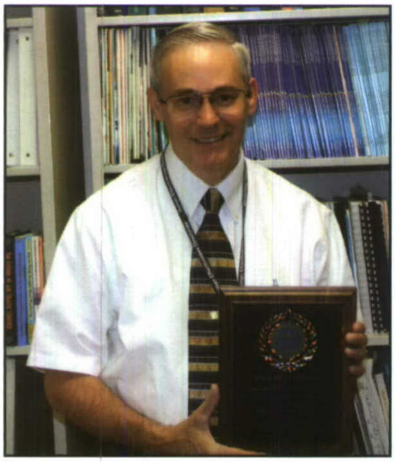
Dr. Kathleen Robinette, a principal research anthropologist with AFRL's Human Effectiveness Directorate, was elected an Honorary Fellow of the Human Factors and Ergonomics Society. In her 28 years of experience, Dr. Robinette has developed and directed a diversity of award-winning programs geared towards improving the safety and performance of assorted products, from apparel to workstations. Furthermore, she has fulfilled the responsibility of leading anthropometry to the new technological paradigm of three-dimensional automated scanning.

For more information contact
afrl.rh.tech.info@wpafb.af.mil • (937)255-3814

Principal Investigator of Landmark Study Mentored at AFRL

Leveraging knowledge and experience gained from working with her AFRL mentors, Dr. Charlie Klauer, a senior research associate at the Virginia Tech Transportation Institute, managed a landmark study for determining what drivers are doing prior to a crash. As principal investigator for the 100-Car Study, Dr. Klauer provided the analysis and wrote a research report indicating that 80% of accidents are caused by distracted motorists. The landmark study led to creation of the first database to house precise information regarding the moments leading up to a crash or near-miss. This repository of ongoing data provides a huge benefit for transportation researchers, whose work was previously made more difficult by a critical lack of information detailing drivers' precrash/near-miss moments.

For more information contact
afrl.rh.tech.info@wpafb.af.mil • (937)255-3814



Dr. Lloyd Tripp Wins Paul Bert Award

Dr. Lloyd Tripp, integration manager at AFRL's Human Effectiveness Directorate, received the 2007 Paul Bert Award from the Aerospace Physiology Society. Dr. Tripp received the award for his contributions to aerospace physiology as an acceleration researcher. He has been a prolific contributor to the field of aerospace physiology as a centrifuge subject, principal investigator, and author. His research in g-induced loss of consciousness (GLOC) redefined the periods of absolute and relative incapacitation due to high acceleration forces and the effects of GLOC on a pilot's cognitive performance.

For more information contact
afrl.rh.tech.info@wpafb.af.mil • (937)255-3814

AFRL Receives Three Regional Awards for 2007 Technology Transfer

AFRL received three regional awards from the Federal Laboratory Consortium (FLC) for Technology Transfer at the 2007 Midwest/Southeast Joint Regional Conference. The FLC Midwest Region Partnership Award went to AFRL and the University of Cincinnati (UC) for their extensive collaborative efforts involving UC's Genome Research Institute, Laboratory Animal Medical Services, and molecular genetics and psychology departments. The 2007 FLC Midwest Region Excellence in Technology Transfer Award went to AFRL's Biomarker Discovery and Biomonitor Device Development project. Dr. Jim Kearns (pictured middle), chief technology transfer representative of AFRL's Human Effectiveness Directorate, received the 2007 FLC Midwest Regional Coordinator's Excellence Award in recognition of his outstanding work in the process of transferring technology developed by a federal laboratory to the commercial marketplace.

For more information contact
afrl.rh.tech.info@wpafb.af.mil • (937)255-3814

Dr. Michael Murphy Named DEPS Fellow

Dr. Michael Murphy, scientific director of AFRL's Human Effectiveness Directorate, Directed Energy Bioeffects Division, was named a Fellow of the Directed Energy Professional Society (DEPS). The honor recognizes the impact of his significant contributions towards national and international radio frequency exposure standards, his involvement as representative to the World Health Organization, and his research of nonlethal weapons technologies that have been vital to developing and transitioning directed energy weapons to the warfighter.

For more information contact
afrl.rh.tech.info@wpafb.af.mil • (937)255-3814

European Union Honors AFRL Scientists' Nanotoxicology Contributions

The European Union's Nanosafe2 project, a 4-year program to assess risks associated with nanoparticles and develop management plans for safe nanomaterials production, honored AFRL scientists for significant contributions towards the understanding of nanoparticles. Nanosafe2 selected as [June 2007] "nanopaper of the month" a nanotoxicology article coauthored by Mr. Richard Murdock, Ms. Amanda Schrand, Dr. John Schlager, and Dr. Saber Hussain (pictured) (AFRL Human Effectiveness Directorate) and Mr. Andrew Wagner and Dr. Charles Bleckmann (Air Force Institute of Technology). The article, entitled "Cellular Interaction of Different Forms of Aluminum Nanoparticles in Rat Alveolar Macrophages," appeared in the June edition of the *Journal of Physical Chemistry*.

For more information contact
afrl.rh.tech.info@wpafb.af.mil • (937)255-3814

Mr. John Mistretta Elected to SME College of Fellows

The Society of Manufacturing Engineers (SME) elected Mr. John P. Mistretta, a division chief at AFRL's Materials and Manufacturing Directorate, to the prestigious College of Fellows for 2006. Mr. Mistretta's election honors his leadership, innovation, and outstanding contributions within the field of manufacturing. As a Fellow, Mr. Mistretta is recognized by the SME, his peers, and the manufacturing community as a key contributor to the social, technological, and educational aspects of the profession. This honor is achievable only through years of dedication and service to manufacturing engineering.

For more information contact
techinfo@afrl.af.mil • (937)255-6469

Dr. James Grote Honored for Bioengineering Contributions

The Dayton, Ohio, Chapter of the Institute of Electrical and Electronics Engineers honored Dr. James Grote, a senior electronics engineer at AFRL's Materials and Manufacturing Directorate, with the highly coveted Dr. Fritz J. Russ Bioengineering Award. The award recognizes Dr. Grote's significant contributions in the field of bioengineering research, including important advances in developing a revolutionary new class of polymer, or "biopolymer," based on DNA derived from biowaste materials. A number of electro-optic and electronic devices fabricated from the material have demonstrated enhanced performance over state-of-the-art devices made from conventional, organic-based materials. With applications ranging from simple (e.g., eyeglasses, food containers) to complex (e.g., light-emitting diodes, electrical transistors for aerospace applications), the biopolymer will benefit the Air Force and commercial industry alike.

For more information contact
techinfo@afrl.af.mil • (937)255-6469

Lieutenant Todd Turner Receives Air Force Outstanding Scientist Award

First Lieutenant Todd Turner, a combat support technologies engineer at AFRL's Materials and Manufacturing Directorate, received the 2006 Air Force Outstanding Scientist Award in the Junior Military category for his exceptional accomplishments and contributions to the Air Force and national defense. The award honors Lt Turner's work towards the development of an advanced lightweight body armor system for military personnel, as well as other technologies. His work exemplifies the highest level of technical expertise, professionalism, and dedication.

For more information contact
techinfo@afrl.af.mil • (937)255-6469

Composites Concepts Researchers Garner "Star Team" Award

A distinguished group of scientists and engineers from AFRL's Materials and Manufacturing Directorate earned the highly coveted Air Force Office of Scientific Research Star Team Award for vital contributions to the Air Force mission. The award recipients are members of a highly skilled research group known as the Advanced Organic Matrix Composites Concepts Team. Dr. Ajit Roy (pictured third from right) led the team and was recognized for his leadership and related contributions. In addition to Dr. Roy, the primary contributors to this award-winning research effort include Dr. Dave Anderson, Dr. Valeriy Buryachenko, Mr. John Camping, Dr. Chenggang Chen, Dr. Sabyasachi Ganguli, Dr. Ran Y. Kim, Dr. Sirina Putthanarat, Mr. William Ragland, and Dr. Sangwook Sihn.

For more information contact
techinfo@afrl.af.mil • (937)255-6469

Dr. Timothy Bunning Appointed American Physical Society Fellow

Dr. Timothy Bunning, a polymer physicist at AFRL's Materials and Manufacturing Directorate, received a Fellow appointment from the 45,000-member American Physical Society. Dr. Bunning was recognized for important contributions in the field of advanced organic-based photonic materials and components; specifically, his contributions include development of passive and dynamic diffractive structures formed using complex holographic photopolymerization techniques, development of polymer photonic structures using plasma-enhanced chemical vapor deposition, structural development of polymer/liquid crystal composites, and investigation of liquid crystalline materials and technologies.

For more information contact
techinfo@afrl.af.mil • (937)255-6469

Dr. Timothy Bunning Named International Society for Optical Engineering Fellow

The International Society for Optical Engineering appointed Dr. Timothy Bunning, a polymer physicist at AFRL's Materials and Manufacturing Directorate, Fellow status. The society recognized Dr. Bunning for important contributions in the field of advanced organic-based photonic materials and components—specifically, for his development of passive and dynamic diffractive structures formed using complex holographic photopolymerization techniques, development of polymer photonic structures using plasma-enhanced chemical vapor deposition, development of polymer/liquid crystal composite structures, and investigation of liquid crystalline materials and technologies.

For more information contact
techinfo@afrl.af.mil • (937)255-6469

Dr. Bob Sierakowski Receives Best Paper Award

Dr. Bob Sierakowski, chief scientist of AFRL's Munitions Directorate, received an award for coauthoring a technical paper entitled "A Study of Impacted Electromechanically Loaded Composite Plates." The American Society of Mechanical Engineers (ASME) Aerospace Division's Structure and Materials Committee selected the paper as the 2007 ASME/Boeing Best Paper from more than 1,900 entries. Dr. Sierakowski and coauthor Dr. Olesya Zhupanska, of the University of Florida, received the prestigious award at the American Institute of Aeronautics and Astronautics Structures, Structural Dynamics, and Materials Conference, held in Honolulu, Hawaii.

For more information contact
afrlmark@eglin.af.mil • (850)882-3009

Dr. Biswa Ganguly Recognized for Career Achievements

Dr. Biswa N. Ganguly, a senior research physicist at AFRL's Propulsion Directorate, was selected to receive the 2006 Air Force Materiel Command (AFMC) Career Achievement Award, presented as part of the 2006 AFMC Engineering and Technical Management Awards. The honor recognizes Dr. Ganguly's distinguished 24-year career.

For more information contact
afrl.rz.techinfo@wpafb.af.mil • (937)255-3428

AFRL Propulsion Researchers Earn AIAA Associate Fellow Status

The American Institute of Aeronautics and Astronautics (AIAA) recognized Drs. Richard Fingers (pictured top right), Steven Gorrell (pictured top left), and John Phillips (pictured bottom), of AFRL's Propulsion Directorate, as Associate Fellows for 2007. AIAA Associate Fellows are individuals who have accomplished or overseen important engineering or scientific work of outstanding merit and significant contribution to the arts, sciences, or technology of aeronautics or astronautics.

The AIAA is the world's leading professional society addressing the areas of aeronautics and astronautics. The AIAA Fellow title represents one of the most prestigious distinctions in the aerospace industry.

For more information contact
afrl.rz.techinfo@wpafb.af.mil • (937)255-3428

Dr. James R. Gord Earns Optical Society of America Fellows Award

Dr. James R. Gord, a principal research chemist at the AFRL Propulsion Directorate's Combustion and Laser Diagnostics Research Complex, was honored as a Fellow of the Optical Society of America (OSA). His work has led to the development and application of significant optical measurement techniques for advanced propulsion and fuel systems. The prestigious award specifically recognizes Dr. Gord's outstanding service to the OSA and his key contributions in developing optical measurement techniques for combustion and propulsion applications throughout Department of Defense weapons systems.

For more information contact
afrl.rz.techinfo@wpafb.af.mil • (937)255-3428

Dr. Muralidhar Rangaswamy Selected as IEEE Fellow

The Institute of Electrical and Electronics Engineers (IEEE) named Dr. Muralidhar Rangaswamy, a senior electronics engineer at AFRL's Sensors Directorate, a Fellow for his contributions towards mathematical techniques for space-time adaptive radar processing. Dr. Rangaswamy's research focuses on several aspects of adaptive target detection for airborne radar applications, specifically concentrating on the detection of targets immersed in challenging interference backgrounds. Most adaptive radar signal processing methods require knowledge of the interference statistics, which are typically unknown and must be inferred from small amounts of training data essentially sharing the same behavior.

For more information contact
afrl.ry.marketing@wpafb.af.mil • (937)904-9771

Dr. Muralidhar Rangaswamy Receives IEEE Distinguished Member Award

The Institute of Electrical and Electronics Engineers (IEEE)-Boston Section honored Dr. Muralidhar Rangaswamy, a senior electronics engineer at AFRL's Sensors Directorate, with its 2006 Distinguished Member award. The IEEE is a nonprofit organization and the world's leading professional association for the advancement of technology. The award recognizes Dr. Rangaswamy's technical contributions in the areas of radar phenomenology, space-time adaptive radar signal processing, and waveform-diverse sensing and processing, as well as his history of excellent service to the IEEE-Boston Section.

For more information contact
afrl.ry.marketing@wpafb.af.mil • (937)904-9771

High-Performance Computing Modernization Program Honors Dr. Kueichien Hill

The Department of Defense High-Performance Computing Modernization Program (HPCMP) named Dr. Kueichien Hill, a predictions technical leader at AFRL's Sensors Directorate, the HPCMP "Innovative Management Hero" for 2006. Dr. Hill is the nation's guiding force in computational electromagnetics (CEM) technology development, orchestrating CEM investments across services and agencies and fostering in-house CEM research to address the needs of modern military aircraft development. Her innovative efforts have revolutionized radio frequency predictions, and her CEM design tools are directly influencing future weapon systems that provide US combat forces with a significant military advantage.

For more information contact
afrl.ry.marketing@wpafb.af.mil • (937)904-9771