



NASA Aviation Safety & Security Program

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Outline

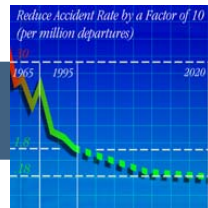
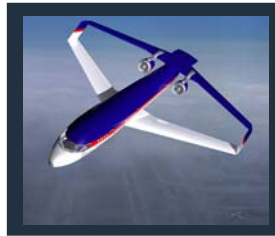


- Introduction to the Aviation Safety & Security Program
- NASA Aviation Safety Program
- FAA Aviation Safety Program
- NASA Aviation Security Program
- Summary

Aeronautics Research Mission Directorate



Mission Directorate Objectives



Protect Air Travelers and the Public



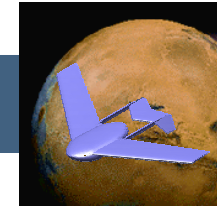
Protect the Environment



Increase Mobility



Protect the Nation

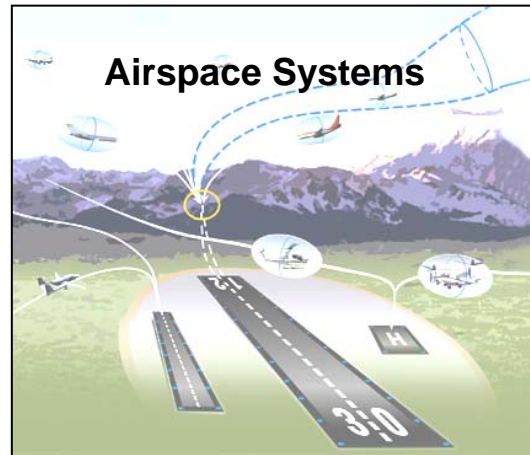


Explore New Aeronautical Missions

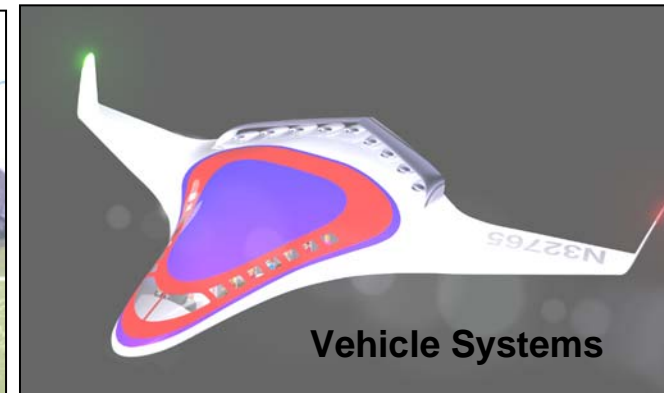
Programs



Aviation Safety & Security



Airspace Systems



Vehicle Systems

NASA Aviation Safety & Security Program



Goal:

Decrease the aircraft fatal accident rate and the vulnerability of the air transportation system to threats and mitigate the consequences of accidents and hostile acts

Objectives:

- Develop and demonstrate technologies that reduce aircraft accident rates and reduce aviation injuries and fatalities when accidents do occur
- Develop technologies that reduce the vulnerability of the National Airspace System to terrorist attacks while dramatically improving efficiency of security
- Transfer these advanced concepts, technologies and procedures through a partnership with the Federal Aviation Administration (FAA) and the Transportation Security Administration (TSA) in cooperation with the U.S. aeronautics industry



Outcomes:

- By 2005, enable a reduction of the aviation fatal accident rate by 50% from the FY 91-96 average.
- By 2009, enable a reduction in the vulnerability exposure of aircraft and other components in the air transportation system.
- By 2012, facilitate the near real-time identification and resolution of risks and vulnerabilities in the air transportation system.

AvSSP Strategic Foci



Human Error Avoidance



Aircraft Self-Protection & Preservation



**Protecting
Air Travelers
and the Public**

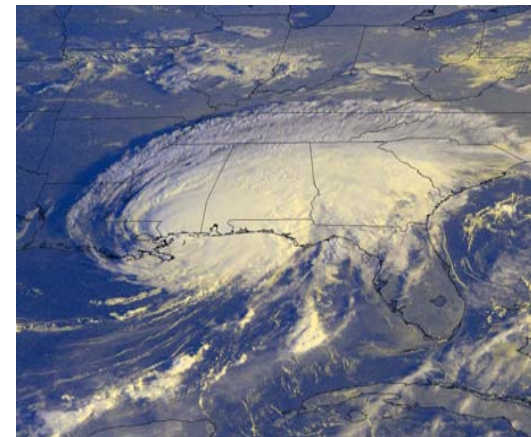
System Vulnerability Discovery & Management



Hostile Act Intervention & Prevention



Environmental Hazards Awareness & Mitigation



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Aviation Safety Projects FY 2000-2005

Vehicle Safety Technologies

Synthetic
Vision Systems



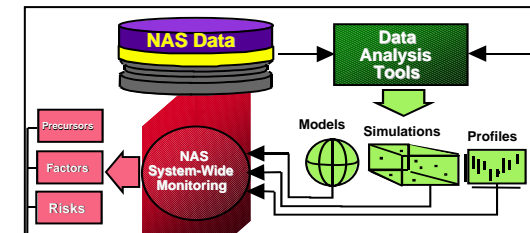
Accident
Mitigation

Single Aircraft
Accident
Prevention



System Safety Technologies

Aviation System
Monitoring & Modeling



Weather Safety Technologies



Weather Accident
Prevention



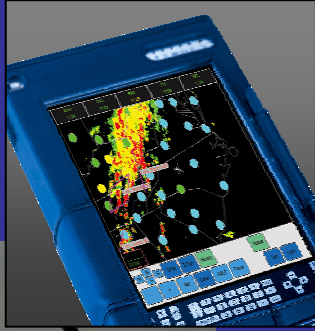
Aircraft Icing

System-Wide Accident
Prevention

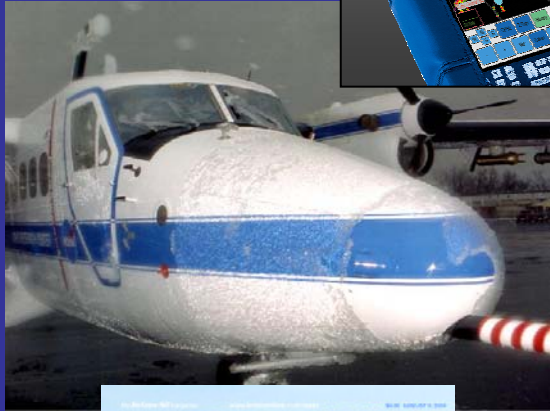


Aviation Safety Greatest Hits

Graphical Weather in the Cockpit



Ice Protection



Clear Skies All the Time



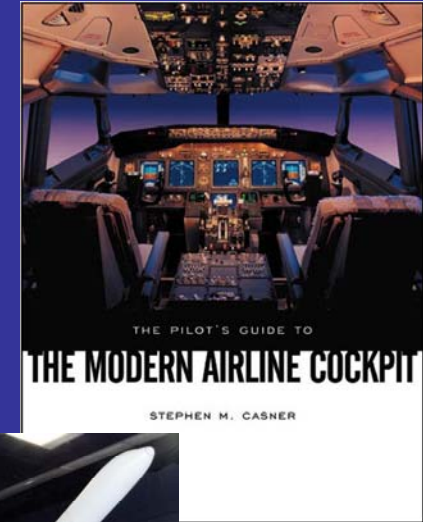
Cargo Bay Fire Detection



Airspace and Aircraft Monitoring



Training Solutions



Improved Flight Simulation

NASA Aviation Safety R&D Planning Workshop



*Aviation Safety Planning Workshop
March 2-4, 2004*

*To solicit input from industry and
other Government agencies
for future projects in NASA's aviation safety
research and development program*

**Working Groups recommend
prioritized investments for FY
06-10**

**~300 Industry &
Government
participants**

***Aircraft Self-Protection
& Preservation***

**Working Groups
(Reflect NASA strategic foci)
for Safety R&D**

***System Vulnerability
Discovery & Mgmt***

***Environmental Hazards
Awareness & Mitigation***

***Human Error
Avoidance & Mitigation***

Important Factors for New Safety R&D Planning



Focus will shift to:

- “Revolutionary” technologies, as well as “retrofit”
 - Mix of next generation aircraft/technology/ATM and existing fleet
 - Potential dynamics of less-than-anticipated industry growth
- Safety factors associated with operation in the next-generation NAS environment (e.g., distributed Air/Ground ATM)
- Space-based communications, navigation, and surveillance
- Appropriate mix aircraft types (Transport, GA, R/C, cargo, supersonic, UAV, PAV...)
- Maintenance of the aging fleet
- New pilot demographics (more inexperienced, but more computer literate)
- Precursor risk assessment, not just past accident data
- Security synergies as well as potentially conflicting requirements

NASA Aviation Safety R&D Planning Workshop



Integrated Aircraft & Propulsion System Self-Diagnosis & Self-Reliance

- In-situ and Robust Sensor Technologies for Airframe Health Management
- Design and Analysis Tools for Software Certification
- Adaptive Controls (including Propulsion) for Structural Load Alleviation
- Propulsion Health Management
- Sensors & Algorithms to Detect Hidden Fires

Environmental Hazards Awareness and Mitigation

- Advanced Ice Protection System Technologies & Tools for Certification
- Four-Dimensional Aviation Weather Digital Database
- Weather Dissemination/Data-Link
- Improved Range and Prediction of Turbulence
- Enhanced Airborne Sensors & Satellite based Weather Products

Human Error Avoidance & Mitigation

- Socio-Technical Risk Assessment Methods
- Procedures/Checklists for Emergency/Abnormal Situations
- Revolutionary Human/Machine Interface Technologies for the Flight Deck
- High-Integrity Data
- Reduced Mode Confusion

System Vulnerability Discovery and Management

- Techniques for Prognostics Approach to Predict Risk
- More Automated Tools to Identify, Gather, and Organize Safety Data

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FAA Aviation Safety Research

- *Fire Research and Safety* - Develops technologies, procedures, test methods, and criteria to reduce the risk of commercial airline accidents caused by hidden in-flight fires and fuel tank explosions and improves survivability during a post-crash fire
- *Advanced Materials/Structural Safety* - Ensures the safety of civil aircraft constructed of advanced materials by developing analytical and testing methods to understand how design, load, and damage can affect composite structures. Develops maintenance and repair methods. Increases the ability of passengers to survive aviation accidents by improving crash characteristics of aircraft structures and by modeling crash events to improve aircraft certification
- *Atmospheric Hazards/Digital System Safety* - Develops technologies to detect frozen contamination, predict anti-icing fluid failure, and ensure safe operations during and after flight in atmospheric icing conditions. Develops technologies, advisory, and guidance material to ensure safe operation in electromagnetic hazards resulting from electro-magnetic interference, cosmic radiation, high intensity radiated fields, and lightning. Ensures the safe operation of emerging, highly complex software-based digital flight controls and avionics systems

FAA Aviation Safety Research, cont.



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- *Aging Aircraft*- Develops technologies, technical information, procedures, and practices to help ensure the continued airworthiness of aircraft structures and systems. Assesses the causes and consequences of fatigue damage of aging aircraft. Ensures the continued safe operation of aircraft electrical and mechanical systems. Detects and quantifies damage, such as cracking, corrosion, disbanding, and material processing defects through nondestructive inspection techniques. Updates and validates airworthiness standards. Establishes damage-tolerant design and maintenance criteria for rotorcraft and commuter airplanes
 - *Aircraft Catastrophic Failure Prevention Research* - Develops technologies and methods to assess risk and prevent the occurrence of potentially catastrophic defects, failures, and malfunctions in aircraft, aircraft components, and aircraft systems. Uses historic accident data to investigate turbine engine “uncontainment” events and propulsion malfunctions
 - *Aviation Safety Risk Analysis* - Ensures that safety oversight keeps pace with the dynamic changes occurring in the aviation environment by better targeting our inspection resources, improving our oversight systems, and providing training for safety-critical employees.

FAA Aviation Safety Research, cont.



- *Air Traffic Control/Airway Facilities Human Factors*- Identifies and analyzes trends in air traffic operational errors and airway facilities incidents, and develops and implements strategies to mitigate these problems. Manages human error hazards, their consequences, and recovery methods in early stages of system design or procedural development
- *Aeromedical Research*- Identifies pilot, flight attendant, and passenger medical conditions that indicate an inability to meet flight demands, both in the absence and in the presence of emergency flight conditions. Defines cabin air quality and analyzes requirements for occupant protection and aircraft decontamination
- *Weather Program*- Develops new technologies to provide weather observations, warnings, and forecasts that are accurate, accessible, and efficient
- *Wake Turbulence*- Provides a better understanding of the swirling air masses (wakes) trailing downstream from aircraft wingtips to reduce safely separation distances between aircraft, supports the safe use of parallel runways, and facilitates the ability of airports to operate closer to their design capacity

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Why NASA in Aviation Security Research?



- NASA Role
 - Explore long-range, advanced technologies
 - Work beyond the risk level and return-on-investment timeframe of U.S. aviation industry
 - Leverage Existing expertise & technology
 - Fill voids/niches as needed/requested
- Focus
 - Vulnerability mitigation for aircraft & systems
 - Detection of vulnerabilities

“The U.S. government has no more important mission than protecting the homeland from future terrorist attacks, ... We must rally our entire society to overcome a new and very complex challenge. Homeland security is a shared responsibility.” - President George W. Bush, Preface to the National Strategy for Homeland Security, July 16, 2002

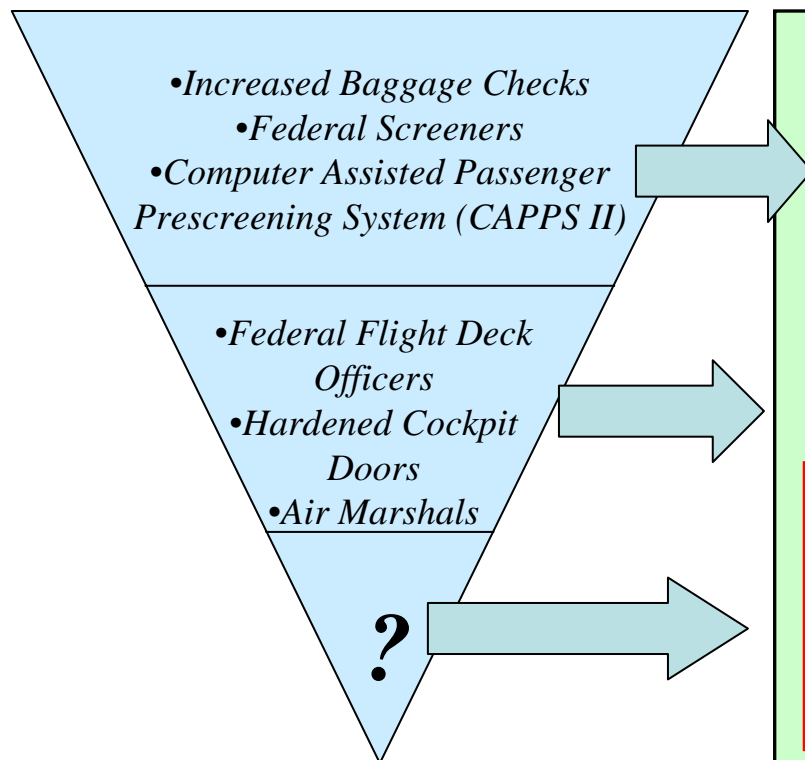
Why focus on Mitigation?



9/11- type scenarios

...terrorists will continue to consider attacks against commercial aircraft in the United States and abroad likely, intending to employ suicide hijackings and bombings as the most promising methods to destroy aircraft in flight, as well as to strike ground targets.

Mr. Steven McHale, Deputy Administrator, TSA, 5 Nov 2003



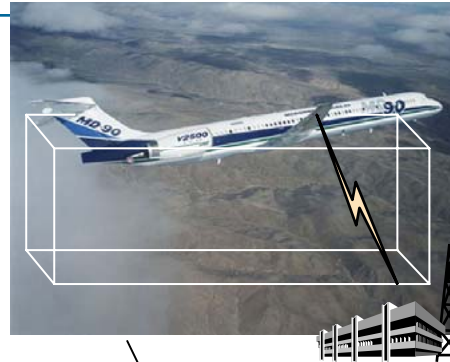
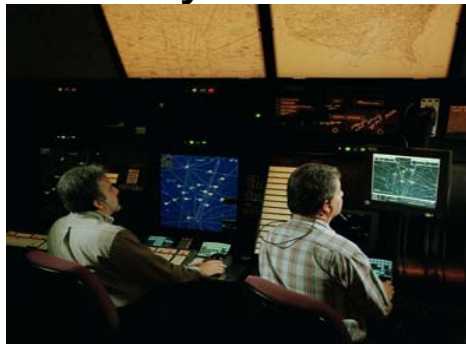
- ...Our first priority is to prevent terrorists from boarding commercial aircraft or getting any type of weapon onboard.
- The second priority is to prevent terrorists from overpowering the crew and taking control of the aircraft if they do get onboard.
- Only if the other interventions are unsuccessful will we need to *deal with preventing hijackers from crashing the aircraft.*

CONCEPT:

Enable layers of security to minimize vulnerability of aviation to threats



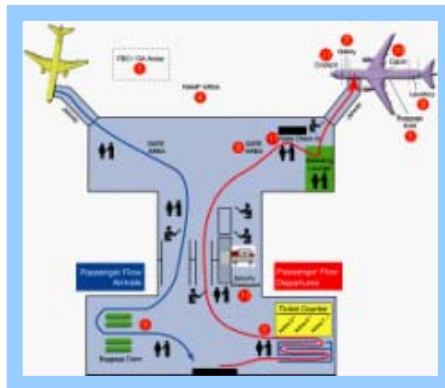
Decision support tools to harden the National Airspace System



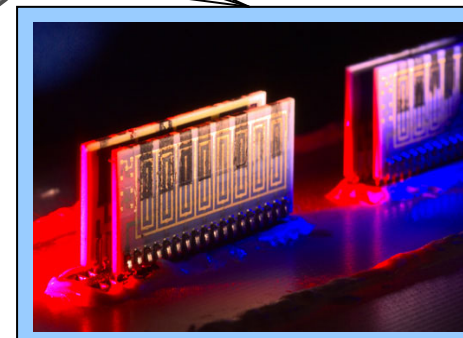
Secure and protect the aircraft; mitigate vulnerabilities



Secure vehicle CNS systems; support improved situational awareness



Increase effectiveness of aviation information screening



Integrate advanced sensors into the aircraft

Security Research Objectives



Aircraft & Systems Vulnerability Mitigation

Develop and advance technologies that will mitigate consequences to the aircraft from an intentional attack

Secure and protect the aircraft



Secure Aircraft Systems for Information Flow

Secured onboard networks & air/ground datalinks, aircraft surveillance for improved situational awareness and, and enabled minimized intrusions into protected airspace

Secure vehicle CNS systems



System Vulnerability Detection

Leverage and advance technologies which will detect and inform users of potential security vulnerabilities in the Air Transportation System

Increase effectiveness of info screening

Harden the National Airspace System



Integrate advanced sensors into aircraft



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Summary



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- NASA Aeronautics Programs are undergoing a “complete overhaul”
 - Aviation Safety and Security Program is changing
 - Safety program efforts have strong support
 - The future technical content is in development
 - A proposal is being considered to phase-out the security parts of the program
 - Significant capabilities are available across the NASA Centers for Aviation Safety Research

Aft Flight Deck



- The Aft Flight Deck (AFD) is an enhancement of, and an extension to, the existing capabilities of the Transport Research System (TRS) on the B-757 Airborne Research Integrated Experiment System (ARIES) B-757.
- The AFD will provide a capability on the ARIES similar to the B-737 Transport Systems Research Vehicle (TSRV) to perform a wider variety of aeronautical research leading to:
 - the enhancement of commercial jet transport safety and efficiency, and
 - the improvement of the safety and capacity of the Air Traffic Control System and the National Airspace System
- The AFD will be a duplicate of the cockpit of the Research Flight Deck Simulator Cab in the Cockpit Motion Facility in Bldg. 1268

Systems & Airframe Failure Emulation, Testing, & Integration (SAFETI) Lab



Purpose

Provide Venue for Integration, Validation, and Demonstration of Aviation Safety & Security Systems Research Efforts and New Technology

Capabilities

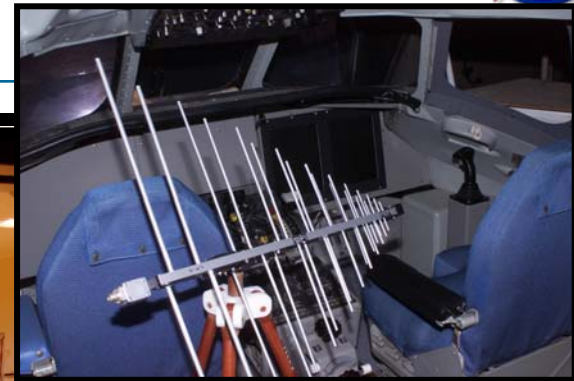
- Embedded Computer Design
- Closed-Loop Systems Assessment
- Vehicle Emulation
- Malfunction/Fault/Failure Emulation

Benefits

- Ability to Assess Complex and Highly Integrated Airborne Systems

Technology

- Closed-Loop Environment
- Hardware in the Loop
- Pilot in the Loop
- Ability to Introduce Faults in Complex and Highly Integrated Systems
 - HIRF (Link to HIRF Lab)
 - Lightning (Bulk Cable Injection)
 - EMI/EMC
 - Faulty or Malfunctioning Components
 - Failed or Damaged Components



Attributes

- Reconfigurable Testbeds
 - Components
 - Data Buses
 - Vehicle Models
- Potential to Link to other LaRC Laboratories/Facilities
 - HIRF Lab
 - Cockpit Motion Facility
 - Structures Test Facilities
- Variable Fidelity Simulation
 - Low Fidelity for Initial Concepts and Designs
 - Linked High Fidelity Demonstrations of Mature Designs

AirSTAR Test Capability



Purpose

To prevent aircraft system failures, detect and identify failures that do occur, and provide enhanced guidance and control capability to prevent and recover from vehicle loss of control

Benefits

- In-flight validation of vehicle dynamics models for high risk/upset flight maneuvers
- In-flight validation of recovery algorithms for aircraft loss of control
- Full-scale manned flight validation is not feasible due to high risk



About AirSTAR

- Generic 5.5% scaled remotely piloted transport model
- 50 pounds; 82 inch wing span
- Turbine engines
- Associated ground-support equipment
- Remote test station
- Telemetry system

Aircraft Icing Capabilities



In-Flight Icing Research



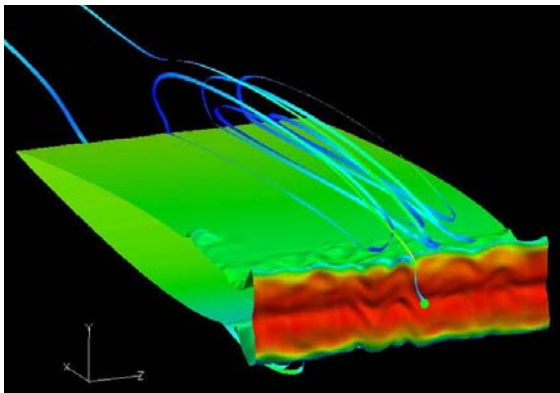
Newly acquired S-3 Viking Aircraft will allow NASA to conduct aircraft icing research in the corporate and commuter jet envelope as well as evaluate swept wing icing.

Experimental Icing Research



Icing Research Tunnel (IRT)

Analytical Icing Research



Icing Aerodynamics and Accretion Modeling and Tools



GRC Icing Capabilities and Expertise Enable More Icing Resistant, Self Preserving Aircraft And Enhance Operations

Fire Sensor Capabilities



GRC Microsystems Fabrication Laboratory
(Class 100 Clean room Facility)

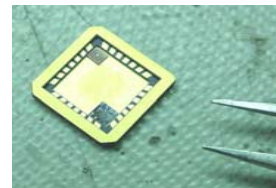
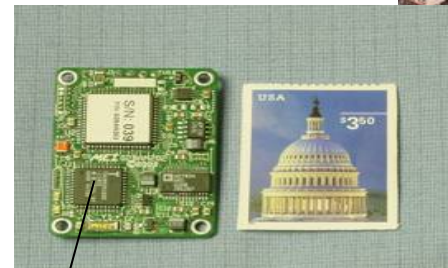


Micro-devices Characterization Facilities



Strong Ties Established with FAA Facilities

Development of
micro/ nano gas sensors
for operation
in harsh and high
temperature
environments



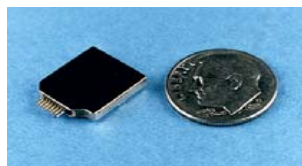
GRC Combustion/Sensor Capabilities and Expertise Enable Increased Fire Situational Awareness and Mitigation Schemes for Self Preserving Aircraft And Enhance Operations



Propulsion Health/Sensor Capabilities



Vehicle Health Management Testbed



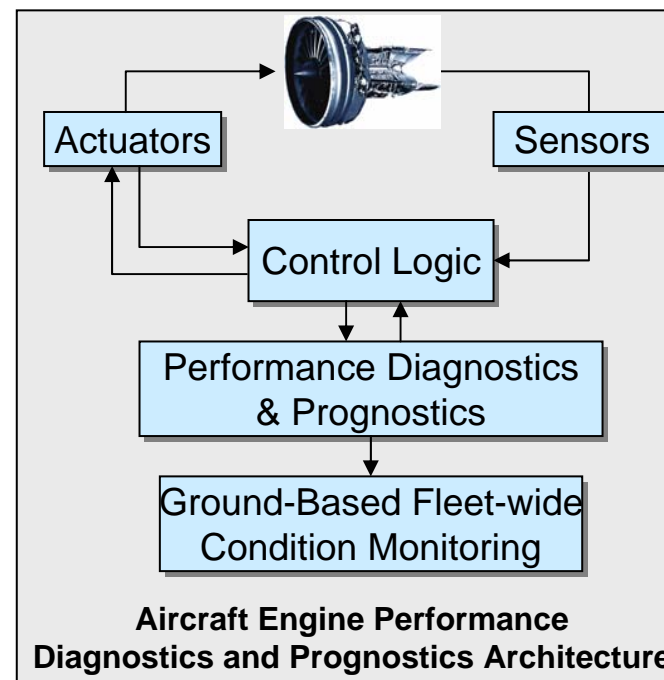
Development of micro/ nano sensors for operation in harsh and high temperature environments



High Temperature Spin System



Control Development and Simulation Lab



GRC Propulsion Health Capabilities and Expertise Enable Increased Engine Situational Awareness and Mitigation Schemes for Self Preserving Aircraft And Enhance Operations