Managing Aging Wiring

Birthplace, Home and Future of Aerospace

New Materials

Diagnostics and Inspection

TECHNOLOGY INTEGRATION

Managing Aging Wiring Systems

Failure Characterization

Interconnection Technologies
- Circuit Breakers
- Connectors

Maintenance Procedures
## Aging Wiring Diagnostics

### Benefits to the War Fighter

The aging of a wiring system can result in loss of critical functions in aerospace equipment or loss of critical information regarding equipment operation. Fielding AFRL’s wiring system diagnostics will:

- Reduce troubleshooting & repair time by 50%
- Reduce unneeded Line Replacement Units (LRUs) replacement by 65%
- Provide the foundation for managing wiring as a system

### Description

- Develop, validate, & transition a portable wiring system tester to the user community (both military & commercial).

### Technology

- Detection technology for opens & shorts, as well as provide fault location, in wiring system.
- Diagnostic system that:
  - guides users in fault detection
  - interprets and archives system data
  - alerts user to type of problem.

### Technology Investment Schedule (FY)

<table>
<thead>
<tr>
<th>Technology Availability</th>
<th>Prior FY02</th>
<th>FY03</th>
</tr>
</thead>
<tbody>
<tr>
<td>Establish Architecture</td>
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<tr>
<td>Integrate Diagnostic System</td>
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<tr>
<td>Testing &amp; Validation</td>
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<tr>
<td>Evaluation of Utility</td>
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<tr>
<td>Technology Availability</td>
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</tbody>
</table>
Predictive Failures & Advanced Diagnostics (PFAD)

**Description**
- Initial foundation for advanced diagnostics and prognostics to better support legacy aircraft

**Technologies**
- Wireless sensors to monitor system parameters
- Data mining for diagnostics/prognostics
- Diagnostic algorithms
- Failure pattern recognition methods

**Benefits to the Warfighter**
- Initial capability for F-16 Radar
  - Reduce maintenance man-hours
  - Restore aircraft to operational status sooner
  - Reduce consumption of spare parts
  - Reduce mission aborts due to system failures
  - Allow warning time to order spares and invoke proactive repairs
- Foundation for extension of the technology to other aircraft and systems

**Technology Investment Schedule (FY)**

<table>
<thead>
<tr>
<th>Year</th>
<th>Data Analysis</th>
<th>Develop Prognostics Algorithms</th>
<th>Develop Diagnostic Algorithms</th>
<th>Develop Architecture</th>
<th>Develop CONOPS</th>
<th>Develop Cost Benefit Analysis</th>
<th>Final Report</th>
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</table>
Description

- Demonstrate Affordable Frameless Transparency Technology Integration for Fighter/Attack Aircraft
- Full Scale Tests for Safety-of-Flight Compliance

Benefits to the War Fighter

- 80% Reduction in Total Ownership Costs
  - Top Rated Affordability Pilot Program
- Reduce Transparency Weight by 20%
- Replacement During Integrated Combat Turn
- Reduce Parts Count by 90%
- Precision Shape for LO
- Precision Optics for Helmet Mounted Display

Technology

- Direct Forming, Injection Molding
- Explosive Severance for Crew Escape

Technology Investment Schedule

<table>
<thead>
<tr>
<th>Requirements Definition</th>
<th>Prior FY01</th>
<th>As of FY02</th>
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</thead>
<tbody>
<tr>
<td>Subscale Manufacturing and Testing</td>
<td></td>
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<tr>
<td>Final Design of Tool</td>
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<tr>
<td>Full Scale Article Manufacturing</td>
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<tr>
<td>Full Scale Article Coating &amp; Testing</td>
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<tr>
<td>Tech Availability</td>
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</tbody>
</table>

Prior FY01 FY02

- Funding ($M) - 6.2 1.26
- 6.3 0.51 0.69
- 7.8 1.10 0.20 0.20

DARPA 1.02 Boeing 1.95 1.00 0.85
Next Generation Aircraft Brakes

Consortium of major US aircraft brake manufacturers with the Ohio Aerospace Institute (OAI):
- Honeywell
- ABSC
- Goodrich
- Parker Hannifin

- $1.93M incl. 50% cost share, FY99–03
- Evaluate a range of SiC based CMCs as aircraft brake friction materials
- Two rounds of materials test & subscale dynamometer evaluation
- Down select best material for full scale dynamometer tests

Second round of material evaluation and subscale dynamometer testing nearing completion

• Reduced wear
• More stable dynamic coefficient of friction
• Higher RTO coefficient
• Smaller/lighter brake
Title: In-line Health Monitoring System for Aircraft Hydraulic Pump and Motors

Objective: Develop in-line monitoring system for early warning of impending failure of aircraft hydraulic pumps and motors

Description:

- Hydraulic Pumps Critical for Aircraft Safety
- Pumps Replaced at Mean Time Between Change
- Catastrophic Pump Failure on Aircraft can result in
  - loss of aircraft
  - contamination of entire hydraulic system
- In AFRL/MLBT pump tests, it has been observed that certain parameters develop unique characteristics when the pump is nearing failure. At this point the pump still has ~10% of its remaining useful life.
- In-line monitoring system proposed to predict pump failure
- Replacing the pumps/motors for cause would increase reliability, maintainability and readiness.

Test 37, Test parameters at ~1319 hours
• Technology Solutions
  – Corrosion Prevention & Control Technologies
  – Non-Destructive Testing & Evaluation Technologies
  – Structural Repair Technologies
  – Coating Technologies
  – Engine Technologies
  – Subsystem Diagnostic & Repair Technologies
  – Maintenance Avoidance Technologies
  – Maintenance Management and Control
  – Maintenance, Repair & Overhaul Business Practices
Dynamic Load Reduction & Response Suppression

Technology Investment Schedule (FY)        As of 18 Jul 02

Milestones       06      07      08      09
System Design and Optimization
System Fabrication
System Integration
Functional Ground Test
Flight Demonstration
Technology Availability

Description

• Demonstrate a full-scale synergistically controlled dynamic load and response suppression system.

Technologies

• Full-Scale Sensor/Actuators for Aircraft Integration
• Active Flow Control System
• Active Dynamic Response Control System
• Integrated Active/Passive Structural Concepts
• Synergistic Active/Passive Control System Design

Benefits to the War Fighter

• Increased Aircraft System Utilization Rates
• Decreased Aircraft Maintenance Actions
• Increased Aircraft Reliability
• Extended Aircraft Fatigue Life
• Reduced No. of Required Field Inspections
• Reduced Level of Required Sup. Equipment
**Fastener Elimination Using Unitized Composites**

**Description**
- Demonstrate a repair/replacement methodology to eliminate mechanical fasteners using robust unitized composite structure

**Technology**
- Integralelv fiber reinforced joints
- Reinforced skin to substructure joints
- Low cost, self locating, bonded assembly
- Unitized composite structure

**Benefits to the War Fighter**
- Reduced support costs
  - Eliminate need for fastener inspections and repair
  - Example: $27M estimated savings in support cost through elimination of inspections and repair of loose fasteners & damaged skins for F-16
  - Tails inspected every 300 hours
- Extends component service life
  - Damage tolerant, non-corrosive, fatigue resistant structure
- Technology is applicable to legacy and new systems

**Technology Investment Schedule (FY) As of 26 Aug 02**

<table>
<thead>
<tr>
<th>Prior</th>
<th>02</th>
<th>03</th>
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<td>Design Development Tests</td>
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<tr>
<td>Tail Fabrication</td>
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<tr>
<td>Tail Testing</td>
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</table>
**Technology Investment Schedule**

<table>
<thead>
<tr>
<th>Description</th>
<th>Benefits to the War Fighter</th>
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<tbody>
<tr>
<td>• Develop laser peening for fracture prevention in fatigue and corrosion-critical aircraft structures.</td>
<td>• LSP process ensures no crack growth from FOD in fan and compressor blade applications</td>
</tr>
<tr>
<td>• Increase the reliability of structural repairs.</td>
<td>• Implemented on F101 and F110: Working implementation on F119 (May 01)</td>
</tr>
<tr>
<td>• Mobile laser peening for aircraft repairs in depot.</td>
<td>• Fatigue prevention in fracture critical aircraft structure</td>
</tr>
<tr>
<td>• Laser peening produces deep compressive residual stresses into metal surfaces to significantly inhibit fatigue crack initiation and propagation.</td>
<td>• Improved reliability of aging aircraft parts</td>
</tr>
</tbody>
</table>

**Technology**

- ManTech for Affordable LSP
- Rapid Laser Shock Peening Development
- LSP of F119 IBRs
- LSP Demonstration for High Strength Affordable Castings
- Engine Technology Availability

**As of 4 Apr 2001**

<table>
<thead>
<tr>
<th>Prior</th>
<th>01</th>
<th>02</th>
<th>Total</th>
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<td>5.3</td>
<td>1.8</td>
<td>1.8</td>
<td>7.1</td>
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</table>

Engine Technology Availability
Applications:
• Thin Wires
• Conductive Elastomers
• Electromagnetic Management
• Photovoltaics/Photodetectors
• Fuel Cells
• RF Polymers
• Lightning Protection
• Electrochromic Devices
• Multifunctional Thermal Mgt
• Conductive Resins
• EMI Shielding
• Battery Charge Collectors
• Battery Electrodes
• Polymer Welding/Repair
• Antennas
• Technology Solutions
  – Corrosion Prevention & Control Technologies
  – Non-Destructive Testing & Evaluation Technologies
  – Structural Repair Technologies
  – Coating Technologies
  – Engine Technologies
  – Subsystem Diagnostic & Repair Technologies
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