JOINT STRIKE FIGHTER
the next generation strike fighter

Structural Prognostics and Health Management

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Design Specification

Air Vehicle Service Life

Ninety percent of all delivered JSF Air Vehicles, by variant, shall achieve either 30 years of operation or 8000 flight hours

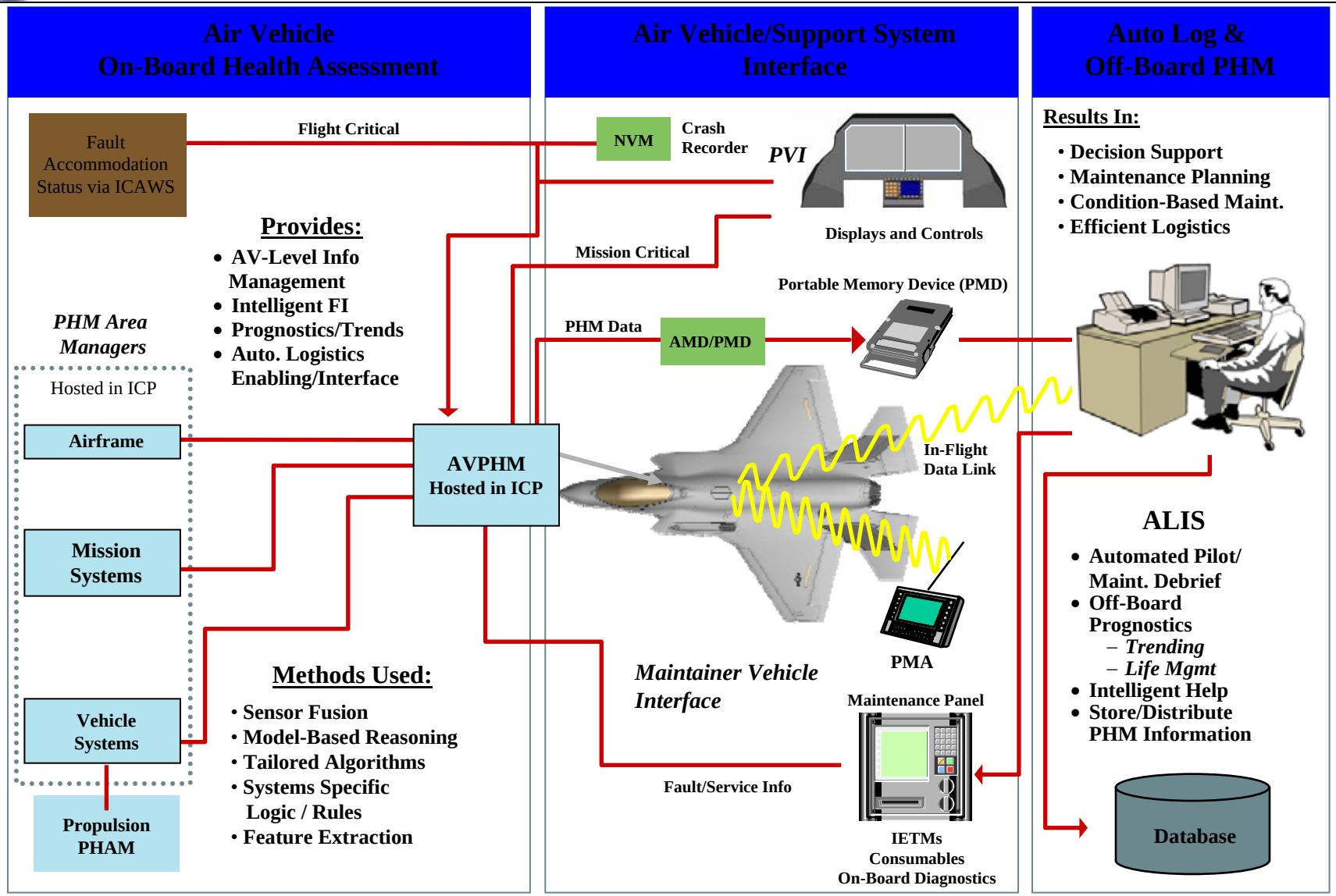
Structural Prognostics and Health Management (SPHM)

SPHM Goals

- Minimize maintenance while maintaining safety
- Eliminate scheduled inspections - Goal is on-condition maintenance
- Achieve condition based maintenance at minimum cost
- Individual aircraft tracking
- Fully automated
- Support structural prognostics
- Minimize dedicated SPHM sensors
- SPHM integral part of AVPHM and OBPHM
- Capability to accept emerging technologies

Structural Prognostics and Health Management (SPHM)

PHM Architecture



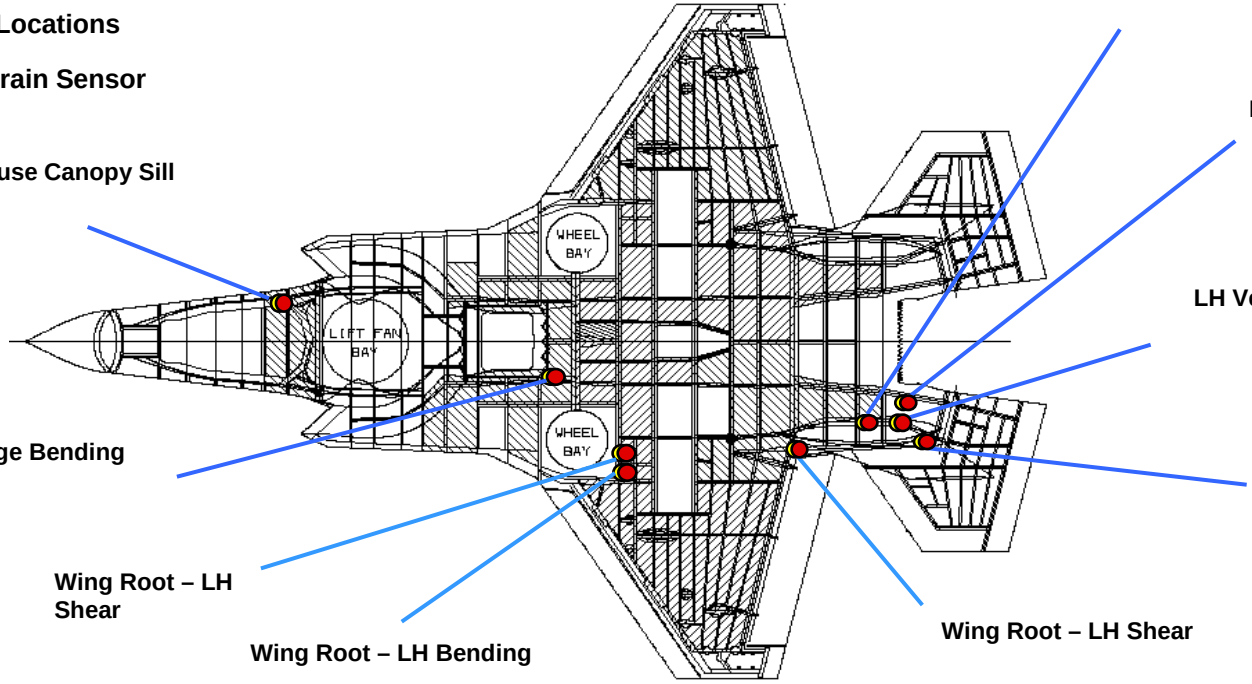
SPHM Functions

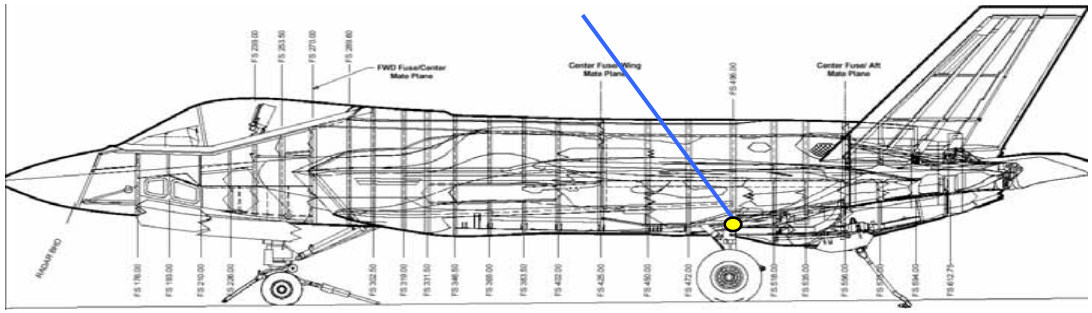
- Operational Loads Measurement
  - Strain gage
  - Parametric models
  - Safe-Life and Damage Tolerant models
- Structural Overload Measurement
- Auxiliary Structural Data collection
- Corrosion Environment Monitoring

Structural Prognostics and Health Management (SPHM)

SPHM Strain Sensor Locations (STOVL)

- Mirrored Locations
- SPHM Strain Sensor





Structural Prognostics and Health Management (SPHM)

Strain Sensors

- JSF philosophy – strain sensors are for model development, verification and refinement
  - All SDD and LRIP Aircraft with strain sensors
  - 10% of remaining aircraft with strain sensors
- One side of aircraft instrumented
  - Other side validated with loads aircraft instrumentation
- Can be in difficult to access locations
  - Primary and Backup gages
  - Will not be maintained – operate until they expire
- All aircraft will be tracked – primary means is parametric equations and dynamic models

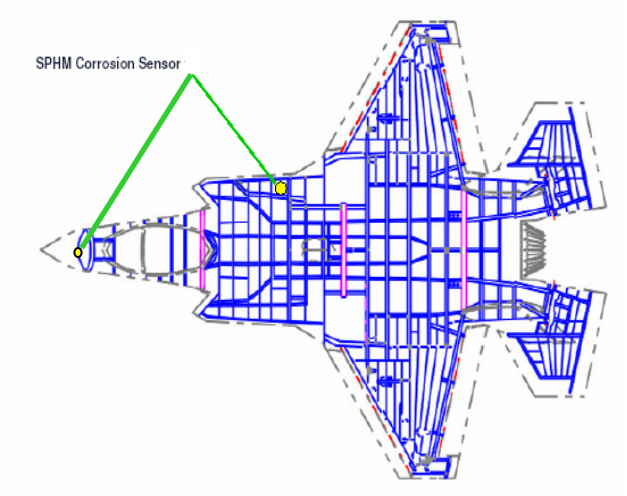
Structural Prognostics and Health Management (SPHM)

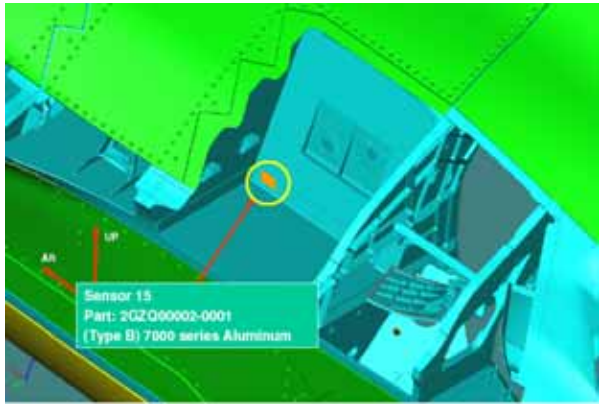
Corrosion Sensors

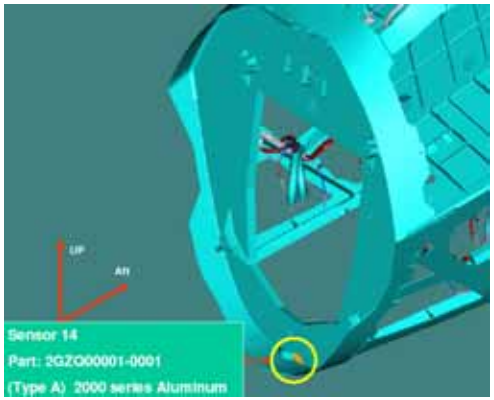
- Replace scheduled inspections with “on condition” inspections
- Sensors in 2 locations on SDD aircraft
  - Demonstrate reliability and refine models
  - Growth capability exists as needs emerge
- Sentinel Resistance sensors
  - Resistance changes as pre-calibrated strips on sensor begin to corrode
  - Tied into aircraft bus to automatically record data
- Looking at multi-variate sensors for future

Structural Prognostics and Health Management (SPHM)

Corrosion Sensors



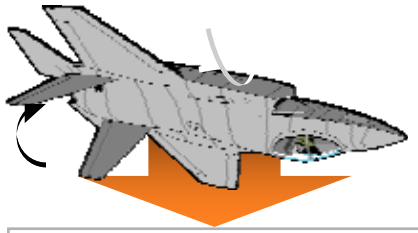


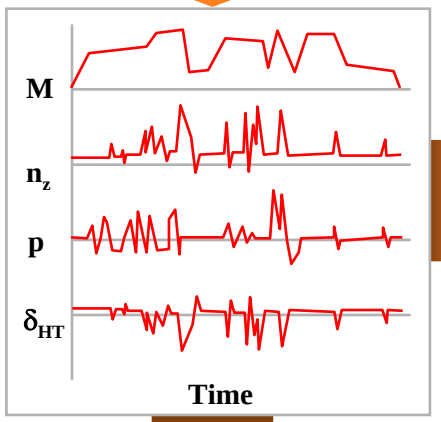


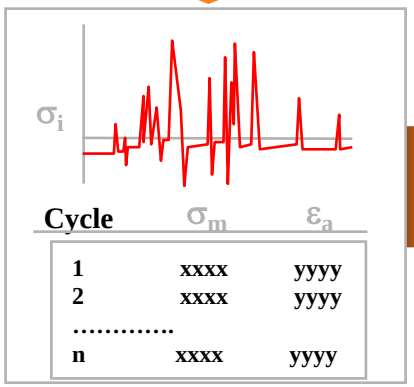
Structural Prognostics and Health Management (SPHM)

Individual Aircraft Tracking

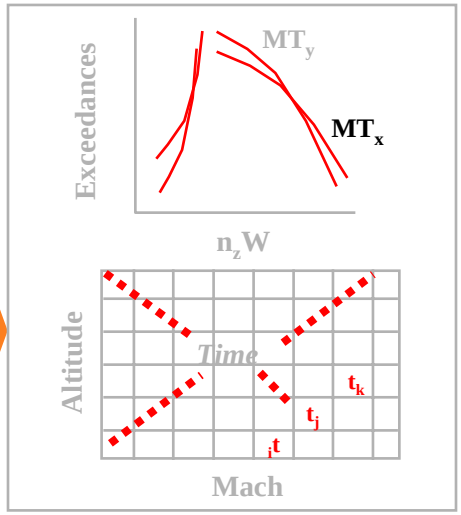
- SPHM Operational Loads Monitoring (OLM)
  - SPHM Area Manager Fed Various Flight Parameters
  - Most Data Sources SOF
  - Time History Captured
  - Parameter Cycle Counting and Usage Statistics Calculated by SPHM Area Manager
  - Fatigue Life Expended for Control Points Tracked
  - Results stored for ALIS download and further force management
  - Future updates are table driven, not OFP changes



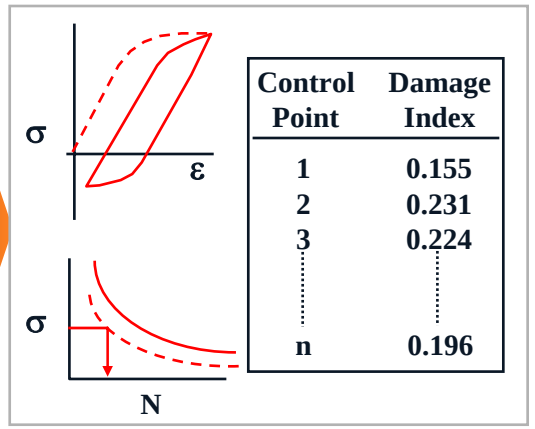




Individual Aircraft Usage



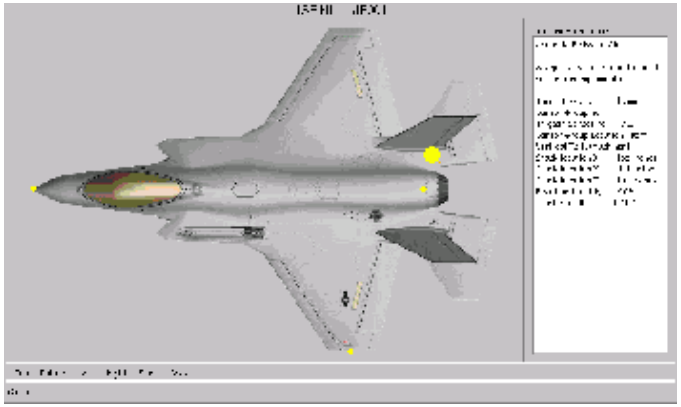
Individual Aircraft Damage



SPHM Architecture Allows 100% Data Capture vs. 40% or less for Legacy A/C

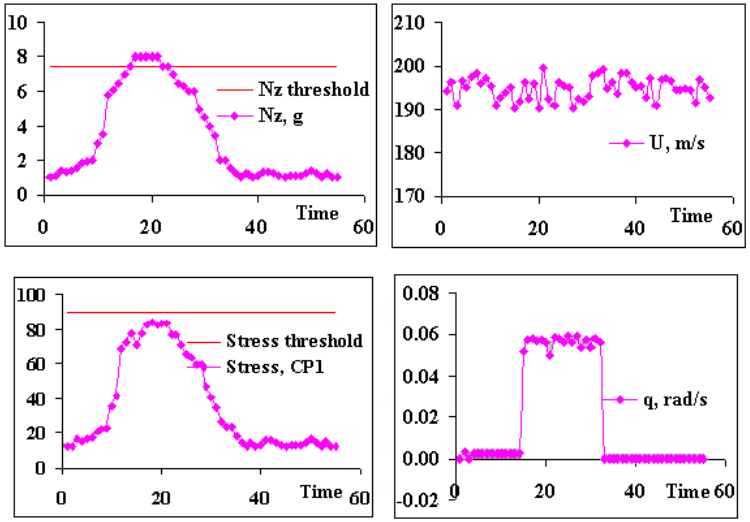
Structural Prognostics and Health Management (SPHM)

Structural Event Monitoring



Maintainer interface will specify exact tasks to be accomplished to verify structural integrity

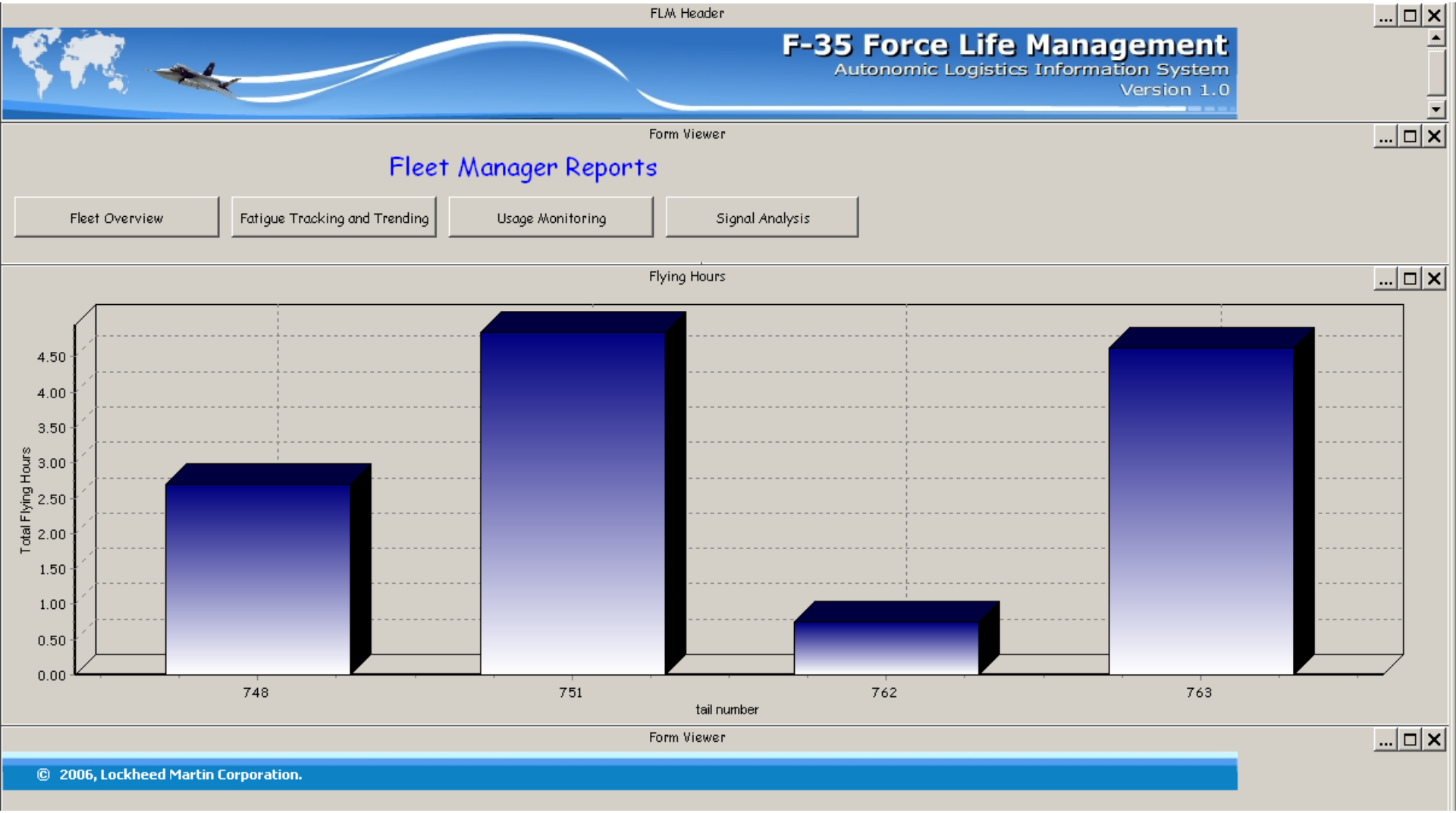
Flight recreation visualization aids understanding of damaging maneuvers



Parameter recording and display available for engineering analysis

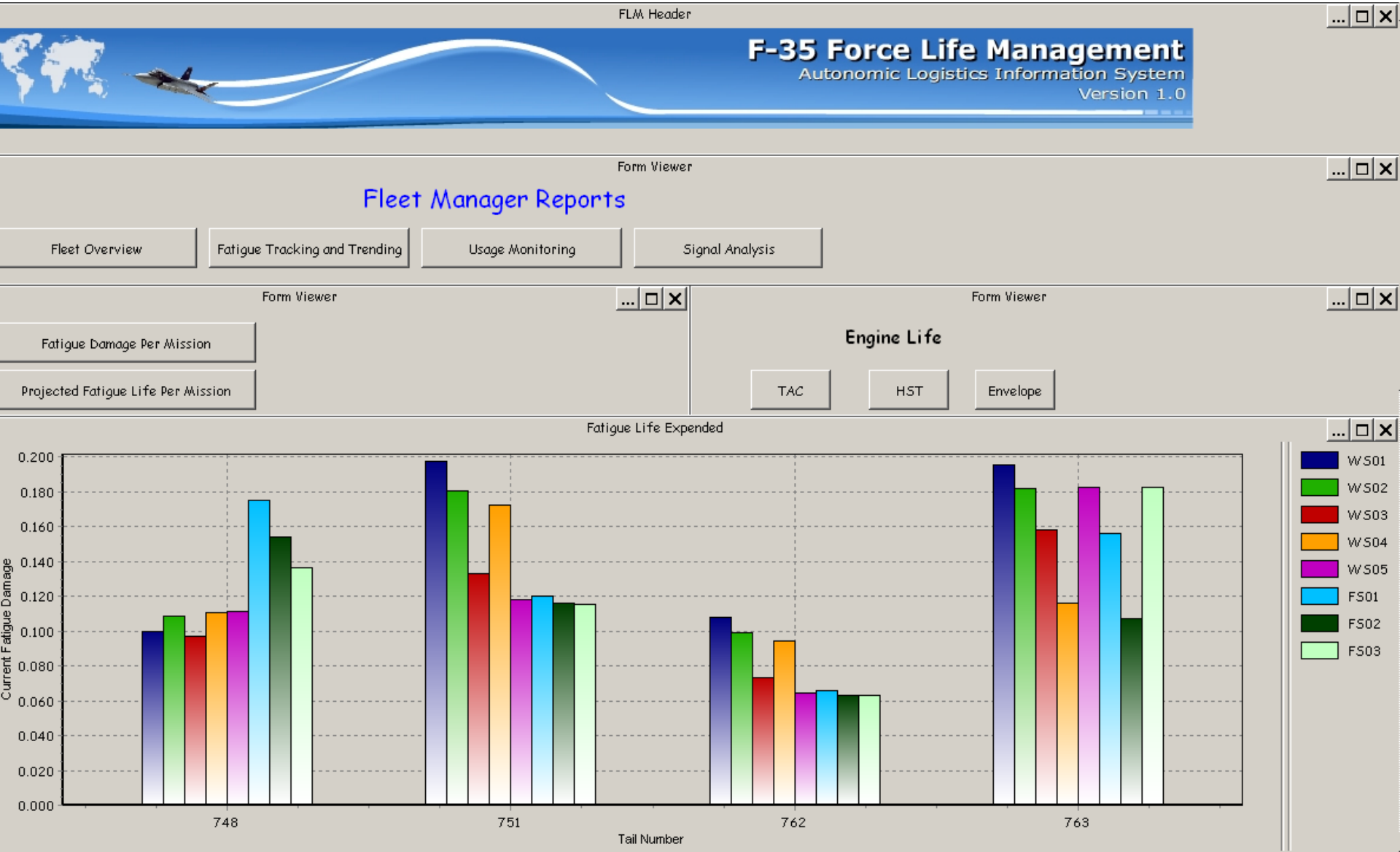
Structural Prognostics and Health Management (SPHM)

Sample FLM Screen



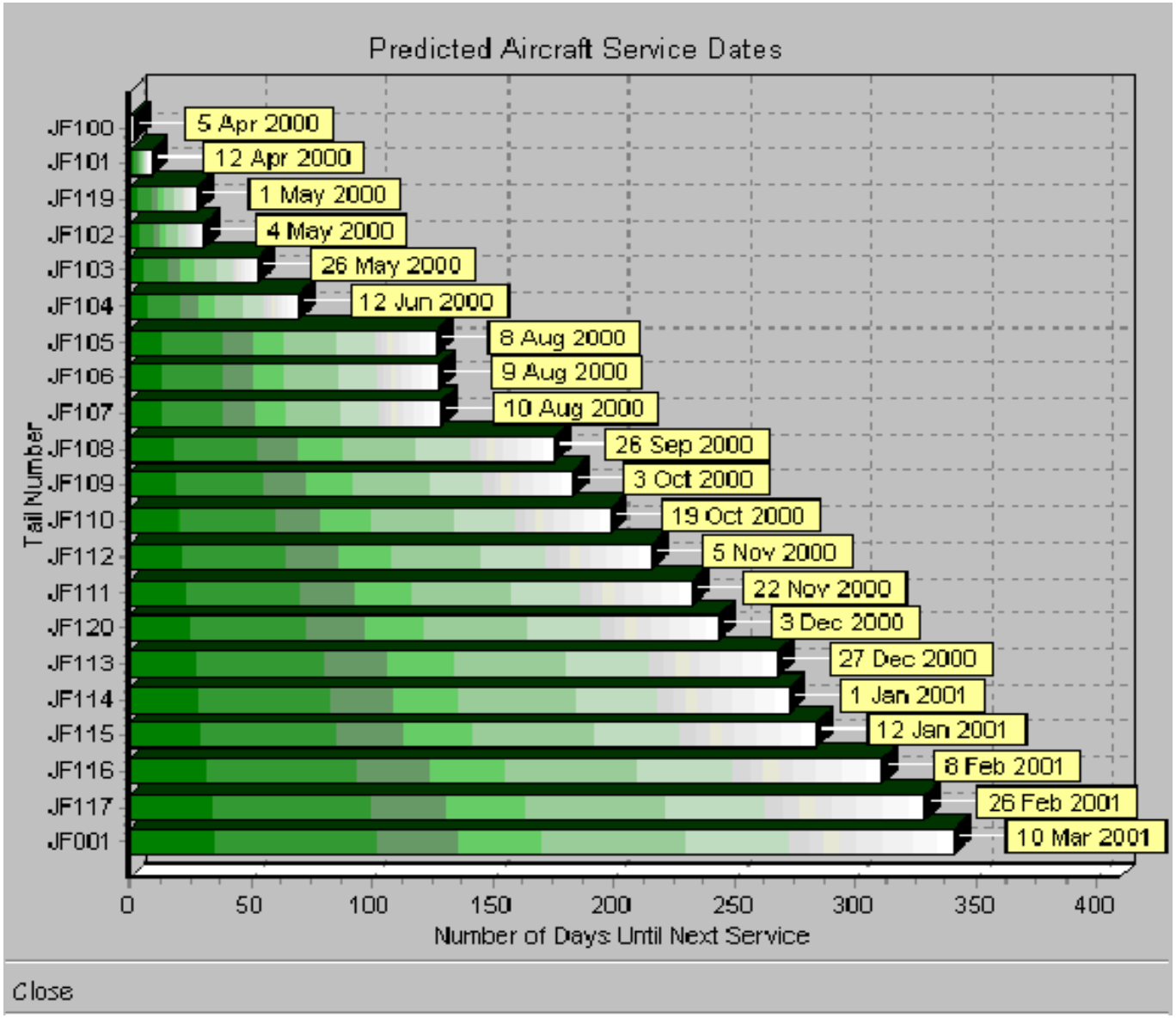
Structural Prognostics and Health Management (SPHM)

Sample Fleet Manager Screen



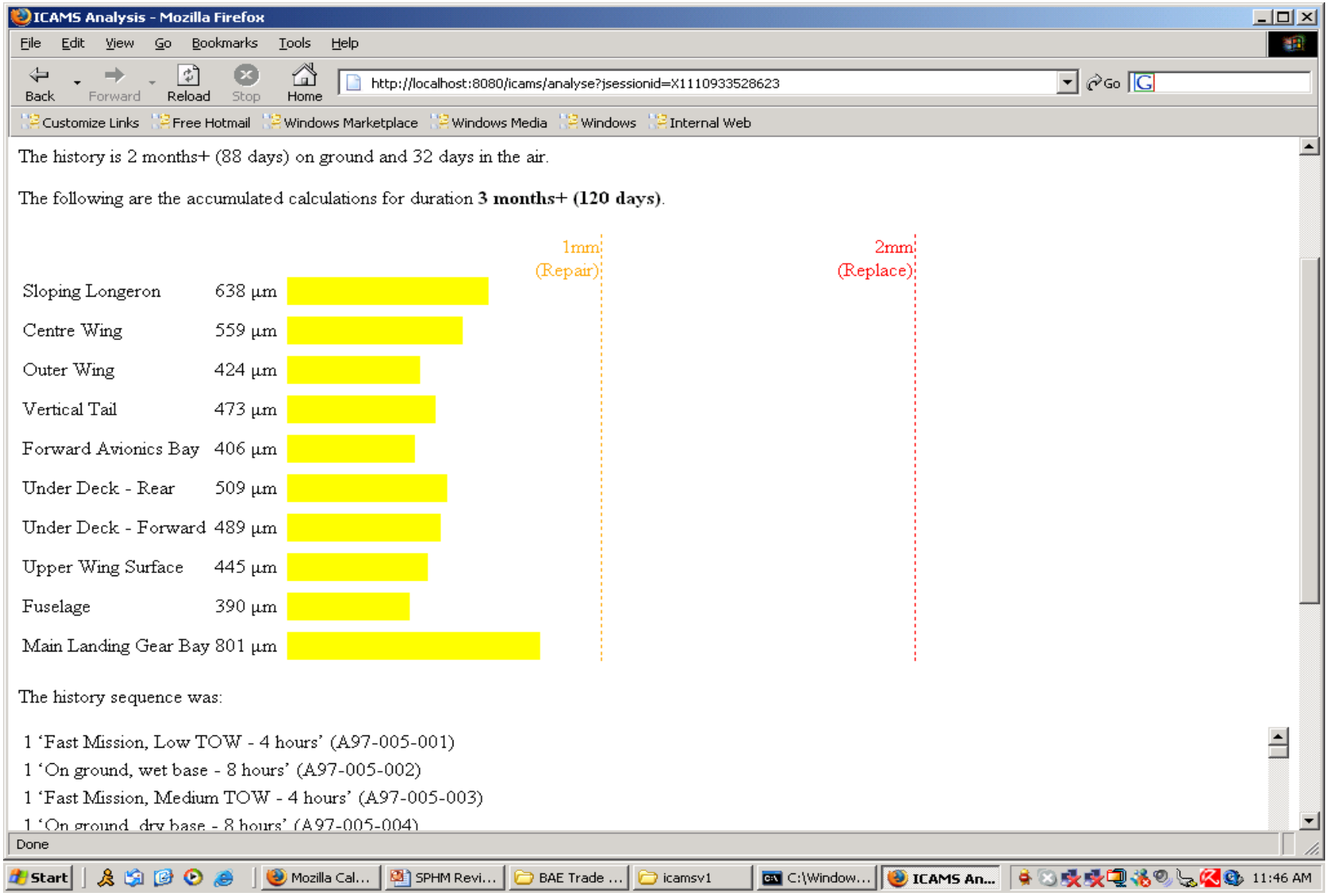
Structural Prognostics and Health Management (SPHM)

Force Life Management Capability



Structural Prognostics and Health Management (SPHM)

Corrosion Model Concept



Structural Prognostics and Health Management (SPHM)

Off Board Tools

- Assess Material Condition
- Anomaly and Failure Resolution System
- Knowledge Discovery
- Force Life Management

Structural Prognostics and Health Management (SPHM)

Future Technologies

- Crack detection and monitoring
  - CVM, MWM technologies
- Structural Integrity Prognosis System (SIPS)
- Airframe Reliability and Risk Assessment

Summary

- JSF embracing tenets of CBM+
- Data needs to support Assess Material Condition and Prognostics are high
  - 100+ paramaters continuously recorded at up to 320 Hz
  - Current projection is 200MB per hour that aircraft is powered
- Data transfer and storage needs stretch current capabilities

Questions?

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