PHM
Prognostics Health Management

Naval Air Vehicle

Lessons Learned

NAS Patuxent River
AIR 4.4.2.2 Diagnostics

PHM Society Conference
Portland, Oregon
14 October 2010
Requirements Evolution

• HMX-1 H-60 mishap was the genesis for IMDS
  – Led the White House requirements memo September 1993
  – System must be proven on fleet rotary wing prior to deployment on VH aircraft

• Mission Needs Statement approved, June 1994

• VCNO memo identified PMA-261/H-53E IMDS as Lead-The-Fleet (LTF) platform, April 1995

• Operational Requirements Document signed, May 2000
## Outfitted Aircraft

### UAV
- MQ-8B (Fire scout)
- MQ-4C (BAMS)
- X-47B (UCAS)

### Fixed Wing / STOVL
- E-2D
- F-18E/F
- F-35 (JSF)
- MV-22
- P-8

### Rotary Wing
- H-1Y/Z
- CH-46E
- C/MH-53E
- CH-53K
- MH-60R/S

Virtually every aircraft in the Naval inventory has some form of a PHM system.
Day In The Life

• Use Case Scenarios
• Operational Environment
• Requirements Interpretation
Validation / Verification

- RDT&E vs. O/S Dollars
- Limited Testing Opportunities
- Failure Modes and Effects Criticality Analysis

Example:

Wiring to the sensors was crossed. System level check was not sufficient to properly detect this scenario.
Data Storage and Retrieval

- Amount of Online Data
- Archival and Retrieval Procedures
- Data Lockout

Data Rate of PHM Equipped Navy Rotary Wing Aircraft

<table>
<thead>
<tr>
<th>Aircraft</th>
<th>Year</th>
<th>Mb/FH</th>
</tr>
</thead>
<tbody>
<tr>
<td>CH-53E</td>
<td>1999</td>
<td>10</td>
</tr>
<tr>
<td>SH-60B</td>
<td>2001</td>
<td>20</td>
</tr>
<tr>
<td>MH-60R/S</td>
<td>2007</td>
<td>30</td>
</tr>
<tr>
<td>CH-53K</td>
<td>*Est</td>
<td>80</td>
</tr>
</tbody>
</table>
Transitioning to CBM

- Dynamic Thresholding
- Maintenance Credits
- Actionable Maintenance
Engine S&T Projects

• Prognostics Diagnostic Based Maintenance
• Fault Detection Hybrid Ceramic Bearings
• Advanced Sensor Applications
• Light Weight Bleed Flow Sensor
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