Human Factors Issues in Maintenance Publication Design

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776 aircraft destroyed in 1950

Impact of Engineering & Administrative Controls:
- Naval Aviation Safety Center (Now NSC)
- Naval Aviation Maintenance Program
- Fleet Replacement Squadron Concept
- NATOPS Program
- Squadron Safety Program
- System Safety Designs
- CRM Program
- HF Reviews
- Climate Surveys

Total Cost of Naval Aviation Mishaps Last FY was nearly $700 Million w/33 Fatalities

31 aircraft destroyed in 2002
Engineering & Administrative Controls have Impacted Hardware Reliability, but....

[Graph showing the trend of Class A, B, & C Mishaps/100,000 Flight Hours from the 70's to the 90's. The graph indicates a significant decrease in mishaps, with a notable reduction in both human error and material failure.]
Mishap Data Analysis Focus:
Naval Aviation Class A FM Causal Factors

Initial emphasis on “Pilot Error,” but to reach goal of cutting human factors mishaps in half the focus has turned to: **Maintenance**
Human Factors Analysis & Classification System

*Maintenance Extension*

**Latent Conditions**
- Ineffective Publication Management System
- Inadequate Oversight Ensuring Publication Use

**Working Conditions**
- Missing Publications
- Outdated Publications

**Maintainer Conditions**
- Stress/Fatigue
- Miscommunication

**Unsafe Acts**
- Did Not Use Maintenance Manual
- Forgot to Tighten Hydraulics Line

**Failed or Absent Defenses**

**Mishap**
- In-flight Fire

Note: Adapted from Reason’s “Swiss Cheese” Model
Preliminary HFACS-ME Analysis of All FY 90-02 Maintenance Mishaps

- 294 of all Naval Aviation Maintenance Mishaps Involved a Publications Problem (28%)
  - 168 Involved Process/Procedure Deficiencies (16%), some common examples include:
    - Missing procedural step and/or steps out of sequence
    - Inadequate procedure for inspection, troubleshooting, etc.
    - Procedures do not include hazard and risk warnings
  - 158 Involved Documentation Deficiencies (15%), some common examples include:
    - Technical data is wrong and/or missing (e.g. torque values)
    - Part number, diagrams, etc. are inaccurate and/or missing
    - Inspection criteria inadequate, missing, and/or inaccurate
Maintenance Mishaps Involving Publications Activity Breakout

- Inspection 31%
- Installation 23%
- Troubleshoot 10%
- Servicing 08%
- Repair 05%
- Removal 04%
- Assembly 04%
E6A Illustrated Parts Diagram Deficiency vs. Aircrew Glove

IPD Wins Hands Down!
Naval Aviation Technical Manual Status

(As of 6/14/00)

68% have not been totally revised in 10+ years

Source: NATEC Master Technical Manual Database
NATEC Technical Manual Status
As of 20 DEC 01

Outstanding Actions

- 2,761 Interim Rapid Action Changes (IRACs)
- 18,780 Tech Pub Deficiency Reports (including 218 CAT I)
- 5,683 Publications require update
### TPDs in Naval Aviation Maintenance

Mishaps Involved a Publications Problem

<table>
<thead>
<tr>
<th>Issue</th>
<th>#</th>
<th>%</th>
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<tbody>
<tr>
<td>Technical data is inaccurate or not established</td>
<td>134</td>
<td>46</td>
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<tr>
<td>Maintenance procedures unclear, incomplete or out of sequence</td>
<td>93</td>
<td>32</td>
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<tr>
<td>Inspection procedures are inadequate or not established</td>
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<td>18</td>
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<tr>
<td>Hazards/Warnings not included in maintenance procedures</td>
<td>13</td>
<td>4</td>
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(n=294)
Long-Term Strategic Initiative: Interactive Electronic Technical Manuals

- IETM Working Group
  - Working group est. November 2001
  - Navy Safety Center in the loop
  - Purpose: Eliminate/minimize stovepipe implementations
  - Program by Program review of digital implementations

- IETM Standard Viewer for Naval Aviation
  - Competitively procure an IETM viewer for Navy; Plan approved by PDASN(RDA)
Electronic Technical Documentation: Potential Opportunities and Pitfalls

- Conversion of traditionally paper-based technical documentation to electronic format
- Current state of technology
  - Most presently converted documentation exists as scanned *pdf* files
  - Current technologies lack sound human centric design principles, intelligent tutoring capabilities, user testing, and accepted mobility
- Electronic manuals can be tedious to use
  - Lowers efficiency and effectiveness of mechanics
- Little guidance exists to maximize the potential of electronic technical documentation (and what guidance that does exist is often ignored!)
Scanned Static Displays

- No interaction
- High memory load for user
- Difficulty navigating and keeping track
Dynamic Electronic Display

- Interactive, Facilitates troubleshooting
- Reduces memory load for user
- Easy to navigate and keep track
Human Factors Guidance: Search/Navigation

- **User’s require:**
  - “Breadcrumbs” or history paths between procedures and illustrations
  - More active linking between text and illustrations
- **Avoid potential to get lost in “hyperspace”**

![Diagram of a document structure with file and help options]
Human Factors Guidance: Portability and Operability

• Wearable/Mobile Displays
  – Permits point of use access to technical publications and technical information
  – Supports circumstances warranting primarily hands-free operation
  – Requires users tend to wear special gear and may inhibit fine motor operations
  – Lighting is variable, and may make readability an issue in some settings
Human Factors Guidance: Provide for Optimized HSI

- **Graphical User Interfaces (GUIs)**
  - Leave enough white space to tolerate user errors
  - Include status indicators that the system is working, cues for user action, acknowledgements, etc.

- **Typography**
  - Reserve use of all caps for headlines or emphasis
  - Increase text sizes to accommodate resolution increase
  - Point size alone is not the only indicator in sizing text
  - Consider phrase-sensitive spacing
Questions?

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