Maintenance Human Factors: Concepts & Challenges

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TWU/AA System Safety Meeting
Dallas, November 13 - 14, 2006
Agenda

- Human Factors Concepts – Key Examples
- Considerations & Topics for FAA HF Attention
- Selected 2005-2006 Accomplishments
- Future Challenges and Plans
Human Factors Spectacles
Agenda

Human Factors Concepts – Key Examples

Considerations & Topics for FAA HF Attention

Selected 2005-2006 Accomplishments

Future Challenges and Plans
Human Factors Goal – Simply Stated

Ensure continuing safety and efficiency by paying attention to issues surrounding human performance.
Maybe we all need some “thought control?”

Most of our errors are in thinking rather than lack of knowledge.

Think about your actions that may lead to error.

Save time and money?

Apply principles to life.
# Maintenance Errors and the Consequences

<table>
<thead>
<tr>
<th>Date</th>
<th>Company</th>
<th>Aircraft Model</th>
<th>Error Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan 2000</td>
<td>Alaska Airlines</td>
<td>Boeing MD-80</td>
<td>Jackscrew for Elevator Control</td>
</tr>
<tr>
<td>Mar 2001</td>
<td>Lufthansa Airbus</td>
<td>A320</td>
<td>Mis-wired side stick</td>
</tr>
<tr>
<td>Apr 2001</td>
<td>Emery Worldwide</td>
<td>DC-8</td>
<td>Reversed hyd. check-valve</td>
</tr>
<tr>
<td>Aug 2001</td>
<td>Air Transat</td>
<td>A310</td>
<td>Fuel exhaustion over Atlantic</td>
</tr>
<tr>
<td>May 2002</td>
<td>China Airlines</td>
<td>B747-200</td>
<td>In flight break-up at 35K Ft.</td>
</tr>
<tr>
<td>Jan 2003</td>
<td>Air Midwest</td>
<td>Beech1900D</td>
<td>Trim Rigging</td>
</tr>
<tr>
<td>Aug 2003</td>
<td>Colgan Air</td>
<td>Beech 1900D</td>
<td>Trim Rigging</td>
</tr>
<tr>
<td>July 2006</td>
<td>Spectrum Aircraft</td>
<td>Spectrum 33</td>
<td>Mis-Rigging</td>
</tr>
</tbody>
</table>
Boeing’s top 7 Errors 276 In-flight shutdowns (1994)

- Incomplete installation (33%)
- Damage on installation (14.5%)
- Improper installation (11%)
- Equipment not installed or missing (11%)
- FOD (6.5%)
- Improper troubleshooting, inspection, test (6%)
- Equipment not activated or deactivated (4%)
The 12 Common Human Errors

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Sensing and Perception

Human Senses

Human Factors
Human Factors
Human Factors
How to Remember the 5 Senses
What does this mean?

Proprietary graphic used with expressed permission of Lufthansa Technical Training (www.ltthf.com)

7 days per week  ×  24 hours per day  ×  365 days per year

ACTORS AFFECTING PERFORMANCE AND WORK ACTIVITY

Link
The Fatigue Issue is not New!

“O sleep, O gentle sleep, Nature’s soft nurse”

William Shakespeare

1564-1616
Types of Fatigue

Acute Fatigue
- Intense
- Short Duration
- Cured with a good night’s sleep

Chronic Fatigue (harder to fix)
- Frequent recurrence
- Long duration
- Slow recovery
- Often a physical sickness or mental stress causing chronic fatigue.

Proprietary graphic used with expressed permission of Lufthansa Technical Training (www.ltthf.com)
Percent of AMTs from All Shifts by Sleep Duration

Regarding sleep: Do what your mama told you.
Agenda

Human Factors?

Considerations & Topics for FAA HF Attention

Selected 2005-2006 Accomplishments

Future Challenges and Plans
How to define topics for Mx HF Attention

- Apply resources to high payoff opportunities
- Ensure that R&D can be applied, but do not ignore good science
- Attack present challenges with an eye to the future
- Communicate in plain language
How to Accomplish the Human Factors Goals

Attention to:

• people,
• the environment in which they work,
• the actions they perform,
• and the resources necessary to perform the work.
PEAR Details: People

- Physical Factors
  - Physical size
  - Sex
  - Age
  - Physical characteristics

- Strength

- Sensory limitations

- Physiological Factors

- Nutrition

- Health

- Lifestyle

- Fitness for Duty
  - Alertness
  - Chemical Dependence

- Workload

- Experience

- Knowledge

- Training/Certification

- Attitude

- Mental or emotional state

- Interpersonal conflicts

- Personal loss
## PEAR Details: Environment

<table>
<thead>
<tr>
<th>Physical Environment</th>
<th>Organizational Environment</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Weather</td>
<td>- Personnel</td>
</tr>
<tr>
<td>- Location inside/outside</td>
<td>- Supervision</td>
</tr>
<tr>
<td>- Workspace</td>
<td>- Union management relations</td>
</tr>
<tr>
<td>- Shift</td>
<td>- Pressures</td>
</tr>
<tr>
<td>- Lighting</td>
<td>- Crew structure</td>
</tr>
<tr>
<td>- Noise</td>
<td>- Size of company</td>
</tr>
<tr>
<td>- Safety</td>
<td>- Profitability</td>
</tr>
<tr>
<td></td>
<td>- Morale</td>
</tr>
<tr>
<td></td>
<td>- Culture</td>
</tr>
</tbody>
</table>
Agenda

- Human Factors?
- Considerations & Topics for FAA HF Attention
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- Future Challenges and Plans
• The Operator’s Manual for Human Factors in Aviation Maintenance (www.hf.faa.gov/opsmanual)
  • Plain Language Award
  • Published in 3 Languages
  • Widely – adopted by industry
  • Many website hits with document downloads 3000+

• Support of FAR 145 Rule with Guidance Material

• Study of language-related error in maintenance
### Introduction

This manual is in response to the industry's requests for a simple and manageable list of actions to implement a Maintenance Human Factors (MHF) program. A panel of experts selected the following six topics for such a program to be successful:

<table>
<thead>
<tr>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0 Event Investigation</td>
</tr>
<tr>
<td>2.0 Documentation</td>
</tr>
<tr>
<td>3.0 Human Factors</td>
</tr>
<tr>
<td>4.0 Shift/Task Training</td>
</tr>
<tr>
<td>5.0 Fatigue Management</td>
</tr>
<tr>
<td>6.0 Sustaining &amp; Acknowledgement</td>
</tr>
</tbody>
</table>
“Jackscrew assembly failure caused by excessive wear resulting from insufficient lubrication... contributing factors included extended lubrication and end-play check intervals, lack of available parts, organizational norms, regulatory oversight issues, etc.”

NTSB MAR-00/FINAL REPORT

EVENT INVESTIGATION

Chapter 1

“Mechanics would benefit from using Airliner Maintenance Manuals with more specific instructions for critical flight system procedures.”

NTSB/AR-01/00

DOCUMENTATION

Chapter 2

“Shift / Task Turnover

Chapter 4

“A combination of 16 hours of straight work compounded by influenza contributed to fatigue and falling asleep at the wheel...”

AIRPORT INTERNAL REPORT

FATIGUE MANAGEMENT

Chapter 5

“...various initiatives come and go sometimes based on corporate whim... a sustainable maintenance human factors program must have shared support from senior management and all levels of company personnel... the program must show value in continuing safety, worker job satisfaction, and cost control...”

W.E. JOHNSON, FAA

SUSTAINING & JUSTIFYING AN HF PROGRAM

Chapter 6

AmericanAirlines' Training & Conference Center

a DOLCE Conference Destination

Federal Aviation Administration
6.0 Sustaining & Justifying an HF Program

6.6 Key References

A. Sustaining & Justifying an HF Program presentation (Download Document).


Introduction

This manual is in response to the industry's requests for a simple and manageable list of actions to implement a Maintenance Human Factors (MHF) program. A panel of experts selected the following six topics for such a program to be successful:
FAA HF Guidance for Part 145

• FAA AC 145-10, Ch. 3, §301(c)

• The FAA **concurs** with European Authorities in that human factors training related to maintenance practices would provide an additional margin of safety to the repair industry;

• A human factors training program should be related to **maintenance practices** where possible;

• At this time it is recommended. **It is not an FAA regulation.**

• EASA Certificate holder’s must follow EASA rules
Language Error Study

1000 participants: Asia, Latin America, Europe and US.

Main Findings
• Language errors exist but typically found early

• High Accuracy everywhere: Non-native English speakers typically go slower but maintain accuracy

Main Recommendations
• Deliver more specialized language training.
• Provide and translation (full & partial).
- International Conference (ATA)

- Unmanned Aerial Systems (NASA)

- International Survey on HF in Maintenance (CAMI)
Survey Goals and Methods

- **Purpose**: Assess status of maintenance HF
- **Focus**: program support and motivation, organizational policies, fatigue management, error management, and training.
- **Distribution**: Online survey (80 items) 630 addresses.
- **Returns**: 414 respondents (66%) from 54 countries.
- **Experience**: 65% > 20 yrs. maintenance experience.
Respondent Representation

54 Countries
414 Total Respondents
Where do you work?

- Air Maint: 35.0%
- Repair Stn: 8.9%
- Manufacturer: 5.6%
- Mil/Govt: 10.1%
- School/Trn: 8.2%
- Other: 4.8%
- Total: 27.3%
Which is the primary regulatory authority your maintenance operations are designed to be in compliance with?  N=404

<table>
<thead>
<tr>
<th>Regulatory Authority</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Civil Aviation Safety Authority (CASA) N=19</td>
<td>4.7%</td>
</tr>
<tr>
<td>European Aviation Safety Agency (EASA) N=95</td>
<td>23.5%</td>
</tr>
<tr>
<td>Federal Aviation Administration (FAA) N=182</td>
<td>45%</td>
</tr>
<tr>
<td>Transport Canada N=36</td>
<td>8.9%</td>
</tr>
<tr>
<td>Other National Aviation Authority N=72</td>
<td>17.8%</td>
</tr>
<tr>
<td>Topic</td>
<td>ICAO</td>
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<tr>
<td>------------------------------------------------</td>
<td>--------------</td>
</tr>
<tr>
<td>HF for Initial Certification</td>
<td>Annex 1</td>
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<tr>
<td>Continuation Training for HF</td>
<td>Annex 6</td>
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<tr>
<td>Error Management System</td>
<td>Guidance</td>
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<tr>
<td>Fatigue Management System</td>
<td>Guidance</td>
</tr>
<tr>
<td>Accountable Executive</td>
<td>No</td>
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<tr>
<td>Published HF Guidance Materials</td>
<td>Doc 9683-AN/950</td>
</tr>
<tr>
<td>Documentation Reporting Requirement</td>
<td>Guidance</td>
</tr>
<tr>
<td>Procedural Non-compliance</td>
<td>Guidance</td>
</tr>
<tr>
<td>Planning of tasks, equipment, and spares</td>
<td>Guidance</td>
</tr>
<tr>
<td>Shift and task handover</td>
<td>Guidance</td>
</tr>
<tr>
<td>Error capturing (duplicate inspections)</td>
<td>Guidance</td>
</tr>
</tbody>
</table>
Regulatory Support and Close Work

![Bar chart showing % Agreement for different agencies]

- CASA
- EASA
- FAA
- Transport Canada
- Other NAA

TWU/American Airlines System Safety Meeting
Dallas, TX
November 14, 2006
Fatigue is “Important” but few programs

- Impact of fatigue was recognized by 82.1%.

- Fatigue Management System
  - Overall, 25% have a fatigue management system.

- Training on Fatigue Management
  - 35.9% provide training on fatigue management.

![Bar chart showing the percentage of compliance with the system and training on fatigue management across different organizations.](chart.png)
Transport Canada and EASA have HF Training

![Bar chart showing the percentage of respondents in different categories across different aviation authorities.](chart.png)
• Web-Based Surveillance and Auditing Tool (WebSAT)

• Revised Training Course for FAA Inspectors

2 Days  →  3 Days
Highly Revised!
Additional Selected 2006 Activity

- Rewrite of “Human Factors Guide for Maintenance and Inspection.”

- Revive “hfskyway.faa.gov”

- AFS Mx Human Factors Plan
Agenda

Describe an ideal HF Mx & Ramp Safety Conference

Considerations & Topics for FAA HF Attention

Selected 2005-2006 Accomplishments

Future Challenges and Plans
Challenges

• Maintenance HF Regulations: 25, 65, 121, 135, 145, 147.

• Fatigue R&D? Guidance? Regulation?

• Advanced Technologies, VLJs, Rotorcraft, UAVs, Avionics, Commercial Space travel, Aging Aircraft, …..

• Ensuring Quality & Safety in all Maintenance Organizations

• General Aviation Maintenance HF

• SMS in Maintenance
Agenda

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Q&A (Time permitting)

Thank you