Human Factors and Fatigue: Progress and Products

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Chief Scientific & Technical Advisor for Human Factors in A/C Maintenance Systems
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AVS Organization

Over 7,200 Employees dedicated to Aviation Safety
<table>
<thead>
<tr>
<th>Chief Scientist Specialties (21)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aeronautical Communications</td>
</tr>
<tr>
<td>Advanced Avionics &amp; Electrical</td>
</tr>
<tr>
<td>Advanced Composite Materials</td>
</tr>
<tr>
<td>Advanced Control Systems</td>
</tr>
<tr>
<td>Aircraft Computer Software</td>
</tr>
<tr>
<td>Aircraft Safety Analysis</td>
</tr>
<tr>
<td>Crash Dynamics</td>
</tr>
<tr>
<td>Electromagnetic Interference</td>
</tr>
<tr>
<td>Engine Dynamics &amp; Safety</td>
</tr>
<tr>
<td>Fatigue and Damage Tolerance</td>
</tr>
<tr>
<td>Flight Deck Human Factors</td>
</tr>
</tbody>
</table>
Presentation Plan

- How to See and Recall HF Basics
- Alertness / Fatigue (with interventions)
- Questions and Discussion
Use “Special” Spectacles to see Human Factors
• **People** who perform the job

• **Environment** for work - Organizational and physical

• **Actions** (tasks) performed as part of the job

• **Resources** like equipment, tools, procedures, and more
Example People Topics

Physical
- Size
- Gender
- Age
- Strength
- The five senses

Physiological
- Health
- Nutrition
- Lifestyle
- Alertness/fatigue
- Chemical dependency

Psychological
- Experience
- Knowledge
- Training
- Attitude
- Emotional state

Psychosocial
- Interpersonal relations
- Ability to communicate
- Empathy
- Leadership
- Professionalism
Workshop to identify HF problems*

30 Participants

FAA

AFS
AIR
CAMI

Non-FAA

MRO (1)
OEM (2)
NTSB (1)
Transport Canada (1)

*Conclusions not necessarily endorsed by organizations
### The “Top 8” Mx HF Challenges*

<table>
<thead>
<tr>
<th>Pre-Workshop Ranking</th>
<th>Post-Workshop Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fatigue/Alertness</td>
<td>1 Use of Technical Pubs</td>
</tr>
<tr>
<td>Technical Knowledge/Skill</td>
<td>2 Fatigue/Alertness</td>
</tr>
<tr>
<td>Return-on-Investment</td>
<td>3 Safety Culture</td>
</tr>
<tr>
<td>Complacency/ Tech Pubs</td>
<td>4 Event Reporting Data (MEDA, LOSA, ASAP)</td>
</tr>
<tr>
<td>Workplace Pressure</td>
<td>5 Return-on-Investment</td>
</tr>
<tr>
<td>Shiftwork</td>
<td>6 Establish HF as Priority</td>
</tr>
<tr>
<td>Safety Culture</td>
<td>7 Professionalism (Gen gaps, etc.)</td>
</tr>
<tr>
<td>General Work Environs</td>
<td>8 Required Inspection Items</td>
</tr>
</tbody>
</table>

*Based on Rank Order
## Comparing Mx HF Challenges in US and European Union

<table>
<thead>
<tr>
<th>EASA Group</th>
<th>North American</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measure effectiveness of HF</td>
<td>1 Use of Technical Pubs</td>
</tr>
<tr>
<td>Expand HF to all Mx Organiz.</td>
<td>2 Fatigue/Alertness</td>
</tr>
<tr>
<td>Fatigue Risk Management</td>
<td>3 Safety Culture</td>
</tr>
<tr>
<td>Address Organiz. Factors</td>
<td>4 Event Reporting Data (MEDA, LOSA, ASAP)</td>
</tr>
<tr>
<td>Improving Reg. Oversight</td>
<td>5 Return-on-Investment</td>
</tr>
<tr>
<td></td>
<td>6 Establish HF as Priority</td>
</tr>
<tr>
<td></td>
<td>7 Professionalism (Gen gaps, etc.)</td>
</tr>
<tr>
<td></td>
<td>8 Required Inspection Items</td>
</tr>
</tbody>
</table>

*Based on Rank Order*
Suggestions from Fatigue Workshop

1. Public Relations (Mantra, HAI & ATA, Case for change, Promotional campaign)

2. Fatigue Education (For maintainers, in schools, and for families)

3. Hours of Service Limits (Duty time limit changes)

4. Fatigue Risk Management System (FRMS) (Fitness-for-duty policy and responsibility)

*Based on Rank Order
5. Fatigue Assessment Tools

6. Accountability in SMS for ignoring HF (Integrate FRMS with SMS)

7. Get sleep history from LOSA data (Collect ASAP data for risk analysis)
Presentation Plan

How to See and Recall HF Basics

- Alertness / Fatigue (with interventions)

- Questions and Discussion
## Fatigue as a Contributing Factor?

<table>
<thead>
<tr>
<th>Date</th>
<th>Flight</th>
<th>Location</th>
<th>Ftl.</th>
<th>Contributing Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>06/99</td>
<td>AAL 1420</td>
<td>Littlerock, AR</td>
<td>13</td>
<td>Pilot awake for 31 hrs, First Officer on a 3-day, 6-leg sequence</td>
</tr>
<tr>
<td>01/03</td>
<td>Air Midwest 5481</td>
<td>Charlotte, NC</td>
<td>21</td>
<td>Flight Control Misrigging</td>
</tr>
<tr>
<td>10/04</td>
<td>Corporate Airlines 5966</td>
<td>Kirksville, MO</td>
<td>13</td>
<td>CRM, Extended hour, minimum rest, tough schedule, 6th flight segment</td>
</tr>
<tr>
<td>08/06</td>
<td>Comair 191</td>
<td>Lexington, KY</td>
<td>49</td>
<td>Wrong runway for take-off, early AM</td>
</tr>
</tbody>
</table>
“Since no serious person would dismiss potentially detrimental consequences of fatigue to aviation, continuing studies of fatigue are being conducted. Time changes, equipment changes, and responsible monitoring of altered conditions in relation to fatiguing factors is a ‘communal’ requirement of those engaged in aviation” (Mohler, 1965).
“Fatigue is a serious challenge in aviation for many reasons.

We have to do something about it!”

(Bill Johnson, Now!)
FAA Fatigue Studies by Scientific Specialty:

Auditory fatigue
Fatigue and Stress
Cariorespiratory Assessment of Decongestants-Antihistamine on Altitude, +Gz and Fatigue Tolerance

Effects of prior physical exertion on tolerance to Hypoxia, Orthostatic Stress, & Physical Fatigue
Blink rate as a Measure of Fatigue
Effects of Alcohol on Fatigue
Shiftwork, Age, and Performance in ATC
Effect of Maintenance Working Environments on fatigue
Ocular Correlates of Fatigue
Shift Rotation Assessment
Predicting Fatigue with Voice Analysis
Analysis on incident reports and surveys
Training, scheduling, measuring, and other interventions

60s - 80s
90s
2000s
We know

• What fatigue is
• What causes it
• How to measure it
• How it affects performance, generally and specifically

• What are the countermeasures
• That proper schedules for quality sleep are critical
• That personal responsibility is important
Who must take action?

- Company
- Regulator
- Labor
- Science
- Fatigue Management
The Next Steps

• Generate a “Collective Will” to address fatigue challenges

• Improve investigative techniques related to fatigue/fitness for duty

• Create and implement the interventions

• Validate real-time fatigue assessment technologies & countermeasures

• Regulate/Guide FRMS

• Measure the impact of FRMS

• Reinforce the business/safety case for proper rest
Presentation Plan

How to See and Recall HF Basics

• Alertness / Fatigue *(with interventions)*

• Questions and Discussion
From www.mxfatigue.com

2+ hrs. of web-based training on fatigue

Award-winning 20 minute fatigue video

Web-based fatigue assessment software

Return on Investment software

Order DVDs and more…
Utilize Available Resources

- Fatigue Countermasure Training

Click on the button to launch the desired lesson, video, or course exam. Note: you should complete all lessons before attempting the course exam.

- Video: Grounded
- Lesson 1: Fatigue Basics
- Lesson 2: Sleep Basics
- Lesson 3: Fatigue Management Strategies
- Course Exam
FAA Fatigue Awareness Video

Go to www.mxfatigue.com
From www.mxfatigue.com

- 2+ hrs. of web-based training on fatigue
- Award-winning 20 minute fatigue video
- Web-based fatigue assessment software
- Return on Investment software
- Order DVDs and more…
### Overview

- This is a prototype tool being developed with the support of the FAA to assess fatigue related risk in aviation operations.

- The tool can be used to record incident data, and to give feedback regarding fatigue levels and incident risk.

### Usage Guidelines

- To assess fatigue, you must enter sleep and work history over a period of several days.

- If you are reporting an incident, you should provide details of the incident.

- After you submit your data, a fatigue risk report will be generated. You can print or save the report.
**User Information**

<table>
<thead>
<tr>
<th>Airport Closest to Residence</th>
<th>IATA</th>
<th>ICAO</th>
<th>Airport Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Typical Work Commute</td>
<td>hrs</td>
<td>min</td>
<td></td>
</tr>
<tr>
<td>Typical Sleep Period on Non-Work Days</td>
<td>Time to Bed</td>
<td></td>
<td>Time Out of Bed</td>
</tr>
</tbody>
</table>

**Are You Reporting An Incident?**

- [ ] No
- [ ] Yes

**Work And Sleep History**

In order to generate a fatigue assessment for a work shift of interest, please describe the work and sleep history during the 72 hours prior to the end of that work shift.

- **Work History** - Please enter the work shift of interest, and all work shifts during the previous 72 hours. Check the N/A box if you did not work a shift during that day.
- Location should correspond to the shift start location and all times should be specified in that timezone.

<table>
<thead>
<tr>
<th>Shift of interest</th>
<th>Location</th>
<th>Work Start Date</th>
<th>Work Start Time</th>
<th>Work End Date</th>
<th>Work End Time</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>&lt;M/d/yyyy&gt;</td>
<td>15</td>
<td>&lt;M/d/yyyy&gt;</td>
<td>15</td>
</tr>
<tr>
<td>Shift 1 day prior</td>
<td>N/A</td>
<td>&lt;M/d/yyyy&gt;</td>
<td>15</td>
<td>&lt;M/d/yyyy&gt;</td>
<td>15</td>
</tr>
<tr>
<td>Shift 2 days prior</td>
<td>N/A</td>
<td>&lt;M/d/yyyy&gt;</td>
<td>15</td>
<td>&lt;M/d/yyyy&gt;</td>
<td>15</td>
</tr>
</tbody>
</table>
Work And Sleep History

Hours worked in the last 24 hours: 12.0 hrs.
Hours worked in the last 48 hours: 24.0 hrs.
Hours worked in the last 72 hours: 36.0 hrs.
Total hours worked: 36.0 hrs.

Hours slept in the last 24 hours: 4.0 hrs.
Hours slept in the last 48 hours: 11.0 hrs.
Hours slept in the last 72 hours: 11.0 hrs.
Total hours slept: 26.0 hrs.

Typical Commute and Sleep Times

Typical work commute: 0 hrs. 30 min.

Typical sleep period on non-work days:
Time to bed: 23:00
Time out of bed: 07:00
Duration of sleep period on non-work days: 8.0 hrs.

Fatigue Estimate

Work And Sleep History (GMT-4)

[Graph showing work and sleep history with dates from 09/23/2011 to 09/27/2011]
Fill in the Blanks for ROI

\[
\text{NET RETURNS (Benefit)} = \left( \frac{\text{ESTIMATED RETURN (Benefits)}}{\text{PROBABILITY OF SUCCESS}} \right) - \text{INVESTMENT (Cost)} = \text{RETURN ON INVESTMENT (ROI)}
\]
Projects are always faced with things that can go wrong. This step will help identify potential risks to the project and what can be done to improve your probability of success.
### Estimate Investments - "How much will the project spend?"

#### A: Select the types of employees involved in the project and input their estimated salary, and how much time they will spend

<table>
<thead>
<tr>
<th>Role for Each Type of Employee on the Project</th>
<th>Notes About Employees' Roles</th>
<th>Hourly Employee Salary</th>
<th># of Employees on the project</th>
<th># of Hrs./Employee</th>
<th>Total Labor Hours</th>
<th>Total Safety Interv</th>
<th>Labor Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Technician</em></td>
<td>Painting</td>
<td>$25.00</td>
<td>30</td>
<td>100</td>
<td>3,000</td>
<td>$75</td>
<td></td>
</tr>
<tr>
<td><em>Manager</em></td>
<td><em>Equipment Supervisor</em></td>
<td>$32.50</td>
<td>10</td>
<td>15</td>
<td>150</td>
<td>$4</td>
<td></td>
</tr>
<tr>
<td><em>Equipment Technician</em></td>
<td>Rework ground equipment</td>
<td>$27.50</td>
<td>7</td>
<td>375</td>
<td>6,125</td>
<td>$168</td>
<td></td>
</tr>
<tr>
<td><em>Personnel</em></td>
<td><em>Revise Procedures</em></td>
<td>$15.00</td>
<td>10</td>
<td>50</td>
<td>500</td>
<td>$7</td>
<td></td>
</tr>
<tr>
<td><em>Visor</em></td>
<td><em>Revise Procedures</em></td>
<td>$30.00</td>
<td>3</td>
<td>40</td>
<td>120</td>
<td>$3</td>
<td></td>
</tr>
<tr>
<td><em>Support</em></td>
<td>Publish procedures</td>
<td>$12.50</td>
<td>4</td>
<td>40</td>
<td>160</td>
<td>$2</td>
<td></td>
</tr>
<tr>
<td><em>Personnel</em></td>
<td>Training for revised procedures</td>
<td>$15.00</td>
<td>2,000</td>
<td>2</td>
<td>4,000</td>
<td>$60</td>
<td></td>
</tr>
<tr>
<td><em>Visor</em></td>
<td>Training for revised procedures</td>
<td>$30.00</td>
<td>250</td>
<td>2</td>
<td>500</td>
<td>$15</td>
<td></td>
</tr>
<tr>
<td><em>Specialist</em></td>
<td>Develop and deliver training</td>
<td>$27.50</td>
<td>5</td>
<td>300</td>
<td>4,500</td>
<td>$123</td>
<td></td>
</tr>
<tr>
<td><em>Team</em></td>
<td>Develop incentive program</td>
<td>$67.50</td>
<td>8</td>
<td>40</td>
<td>320</td>
<td>$21</td>
<td></td>
</tr>
<tr>
<td><em>Visor</em></td>
<td>Training for new incentive program</td>
<td>$30.00</td>
<td>250</td>
<td>2</td>
<td>500</td>
<td>$15</td>
<td></td>
</tr>
</tbody>
</table>

**Total Labor Investment**

- 2,581
- 2,102
- 20,019
- $500

#### B: Input how much money will be spent on Non-Labor

<table>
<thead>
<tr>
<th>Investment Category</th>
<th>Notes About Investment Categories</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
# Project Summary: What is the total cost and benefit of the project?

## 1. Project Cost Summary

<table>
<thead>
<tr>
<th>Cost Category</th>
<th>2011 Q4</th>
<th>2012 Q1</th>
<th>2012 Q2</th>
<th>2012 Q3</th>
<th>2012 Q4</th>
<th>2013 Q1</th>
<th>Total Investment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labor</td>
<td>$173,140</td>
<td>$210,800</td>
<td>$48,688</td>
<td>$33,688</td>
<td>$33,688</td>
<td>-</td>
<td>$500,003</td>
</tr>
<tr>
<td>Facilities Technician</td>
<td>$75,000</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>$75,000</td>
</tr>
<tr>
<td>Facilities Supervisor</td>
<td>$4,875</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>$4,875</td>
</tr>
<tr>
<td>Ground Equipment Technician</td>
<td>$33,688</td>
<td>$33,688</td>
<td>$33,688</td>
<td>$33,688</td>
<td>$33,688</td>
<td>-</td>
<td>$168,438</td>
</tr>
<tr>
<td>Ramp Personnel</td>
<td>$7,500</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>$7,500</td>
</tr>
<tr>
<td>Supervisor</td>
<td>$3,600</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>$3,600</td>
</tr>
<tr>
<td>Clerical Support</td>
<td>$2,000</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>$2,000</td>
</tr>
<tr>
<td>Ramp Personnel</td>
<td>-</td>
<td>$60,000</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>$60,000</td>
</tr>
<tr>
<td>Supervisor</td>
<td>$1,500</td>
<td>-</td>
<td>$13,600</td>
<td>$92,813</td>
<td>-</td>
<td>-</td>
<td>$15,000</td>
</tr>
<tr>
<td>Training Specialist</td>
<td>$30,938</td>
<td>$92,813</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>$123,750</td>
</tr>
<tr>
<td>Management Team</td>
<td>$10,800</td>
<td>$10,800</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>$21,600</td>
</tr>
<tr>
<td>Supervisor</td>
<td>$3,240</td>
<td>-</td>
<td>-</td>
<td>$15,000</td>
<td>-</td>
<td>-</td>
<td>$15,000</td>
</tr>
<tr>
<td>Misc</td>
<td>$3,240</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>$3,240</td>
</tr>
<tr>
<td>Non-Labor</td>
<td>$487,500</td>
<td>$200,000</td>
<td>$250,000</td>
<td>$250,000</td>
<td>$212,500</td>
<td>$100,000</td>
<td>$1,500,000</td>
</tr>
<tr>
<td>Facilities</td>
<td>$250,000</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>$250,000</td>
</tr>
<tr>
<td>Tools</td>
<td>$187,500</td>
<td>$150,000</td>
<td>$150,000</td>
<td>$150,000</td>
<td>$112,500</td>
<td>-</td>
<td>$750,000</td>
</tr>
<tr>
<td>Incentive Program</td>
<td>$50,000</td>
<td>$50,000</td>
<td>$100,000</td>
<td>$100,000</td>
<td>$100,000</td>
<td>$100,000</td>
<td>$500,000</td>
</tr>
</tbody>
</table>

IHSS 2011
Fifth International Helicopter Safety Symposium
November 8-11, 2011
Worthington Renaissance Hotel, Fort Worth, Texas USA
Probability of Success - "How likely will the Returns be realized?"

**Part A:** Enter a score based on your best assessment of how the project will be managed.

<table>
<thead>
<tr>
<th>Success Categories</th>
<th>Select Score 1-5:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Prior Experience</strong></td>
<td></td>
</tr>
<tr>
<td>1. At least one person on the project team has a working knowledge and experience with Project Management processes</td>
<td>5</td>
</tr>
<tr>
<td>2. At least half of the project team has successfully completed more than two projects of similar size and function</td>
<td>4</td>
</tr>
<tr>
<td>3. The project has been sufficiently resourced and the team is sufficiently competent</td>
<td>3</td>
</tr>
</tbody>
</table>

**Leadership and Customer**

6. The project has defined roles and responsibilities for customer, leadership, and project team members
7. The project has a sponsor with budget authority
8. The customer and project team have agreed to readily identifiable deliverables and success criteria
9. Leadership and the customer agree to participate in all milestone project review meetings
10. Leadership and the customer agree to sign-off deliverables according to the predefined success criteria
11. Leadership and the project team agree the project plan meets SMART (Specific, Measurable, Achievable, Relevant, and Time-bound) metrics | 9 |
12. Leadership and the project team agree that appropriate milestones have been built into the project plan | 3 |
13. Leadership and the project team have developed and approved a risk log with contingencies | 4 |
14. A communications plan has been developed and will be implemented to inform stakeholders of progress | 5 |

**Sub-section average score:** 4.2

**Probable returns - "How much of the estimated Returns will be realized?"**

80%
Investments and Returns Over Time

100% Return
From www.mxfatigue.com

- 2+ hrs. of web-based training on fatigue
- Award-winning 20 minute fatigue video
- Web-based fatigue assessment software
- Return on Investment software
- Order DVDs and more…
Presentation Plan

- How to See and Recall HF Basics
- Alertness / Fatigue (with interventions)

- Questions and Discussion

Thank you,

Bill Johnson
FRMS Process

a. Measure and Assess Current Conditions
b. Modeling and Analysis of Fatigue Risk
c. Manage and Mitigate Fatigue Risk
d. Assessment and Feedback